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Examining Students' Collaborative Skills in an Artificial Intelligence-Assisted Think-Pair-Share Cooperative Learning Model

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Abstract: Collaborative skills are central to primary education, and limited research has examined whether artificial intelligence (AI) support embedded in Think-Pair-Share (TPS) cooperative learning relates to these skills in primary school integrated natural and social science learning, so this study aimed to examine whether and how an AI-assisted TPS model is implemented and how it relates to students' collaborative skills. A quantitative approach with a causal-associative orientation was applied, using questionnaires, observation sheets completed by two observers, and documentation to capture teachers' and students' responses, teacher implementation, and six indicators of collaborative skills. Expert validation of the response questionnaires reached 94%, observation of teacher implementation reached 92.5% across the think, pair, and share stages, the mutual respect indicator reached 96%, and teachers and students reported positive responses. These descriptive findings indicate that the model was implemented in line with its syntax and was accompanied by high observed collaborative behavior, although the absence of a comparison group means that the findings require testing in experimental studies.

Keywords: artificial intelligence, Think-Pair-Share, cooperative learning, collaborative skills, primary education.

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INTRODUCTION

Collaborative skills are widely regarded as a core competence for learners in the twenty-first century, and teachers who implement cooperative learning with high quality describe cooperation as a key competence that students need for later life (Adl-Amini et al., 2024). Research by Veldman et al. (2020) involved 168 Grade 1 pupils in six schools that used cooperative learning within the Success for All program and 144 pupils in four control schools, and it reported more positive and less negative group work behavior in the cooperative learning schools. According to Buchs et al. (2017), elementary school teachers who reported more difficulty in embedding cooperative learning in the curriculum and in finding time for it also reported using it less often, which indicates that teachers' working conditions shape whether cooperative learning is implemented. A study of primary school teachers by Veldman et al. (2020) found that implementation levels differed significantly between teachers, especially in teaching students the cooperative behaviors needed for group work.

Social interdependence theory provides the conceptual basis for cooperative learning. A mixed methods study in German classrooms by Adl-Amini et al. (2024) used the basic elements of cooperative learning, which include positive interdependence, individual accountability, promotive interaction, social skills, and group processing, as indicators of implementation quality, and it reported that only 7% of the observed teachers implemented the basic elements. Research by Le et al. (2018), based on interviews with 19 teachers and 23 students in a teacher education faculty in Vietnam, identified four obstacles to collaboration: students' lack of collaborative skills, free-riding, competence status, and friendship. The authors linked these obstacles to the way teachers set collaboration goals, provided instruction, and assessed collaboration, which indicates that collaborative skills need structured instructional design.

Think-Pair-Share (TPS) is a cooperative learning structure with three stages: individual thinking (think), discussion with a partner (pair), and sharing with a larger group or the whole class (share). Research by Silva et al. (2022) used a quasi-experimental design with fourth-grade students and reported that cooperative learning with TPS and RoundTable was more effective than traditional teaching for developing critical thinking skills. Recent evidence indicates that TPS was associated with improved problem-solving skills and participation among students learning engineering mathematics (Alsmadi et al., 2023). In Indonesia, TPS has been examined in relation to critical thinking in Islamic studies (Kurjum et al., 2020), and a scaffolded think-group-share variant has been examined for satisfaction and learning achievement in elementary English classes (Choi & Mantik, 2017).

Among the TPS studies discussed here, the outcomes have primarily been critical thinking, problem solving, satisfaction, and achievement, and collaborative skills as an outcome of TPS in primary school social studies content have received less attention. In Indonesia, the *Kurikulum Merdeka* (Merdeka Curriculum) gives teachers flexibility in selecting instructional strategies and emphasizes soft skills alongside

academic achievement. At the primary level, the subject *Ilmu Pengetahuan Alam dan Sosial* (IPAS, Integrated Natural and Social Sciences) combines natural science and social science content, and cooperative learning in primary classrooms has been associated with more positive group work behavior (Veldman et al., 2020a). Learners in IPAS lessons are expected to express opinions, respect diverse perspectives, and reach shared decisions in groups, which makes IPAS an appropriate setting for examining collaborative skills.

