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Impact of Think–Pair–Share Strategy in Robot-Assisted Language Learning Classrooms

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Abstract

This study inspects the pedagogical efficacy of the Think–Pair–Share (TPS) collaborative framework for enriching the English language proficiency skills of Saudi secondary school students. The research was conducted within the Southern Province of Saudi Arabia in Robot-Assisted Language Learning (RALL) classrooms. An experimental pre-test/post-test research design was employed to collect a sample of 120 Grade 10 English as an Academic Language (EAL) learners via purposive sampling from three international secondary schools. The members were divided into two sets: an experimental group (n=60), which engaged in RALL curriculum facilitated by the TPS approach, and a control group (n=60), which received RALL teaching via traditional, non-collaborative methods. Data extraction was performed through inferential statistical analysis using SPSS (Version 27) with a focus on evaluating inter-group and intra-group variation in performance. The empirical outcomes demonstrated that the experimental group achieved higher scores in their post-intervention assessment in contrast to the control group. The findings validated that the initiation of the TPS model within RALL classrooms enhances English language acquisition. The study posits that the mere addition of robots for teaching inside the classroom can be ineffective for all-inclusive language development, requiring accompanying this with effective teaching strategies.

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Introduction

Traditional education is still persisting around the globe. Teachers are all-rounders as they set the pace, decide what is taught, and keep a close eye on how progress unfolds (Heinz, Rory & Keane, 2025). In these settings, students mostly act as passive receivers of information as they are expected to digest what is handed to them. They cannot build or shape their own understanding. These old-school methods do spread knowledge, but research shows they do not line up well with the actual needs of today's students (Ali et al., 2025b). Students today want more activities, conceptual understanding, and ownership of their own learning. In the traditional setup, though, students have little say. They are just receivers, not creators (Williams, 2025).

Lately, education has started to shift towards inventiveness. There is a growing push toward letting students take the lead, working together, and jumping into varied activities more actively. This change matters, especially now that technology and digital and inventive learning environments have been extensively used in modern classrooms. Despite the integration of technology, still learners can feel isolated or disconnected. It may be because along with the integration of modern technological tools, it is pivotal to have modern teaching strategies along with them. That is where Think–Pair–Share (TPS) steps in. TPS gets students to think on their own, bounce ideas off a partner, and engage in conversations. It activates peer involvement, collaborative thinking, and group work (Sun, 2025).

21st-Century Competencies vs Collaborative Learning

One major shift in 21st-century education is incorporating innovative skills into the learning experience. Students need to move across subjects and disciplines to cope with today's fast-changing world (Wang & Zhu, 2025). Institutes now focus on building the thinking skills needed by students to manage these rapid technological changes. Researchers constantly stress that mastering these skills is key to thriving in our connected society. One key skill is collaboration. Working and learning in a group is not only helpful, but it is also at the core of learning (Chiu & Rospigliosi, 2025).

Collaboration specifically matters in language classrooms. When students solve problems or tackle tasks as a team, they learn more and receive better results (Rajaram, 2023). Out of the 4Cs, that is, creativity, critical thinking, communication, and collaboration, collaboration is the 21-st century skill that sets people up for success in school and the professional life. Working with others builds real-life people skills. Group work also motivates students to speak up and become involved, no matter what background they have (Konkaew, Dhammapissamai & Suksen, 2025).

Think-Pair-Share (TPS)

Collaborative learning is conditioned with some techniques in EL classrooms. One standout technique is TPS, which was shared by Lyman in 1981 (Wu, Hapsari & Huang, 2025). TPS gets everyone talking. It builds social skills, helps students communicate, and keeps them engaged. Recently, teachers have employed TPS even more

because it encourages everyone to join in and helps cut down on anxiety (Simon, 2025). It encourages them to share their ideas and take responsibility for their learning (Samaila et al., 2025).

TPS works according to the following structure. First, the teacher asks a question and gives everyone a minute to think about it on their own (Think). Next, students pair up and discuss their thoughts or decide on answers together (Pair). Finally, each pair shares their outcomes within a bigger group or with the whole class (Share) (Mohamad et al., 2025). This step-by-step structure provides students with the opportunity to practice without feeling stressed or overwhelmed. It acts like a conversation with a classmate at first, so it feels safer and less intimidating.

Nowadays, TPS has received a boost from digital tools. Technology helps teachers and students access materials and understand new concepts (Turgut et al., 2025). For example, teachers might play a YouTube video to help explain a topic (Yang, Lei & Niu, 2026), while students can use mind-mapping apps or digital platforms like Google Workspace to organize their ideas and work together during discussions (Ekström, Pareto & Ljungblad, 2025). Other creative tools can be integrated to help students learn new languages, like using robots (Zhong, Liu & Huang, 2023). Even when learning from home, students can still build English language skills through TPS by thinking on their own, talking in pairs, and sharing with a group by making use of online features like comment sections and discussion forums (Schina, Romero & France, 2025).

Robot-Assisted Language Learning (RALL)

RALL refers to using social robots to facilitate learning language skills for students such as speaking, writing, reading, and comprehension. Social robots are good at copying human interactions and can take on different social roles, which helps students feel more at ease. They can also tailor their support to fit each learner's skill level and offer feedback that actually feels personal (Yaqin, 2025). RALL is one of many modern approaches adopted by Saudi Arabia as a result of governmental efforts to transform education programs to cope with the global needs (Ali et al., 2025a). Earlier studies have shown that RALL helps with vocabulary, pronunciation, and reading (Iio et al., 2024).

Despite the evident progress in education, English learners still face some challenges. They do not receive enough opportunities to use English in real-life conversations (Li, Kang & Liu, 2025). Their motivation therefore becomes negatively impacted (Derakhshan et al., 2025). In addition, the inclusion of modern processes like RALL can be a disadvantage as the way robots deliver lessons can be a change of face but not a change of methods (Wu & Li, 2024). They do not always match how students learn. Therefore, any technology must embrace some interesting classroom strategies to increase learners' motivation, confidence, participation, and understating.

Reviewing the whole scene, there is not much research that looks at integrating attractive teaching strategies to enhance the impact of using robots in English learning. This study aims to address that gap. It combines the TPS strategy with RALL in Saudi English as an Academic Language (EAL) classrooms to find out the extent to which this integration is viable.

Statement of the Problem

Sticking to old-school teaching methods has negatively affected how well students learn. Motivation, engagement, and teamwork are not away from the negative effect as well. Now, with everyone turning to technology in the classroom, there are fresh tools and new ways to teach. Some of these have proved to be promising. Still, they may take away from real, person-to-person conversations. Relying too much on apps, chatbots, and automated platforms means less human interaction. This harms the collaborative work needed to learn a language. Students who cannot communicate well consequently have weaker grades and low confidence. This gets even worse at the secondary school level, where huge class sizes make it almost impossible for teachers to give individual feedback or support. Hence, following the technology trend, that is, the insertion of technological tools, is not the only way to achieve better learning. These tools must be combined with effective strategies and techniques to enhance learning.

Significance of the Study

This study stands out because it highlights how important it is to keep peer-to-peer conversations alive, even in high-tech RALL environments. It calls for a balance between human involvement and technology, showing that collaboration still matters, no matter how many digital tools we have. Bringing in the TPS strategy in these settings can prove that the best learning happens when we mix new technology with strong, interactive teaching methods.

Research Question

The study attempts to answer the following research question:

- What impact does the Think–Pair–Share (TPS) strategy create on learners' performance within a Robot-Assisted Language Learning (RALL) environment?

Literature Review

The Origin of Educational Robotics

Using robots as teaching assistants is no longer a futuristic idea. It is a reality that has become a hot topic in education (Ryalat et al., 2025). Studies show that robotics helps tackle learning challenges. Papert (1993), for instance, believes that students learn best when they feel independent and able to build structures on their own, like robots. Robots have witnessed major updates due to the recent advancements in communication technology (Albedah, 2025). At first, people mostly used robots in science classes. Now, however, more and more research is studying using robots in learning a language, or RALL. These robots come with a toolkit of speech recognition, text-to-speech, smart filters, and so on. They can deliver information in attractive ways. Students get more involved, which lowers the emotional barriers that usually face language learners (Huertas-Abril & Palacios-Hidalgo, 2025).

Robotic classrooms are different compared to traditional classrooms. There is instant feedback, smoother blending

of digital and real-world learning, and many opportunities for students to take charge. Moreover, robots help everyone stay connected; that is, parents, teachers, and students can all have better engagement by making use of the capabilities robots offer (Liu, Zhang & Yang, 2025).