Research on AI in education has expanded quickly, and a quasi-experiment with college students found that an AI-based chatbot used for after-class review was associated with higher academic performance, self-efficacy, learning attitude, and motivation (Lee et al., 2022). A survey of 368 in-service teachers from elementary to high school in Nigeria showed that confidence in teaching AI predicted the intention to teach AI and that perceived AI relevance strongly predicted readiness to teach it (Ayanwale et al., 2022). An experimental study with 123 Grade 10 students using chatbots found that intrinsic motivation and competence to learn with the chatbot depended on both teacher support and student expertise, and the authors noted that research on AI in education has a weak connection to pedagogical perspectives, particularly in K-12 education (Chiu et al., 2024). These studies indicate that teacher readiness and the pedagogical grounding of AI use remain recurring concerns.

Tegos et al. (2016) compared directed and undirected conversational agent interventions with 96 computer science students working in dyads and reported that both types of intervention improved learning outcomes and dyad task performance, with the directed agent being more effective for individual knowledge acquisition and explicit reasoning. In two studies with 19 and 27 secondary school dyads in Brazil and the Netherlands, de Araujo et al. (2024) reported that dyads with a collaborative conversational agent in the chat shared their thoughts more often than dyads without the agent, and perceived productivity did not differ between conditions. Research by Edwards et al. (2025) reported that the first prototype of an AI agent did not facilitate socially shared regulation as hoped, which the authors linked to mixed perceptions of reliability and unclear roles. Taken together, these studies show that the contribution of AI to collaboration depends on how its role is designed.

At the primary level, Tai and Chen (2024) randomly assigned 85 elementary school learners of English as a foreign language (EFL) to individual or paired interaction with a generative AI chatbot or to a conventional classroom, and they reported that both chatbot groups achieved higher post-test speaking scores than the conventional group. Interviews in the same study indicated that paired interaction with the chatbot involved social dynamics, shared learning experiences, and mutual resolution of language challenges (Tai & Chen, 2024). Studies with older learners add that the way AI support is structured matters, because Darvishi et al. (2024) reported in a randomised controlled experiment on peer feedback that students tended to depend on AI assistance, and self-regulated strategies only partly filled the gap when the assistance was removed. Caution is also warranted, because Fan et al. (2025) reported that

university students who used ChatGPT outperformed the other groups in essay score improvement while their knowledge gain and transfer did not differ significantly, and the authors cautioned that such tools may promote dependence on technology.

The closest evidence on AI within TPS comes from university settings. According to Lobo-Quintero (2025), a mixed-methods quasi-experimental study with 140 computer science undergraduates examined an AI-enhanced TPS platform in which a chatbot provided scaffolding for creative thinking. The experimental group showed productivity gains of 30% to 37% and a 99% increase in thematic diversity, together with moderate lexical standardization effects. Research remains limited regarding how AI-assisted TPS relates to collaborative skills among primary school students, particularly in IPAS learning in Indonesia.

This study addresses an underexplored aspect of AI-supported cooperative learning in primary education. This study aims to examine whether and how an AI-assisted TPS model is implemented and how it relates to students' collaborative skills in IPAS learning. This study extends previous research on TPS and AI-supported collaboration by examining collaborative skills, assessed through teacher and student responses, classroom observation, and documentation, in an AI-assisted TPS model within an Indonesian primary school IPAS context. Specifically, this study addresses three research questions: 1) How do teachers and students respond to the AI-assisted TPS model? 2) To what extent is the AI-assisted TPS model implemented in accordance with the think, pair, and share stages? 3) What levels of collaborative skills, represented by six indicators (active participation, working productively, responsibility, flexibility, compromise, and mutual respect), are observed during AI-assisted TPS learning?

METHOD

Research Design

This study employed a quantitative approach with a causal-associative orientation. The AI-assisted TPS model was treated as the independent variable (X), and students' collaborative skills were treated as the dependent variable (Y). Data were analyzed descriptively as percentage scores, and no comparison group or inferential test was used. The results therefore describe the level of implementation and the observed collaborative skills, and they are not used to estimate causal effects.

Participants

The participants were the teacher who implemented the IPAS lesson and the students who took part in it. The teacher completed the teacher response questionnaire, and the students completed the student response questionnaire. Two observers, namely the researcher and a peer, recorded the observation data during the lesson. The identity of the school is not reported in order to maintain anonymity.