Functional Features of Robots

Robotic agents are equipped with unique features that help people learn languages faster. To begin with, robots do not feel tired or bored; they can repeat the same language tasks while always keeping the same level of performance (Howard et al., 2025). That means learners get a plethora of verbal drills, which is much needed when trying to master a new language. One can also program robots to adjust lessons without prior preparation (Chu & Cabibihan, 2025). They can tailor the curriculum to match each student's skills and needs, addressing the zone of proximal development, or the gap between what a learner can do independently and what they can do with the guide of a mentor. In addition, robots keep everything digital. Every lesson and every step of progress are all tracked and stored, making it easy to see how students grow over time. Many robots nowadays also have human-like shapes and use gestures or movements, which makes students curious and helps lower anxiety (Kang & Kim, 2025). That kind of environment makes them more comfortable speaking up in the target language. Finally, the integration of modern technology like automated speech recognition and AI allows robots to handle any conversation. Instead of producing ready-made responses, they interact in real-time and provide corrective feedback even when learner input contains syntactic or phonological errors (Banko, Leoste & Öun, 2025).

Critical Challenges and Systemic Limitations in RALL

Despite the exponential development in technology, robots in education still face some serious impediments. First, schools and technology developers need a solid plan for working together, especially when it comes to customizing robots for classrooms. The missing element is the strong Human-Robot Interaction (HRI) models built on what we know about second and foreign language learning (Cheng et al., 2025).

What is more, more studies are needed that compare RALL to traditional teaching. Further, ethics and data privacy are strong areas of concern. Like any technological tool, it might be abused when there is lack of awareness and terms of use. Another limitation is that students may rely too much on robots, leading to abandonment to human teachers. Nevertheless, the biggest problem could be that robots can try to replicate humans but they are not systemized to instruct various learning strategies that can elevate motivation in learning. Further, working with robots may harm peer and group work. They are more likely to take control of the classroom, and that stands against group conversations and peer interaction (Deng et al., 2024).

Integrating Cooperative Learning: TPS

How well RALL works depends on the teaching approach behind it. Older classrooms might not have the up-to-date approaches needed for today's classrooms. That is where TPS comes in. It is a hands-on, cooperative strategy to get students involved. With TPS, robot-assisted lessons can be divided into three steps: first, students receive

instruction from the robot, and they think on their own; then, students have a discussion with a partner; finally, the whole class shares ideas together. It helps students think deeper and build their own understanding (Wu, Hapsari & Huang, 2025).

TPS is not exactly new. Lyman introduced it back in 1981 (as in Pacala, 2025) to boost student engagement by mixing individual reflection with peer discussion. Unlike the teacher-centered model, TPS follows social constructivism (Vygotsky, 1978, as in Hausfather, 1996). This means that students learn better when they talk together, solving problems and sharing ideas in a group (Ibe, 2025).

TPS in EAL classes creates a visible impact. Students do not memorize like passive learners. They share and sharpen their thoughts collectively, which leads to more advanced thinking and real language use (Ali et al., 2025c). Additionally, the step-by-step setup gives everyone an opportunity to warm up before diving into conversations, making it less stressful and boosting their confidence when speaking.

One of the biggest advantages of TPS is its flexibility. One can use it with big or small classes, younger or older students, and across all levels of language skills (Swai, 2025). That means even schools with fewer resources or in rural areas where students often miss out on real conversations can benefit. Such solid theory and practical results clearly explain why more and more EAL programs are bringing TPS into the modern technology classrooms (Taher, Tripathi & Acharya, 2025).

Activity Theory

Activity theory (Figure 1) puts human activity at the center and looks at it through the lens of three elements: the subject, the object, and the tools they use (Spante & Egelström, 2024). The subject is the one who is doing the activity. It can be one person or a whole group. The object is what they are aiming for, the goal that drives what they do. The tools are everything they use along the way, whether it is physical equipment or abstract ideas and symbols that shape how they act.

Vygotsky suggested the original idea, but it was later expanded by adding more layers, rules, and division of labor. Rules are all the written and unwritten norms that guide how people take part, while division of labor breaks down who does what. All these pieces come together to form the community side of an activity system. Basically, they show how what one person does fits into a bigger social picture. This expanded model helps investigate how people work together, especially in complicated organizations, by connecting what each person does to the bigger structure.

Analytical Components of the Activity System

A comprehensive work activity system is synthesized through the dynamic interplay of four constitutive dimensions:

- **Social Actors:** Comprising individual practitioners and their collaborative network of colleagues.

- Mediating Artifacts: Inclusive of conceptual frameworks, technological apparatus, and physical equipment utilized during the labor process.
- Regulatory Frameworks: The systemic rules and conventions that govern operational conduct.
- Teleological Orientation: The specific objective or purpose toward which the collective efforts of the community are directed (Woo, Guo & Susanto, 2025).

In this framework, technology is not a neutral tool, but it shapes the way people act and interact. Here, rules guide how individuals and their communities interact, while the division of labor determines how communities relate to what they are working on (Tatik, Nguyen & Loughland, 2025).

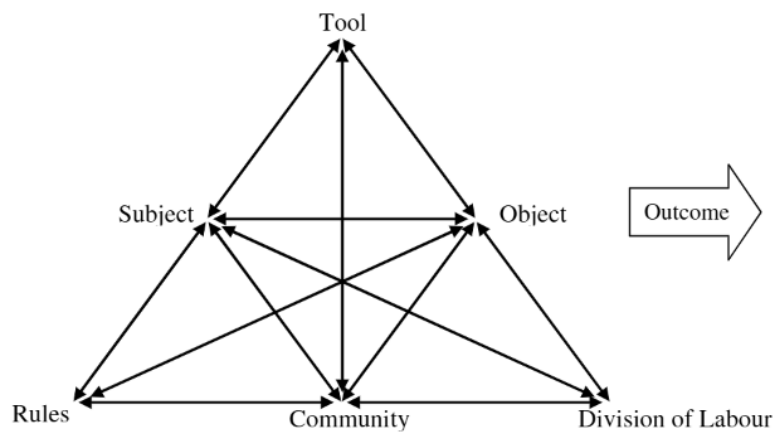


Figure 1. The Activity System

Technology tools are shaped by social practice and how people use them. The object people are working on shapes how they think and what they want to do, and at the same time, their actions change that object. Taber (2025) points out that the work people do with the material properties affects how they think about a task. This shows how learning and working are a two-way path between people and their environment.

Previous Research on Activity Theory

Lately, researchers have explored the benefits of the activity theory in real-life studies. Dai et al. (2025), for example, looked at project-based learning in Internet of Things (IoT) courses using this theory. They checked out how students felt about their classes and how well the activity theory approach worked for reshaping the classroom. They found that project-based learning rooted in the activity theory made students become more involved, feeling more motivated, and showing more signs of learning compared with traditional teaching methods.

Li et al. (2025) investigated how chatbots shape learning in the classroom. They collected 37 studies from 2014 to early 2025. A thorough review showed that educators resort to the activity theory to guide how they design lessons, especially when AI and chatbots are involved. The researchers pointed out that if you correctly use the main ideas from the activity theory, you can boost learner support and make chatbot-driven learning more effective.

Ebadi et al. (2025) explored the impact of AI tasks on fostering learners' speaking skill on a sample of 64 Iranian EFL students. Their study focused on using the activity theory to consider learning a dynamic aspect. The findings indicated high scores of learners using AI tools. AI tools nurtured learners' motivation, confidence, and autonomy. Along the same line, Rahimi, Fathi, and Zou (2025) used the activity theory to study the effect of automated written corrective feedback (AWCF) on English language learners. They ran a mixed-methods study, splitting students into two groups: one having feedback from a computer, and the other following traditional approaches. Students with automated feedback did better than those with traditional feedback. The researchers linked this to higher engagement, more active learning, and better collaboration.

Recent Reflections on TPS Research

Recent studies shed light on the use of TPS in language learning. Fiqhiyah et al. (2025) wanted to know how EFL learners feel about using TPS to boost their reading skills. They interviewed seven students and handed out questionnaires to 24 English learners. Most students found TPS not only effective, but also enjoyable and engaging. They said it helped them better understand what they read.

Lam (2025) conducted a quasi-experimental study with 46 tenth-grade students in Vietnam, investigating the extent to which TPS works as a cooperative learning strategy. The intervention lasted 12 weeks. Students in the experimental group showed clear improvement on their speaking tests. Interviews supported this finding, with students saying that TPS helped them feel more confident, less anxious about speaking, and better at generating ideas through collaboration.

Humaira, Ivone, and Zubaidi (2025) used TPS as part of a Classroom Action Research project with 36 eleventh-grade students over eight sessions. They gathered data from speaking tests, questionnaires, classroom observations, and interviews. Students' speaking was measured on fluency, vocabulary, grammar, and pronunciation using an analytical rubric. Results showed clear improvement in fluency, along with improvements in the other categories. On top of that, students reported richer vocabulary, more confidence, and a better understanding of other cultures, especially after interacting with international peers.

Li et al. (2025) adopted a mixed-methods approach to identify if AI-mediated pronunciation practice affects EFL learners, especially in terms of pronunciation, language anxiety, and enjoyment. They used Vygotsky's sociocultural theory as their lens. The study divided 100 participants into two groups: one used AI for interactive speaking tasks on EAP TALK, while the other did peer-led pronunciation practice via WeChat. They measured progress with pronunciation tests and scales for anxiety and enjoyment. They also collected reflective reports for extra insight. Both groups became better at pronunciation and reported enjoying the process more, but the AI-supported group showed higher improvements. The analysis suggested that AI tools acted like digital mentors, giving learners personalized support directly in their zone of proximal development.

Previous research has shown that TPS works well in different classroom settings. Yet there is still not much work on how TPS performs in digital learning environments. The current study is one of the first to apply TPS to RALL

classrooms. By studying TPS in this new, technology-driven context, we aim to fill a gap in the literature and lay the groundwork for future studies on how collaborative strategies like TPS can be used in the fast-changing world of digital education.

Method

To see how the TPS strategy affects English language learning, this study adopted a quantitative approach. An experiment was set up where two groups of students took the same pre-tests and post-tests; hence, their progress over time can be tracked. All their scores were later gathered and compared. To identify if TPS had any impact, SPSS (Version 27) was used to statistically interpret the scores.

Population and Sampling

The study targeted students learning EAL in the southern part of Saudi Arabia. The sample included 120 students, all from 10th grade public sector schools. All of them were selected from six different secondary schools using convenient sampling. This sampling method made data collection easier, faster, economical, and authentic (Stratton, 2021).

Research Tool

The research experiment centered on the TPS strategy to measure its impact on students' writing skills. To ensure a successful experiment, we closely monitored reliability and validity.

To make sure the content was valid, only official material from the curriculum set by the Saudi Ministry of Education was utilized. From the syllabus, the focal-point was the paragraph writing section, with emphasis on the following:

- Topic sentence
- Development
- Coherence and unity
- Conclusion

Both the experimental and control groups used the same content and had the same teaching, except for the learning strategy. In addition, both groups had robots leading their lessons, but the teaching strategy was the only difference. The robots:

- Taught paragraph writing techniques
- Repeated concepts as needed
- Looked and moved like humans
- Interacted with the students
- Introduced new topics with audio and visual examples
- Encouraged students to answer on their own

- Gave feedback on students' answers.

The control group learned using robot-centered instruction, while the experimental group learned through TPS collaborative work. In addition, we selected passages that fit students of all levels to guarantee fairness.

Variables

The study had two main independent variables: the TPS strategy and the traditional robot-led method. Learning outcomes were the dependent variable. We also considered some extra factors, like teacher behavior, students' academic background, and demographics. To ensure fairness, both groups shared the same background; all students were native Arabic speakers, in the science track, and at a similar intellectual level.

We controlled for variables like gender, ethnicity, age, previous English grades, classroom environment, teaching approach, test format, timing, and digital skills. Everyone in the study was male, Arabic, and Asian, aged 18 to 19, so their cognitive development was about the same. We checked their past English exam scores as well to make sure that the sample was homogeneous. Both groups had 35-minute daily lessons from robots, and each writing test lasted 50 minutes. The test had three prompts, so students wrote three 150-word paragraphs. Classroom settings were comfortable and well equipped for both learning groups, and all instruction was in English. The test format was already known to the learners. Also, everyone in the study was already comfortable with using robots for learning.

Results

The results are based on the compiled dataset extracted after applying the statistical tests. Two tests, i.e., paired-samples and independent-samples t-tests, were applied. The performance scores for both the control and experimental groups are explained in Tables 1 to 5. The comparison of the two groups was recorded at two instances: once before the intervention started, and again after its conclusion. To guarantee the soundness of data, skewness and kurtosis was measured for normal distribution and validity.

Pre-test is the baseline test which provides the learners with earlier knowledge and assists in comparing it with the post-test results. In this way, it is the starting point which can provide vivid picture for success of any treatment (Bloomfield et al., 2021) Adhering to its value, pre-test was applied to understand the earlier knowledge subset of the learners regarding the phenomena under study.

Comparison of Treatment Conditions and Preliminary Assumptions

Before conducting the main analyses, the preliminary assumptions were observed. We checked skewness and kurtosis to confirm the data followed a normal distribution. We also calculated standard deviation to identify the extent to which the scores varied within and between the groups, which confirmed that our data was solid and our results were reliable.

The main terms used in the analysis tables are as follows:

Mean Value	ME
Standard Deviation	SN
Skewness	SS
Kurtosis	KT
Shapiro-Wilk	SH
Control Group	CT
Experimental Group	EP
Confidence Interval	CI
Lower Limit	LT
Upper Limit	UT
Cohen's <i>D</i>	CN

Table 1. Statistics Presentation of Pre- and Post-testing: CT and EP Groups (no. of participants = 60), including SS and KT

		<i>ME</i>	<i>SN</i>	<i>SS</i>	<i>KT</i>	<i>SH</i>
CT	Pre-test	7.77	1.22	0.55	0.55	0.97
	Post-test	8.81	1.16	0.22	0.14	0.98
EP	Pre-test	7.79	1.22	-0.08	-0.68	0.96
	Post-test	11.18	0.91	0.26	-0.16	0.97

Table 1 presents the pre-test and post-test results for the two groups, CT and EP. The table reports descriptive statistics, including ME, SN, SS, and KT. SH statistics are also displayed for both groups. Skewness values falling between -2 and $+2$ indicate normal distribution, consistent with the criteria outlined by Menaha et al. (2023). The SH findings were non-significant, further supporting the assumption of normality for both datasets. In addition, a bootstrap procedure based on 5,000 resamples was applied to estimate sampling distribution, following established recommendations (González-Estrada, Villaseñor & Acosta-Pech, 2022).

Table 2. Independent-sample t-test Pre-test Results (CT and EP), N = 120

Variable	EP (60)		CT (60)		<i>t</i> (118)	<i>p</i>	95% CI		
	<i>ME</i>	<i>SN</i>	<i>ME</i>	<i>SN</i>			<i>LT</i>	<i>UT</i>	<i>CN</i>
Pre-test	7.79	1.22	7.77	1.22	-0.09	.005	-0.42	-0.46	0.002

An independent-samples t-test was conducted in SPSS to analyze pre-test differences between the treatment groups. The mean scores for CT and EP were 7.77 and 7.79, respectively, reflecting a negligible difference between the two groups. The standard deviations for both groups were identical ($SN = 1.22$), indicating limited dispersion and comparable variability around the mean.

The application of Levene's test supported the assumption of equal variances ($F = 0.016, p > .05$), suggesting that

the distribution of pre-test scores was consistent across groups. Initial examination of the pre-test results indicated no meaningful difference in performance prior to the intervention. However, the t-test yielded a value of $t = -0.09$ with a p-value of .005, which is below the .05 significance threshold, implying a statistically significant difference between the groups.

The 95% confidence interval ranged from -0.42 to -0.46 , indicating that the estimated mean difference falls within this interval. Since zero was not included within the confidence limits, the result suggests statistical significance at the selected level. The calculated effect size using Cohen's d was 0.0082.

Table 3. Independent-sample t-test Post-test Results (CT and EP), $N = 120$

Variable	EP		CT		$t (118)$	p	95% CI		
	(60)		(60)				LT	UT	CN
	<i>ME</i>	<i>SN</i>	<i>ME</i>	<i>SN</i>					
Post-Test	11.18	0.91	8.81	1.16	12.47	<.001	1.99	2.75	2.28

The performance of the CT and EP groups was assessed through comparative analysis, revealing that the mean score of the EP (11.18) exceeded that of the CT (8.81), indicating a notable effect of the intervention. The standard deviation for the EP ($SN = 0.91$) reflects a tighter clustering around the mean, whereas the CT displayed a higher SN (1.16), highlighting greater variability and comparatively lower performance.

Levene's test confirmed the homogeneity of variance assumption ($F = 1.3111$, $p > .05$), indicating stable variance across both groups' post-test scores. The independent-samples t-test yielded $t = 12.47$, demonstrating a statistically significant difference between the groups, with EP outperforming CT. The 95% confidence interval ranged from 1.99 to 2.75, excluding zero, which further substantiates the significance of the effect.

The effect size, calculated using Cohen's d , was 2.28, indicating a large difference between groups according to Cohen's (1988) criteria.

Table 4. Summary Item Statistic, CT

	Mean	Min (pre-test)	Max (post-test)	Range (x_1 & x_2)	Ratio = Max / Min	Variance	No. of items
Item Means	mc = 8.29	m1 = 7.77	m2 = 8.81	md = 1.04	rm = 1.13	vb = 0.639	2
Item Variances	vp = 1.42	v1 = 1.49	v2 = 1.35	vd = 0.14	vr = 0.91	vv = 0.057	2
Inter-Item Correlations	.785	.785	.785	1.000		.000	2

The reported values highlight the differences in the CT group between the pre-test (x_1) and post-test (x_2) scores, as shown in Table 4. The pre-test minimum is x_1 , and the post-test maximum is x_2 . The mean scores were $x_1/m_1 = 7.77$ and $x_2/m_2 = 8.81$, yielding a mean difference ($md = m_2 - m_1$) of 1.04 and a mean ratio ($mr = m_2/m_1$) of 1.13 ($\approx 13.1\%$ increase). The combined mean (center point, mc) was calculated as 8.29.

Variance between the pre- and post-test means (vp) was 1.42, representing variability among the scores. Individual variances were $v_1 = 1.49$ and $v_2 = 1.35$, resulting in a variance difference ($vd = v_2 - v_1$) of 0.14 and a variance ratio ($vr = v_2/v_1$) of 0.91. The pooled variance (vb) was 0.639, reflecting overall variation within the groups, and the variance of the difference (vv) was 0.057, indicating the change in variability between pre- and post-test scores. Paired-sample analysis further demonstrated a strong positive correlation between the pre- and post-test measurements ($r = 0.785$).

Table 5. Summary Item Statistic, EP

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	No. of items
Item Means	mc = 9.485	m1 = 7.79	m2 = 11.18	md = 3.39	mr = 1.435	vb = 0.767	2
Item Variance	vp = 1.158	v1 = 1.49	v2 = 0.83	vd = 0.0660	vr = 0.556	vv = 0.971	
Inter-Item Correlations	.739	.739	.739	.000	1.000	.000	2

The reported values illustrate the differences in the EP group between the pre-test (x_1) and post-test (x_2), as presented in Table 5. The minimum score corresponds to x_1 and the maximum to x_2 . The mean scores were $x_1/m_1 = 7.79$ and $x_2/m_2 = 11.18$, resulting in a mean difference ($md = m_2 - m_1$) of 9.485 and a mean ratio ($mr = m_2/m_1$) of 1.435 ($\approx 43.5\%$ increase). The combined mean (center point, mc) was 11.685, and the variance between the two means (vp) was 1.158, reflecting variability across the group.

Individual variances were $v_1 = 1.149$ and $v_2 = 0.83$, producing a variance difference ($vd = v_2 - v_1$) of 0.660 and a variance ratio ($vr = v_2/v_1$) of 0.556. The pooled variance (vb) was 0.767, indicating overall variability within the group. Also, the variance of the difference (vv) was 0.971 which presents the change in variance between pre- and post-test scores. The paired-sample analysis further showed a strong positive correlation between the pre- and post-test scores ($r = 0.739$).

Discussion

In this research, TPS strategy has shown to significantly enhance learners' paragraph writing skills. The improved performance of the learners is a vivid proof of the impact of TPS strategy on enhancing collaboration, communication, and concept development. TPS assisted in construction, correction, and rectification of content (Su & Yang, 2023). English paragraph writing in EAL setting is challenging. Even with the inclusion of modern technology like robots, the classrooms become robot-centered where teaching methods are controlled by these robots. This nurtures teacher-dominated ambiance. Thus, collaboration and peer communication activities may not be encouraged which makes the learning environment demotivating. This is where TPS can be employed for better outputs.

Wu et al. (2025) shared that a common challenge in international classrooms is to encourage all students to contribute actively. Many learners of EAL may feel intimidated to speak publicly. This can be more of a

psychological and mental predicament rather than issues in mastery of a language. Moreover, robots are trained for teaching methods relevant to covering syllabi only. TPS addresses this challenge by providing students with time to formulate their thoughts individually before engaging in partner discussions. Further, TPS creates instances where learners can communicate to learn and express ideas which leads to communicative competence. It is also evident in this study how this approach allows learners to prepare and produce responses away from anxiety. This supports fair participation.

Moreover, the writing drills can be an individual activity even in robot-assisted classrooms (Ibe, 2025). However, the TPS framework supports learners by creating a safe and systematic environment to express their ideas. During the “Think” phase, learners think internally of their responses, while the subsequent “Pair” phase provides a platform for oral practice with immediate feedback. This interactive process allows students to refine grammar, expand vocabulary, and improve pronunciation before contributing to the larger group discussion in the “Share” phase. This is also evident in our experiment where the learners were paired up to interact which helped them become aware of their mistakes, improved their vocabulary, and facilitated learning about the paragraph structure. In addition, this structured strategy reduces barriers to participation and strengthens student confidence, which are the key competencies to elevate the performance of learners. The application of the TPS method fostered inclusive classroom environments where every student can engage meaningfully.

Swai (2025) shared that in conventional classroom discussions and even in robot-assisted classrooms, more fluent or confident students can dominate, leaving others hesitant to contribute. The TPS model in this research mitigated this issue by providing a structured mechanism that ensures all students have the opportunity to speak. The “Pair” phase, in particular, guarantees that each learner can articulate their ideas, resulting in more equitable and comprehensive classroom dialogue.

Taher, Tripathi, and Acharya (2025) mentioned that ESL classrooms frequently comprise students with diverse language proficiency levels. This can create psychological hindrances in learning. Here in this study, TPS accommodated these differences by training the robot to strategically pair learners according to their needs. Higher-proficiency students can mentor peers requiring additional support, reinforcing their own understanding in the process. Alternatively, pairing learners of similar proficiency promotes mutual development and collaborative growth.

Besides, this research shared a robust demo of the core tenets of the activity theory. This research found that learners did not merely execute tasks in isolation but actively engaged in collective tasks to optimize their academic performance. Rahimi, Fathi, and Zou (2025) shared that the activity theory emphasized on this interplay between the individual practitioner and their broader collaborative ecosystem. Similarly, Taber (2025) stated that the activity theory serves as a catalyst for active learning, fundamentally elevating the educational experience.

The integration of technology within this study further aligns with the activity theory’s perspective on tools. The robot-assisted classroom environment was seamlessly adopted by learners, yet the instructional strategy remained human-centric rather than being dominated by the technology. This supports the theoretical position that

technology is never a neutral instrument; rather, it actively mediates and reshapes human agency and social interaction (Dai et al., 2025).

On a final note, the empirical findings of this research find strong parallels in contemporary literature. The results resonate with Fiqhiyah et al. (2025), who established that TPS is not only pedagogically effective but also a means to foster a sense of agency through collaborative engagement. Similarly, the study aligns with Lam (2025), whose findings suggest that TPS enhances learner confidence, mitigates performance anxiety, and stimulates creative ideation. Finally, these results are consistent with the Classroom Action Research conducted by Humaira, Ivone, and Zubaidi (2025), which reported significant advancements in oral fluency and comprehensive linguistic development.

Conclusions

The TPS strategy evidenced to be an effective educational approach for enriching student retention and the application of learning in RALL EAL classes. The study included both experimental and control groups, with TPS implemented exclusively in the experimental group. The findings indicated that learners in the experimental group outperformed those in the control group. TPS engaged the learners in pertinent discussions and assisted them actively exchange ideas. Further, the learners practiced their thoughts freely which promotes autonomy. Learners' autonomy is a pivotal element to elevate engagement and deeper learning. Therefore, the inclusion of robots per se for teaching inside the classroom is proved to be insufficient for all-inclusive language development, requiring accompanying this with effective teaching strategies, such as TPS in this study. Overall, TPS offers multiple advantages, including structured thinking time, collaborative interaction, and increased classroom engagement and confidence. Evidence from prior research supporting this study's findings, indicating that TPS can meaningfully improve achieving learning outcomes. Hence, TPS serves as a promising strategy for fostering both comprehension and active participation in the classroom.

Research Limitations

There were a few limitations to the study. All participants were male, and we only collected data from public schools. However, we set these limits on purpose to keep the population as homogeneous as possible.

Recommendations for Future Research

Based on the findings of this study, several paths for further investigation are suggested:

1. exploring the application of TPS in other academic domains, such as mathematics, science, and social studies, to evaluate its broader effectiveness;
2. examining how TPS can be leveraged to enhance students' critical thinking and analytical reasoning skills;
3. investigating the potential of TPS to support the development of decision-making and problem-solving abilities across diverse learning contexts;

4. using TPS in other English language learning domains.

Statements and Declarations

Acknowledgments/Notes: Not applicable.

During the preparation of this article, the authors did not use ChatGPT.

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Data Availability: The data used in this study are not publicly available because they contain student-level educational information. Anonymized data may be made available from the corresponding author upon reasonable request and with appropriate permission from the relevant parties. Any data sharing will follow confidentiality and ethical research principles.

Ethics Approval: Not applicable.

Informed Consent: Informed consent was obtained before data collection. Participants were informed about the purpose of the study, the research procedures, and their rights as participants. Participation was voluntary, and the confidentiality of participants' responses was maintained throughout the research process.

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