Research Variables

The independent variable (X) was the AI-assisted TPS cooperative learning model, which organized the lesson into think, pair, and share stages supported by AI-based

media. The dependent variable (Y) was students' collaborative skills. Collaborative skills were observed through six indicators: active participation, working productively, responsibility, flexibility, compromise, and mutual respect among group members. These indicators were recorded on the observation sheet and later summarized as percentages.

Instructional Procedure

The lesson addressed Indonesia's landforms and the characteristics of lowland and highland areas in IPAS, and the teacher opened the lesson, explained the learning objectives, and delivered the material using the student textbook and PowerPoint media. In the think stage, the teacher posed the guiding question "What are lowlands and highlands?" and asked students to think about the answer independently with the support of AI-based media. In the pair stage, students worked with their seatmates, expressed their individual answers, discussed and unified them, and wrote the results on the student worksheet (*Lembar Kerja Peserta Didik*, LKPD). In the share stage, pairs exchanged answers with another pair or group and presented their results, after which the teacher gave appreciation, concluded the lesson, and closed the session.

Figure 1 is presented to show the sequence of the lesson from the opening to the closing so that readers can follow how the think, pair, and share stages were arranged. The figure summarizes the teacher's actions that were later observed and scored in the observation sheet. It also marks where AI-based media provided support during the three stages. The figure appears here because the procedure is the basis for the observation items reported in the Results.

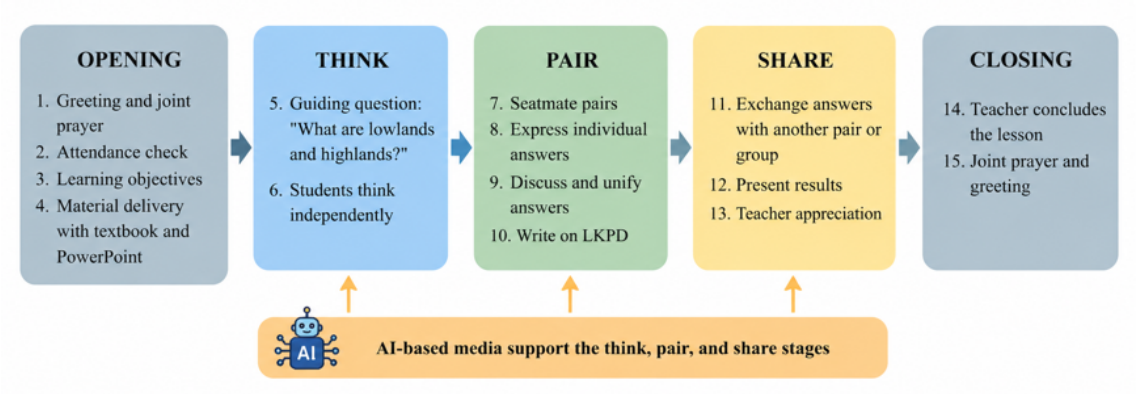


Figure 1. Procedure of the AI-Assisted Think-Pair-Share Lesson

Figure 1 helps readers see that the lesson followed a fixed order of five phases, namely opening, think, pair, share, and closing. This visual order allows readers to link each observation item in Table 4 to a specific phase of the lesson. The figure also benefits teachers and researchers who wish to replicate the procedure, because the sequence and the role of AI-based media at each stage are visible at a glance. For the reader, the figure reduces the need to reconstruct the procedure from the text and makes the later interpretation of lower and higher scores easier to follow.

Data Collection Techniques

Questionnaires: Closed-ended questionnaires were used to obtain teachers' and students' responses toward the AI-assisted TPS model, and respondents selected the answer that best matched their experience. Teachers' responses were measured with a Likert-type scale, which converts ordered response categories into numerical scores (Sullivan & Artino, 2013). Students' responses were measured with a Guttman scale. The scoring criteria and the blueprints of both questionnaires are presented in Tables 1 and 2.

Table 1 presents the blueprint of the student response questionnaire, which was built around the think, pair, and share stages. It lists the indicator, the item numbers, and the number of items for each stage, giving 15 statements in total. The table is placed here so that readers can see how the student statements were distributed across the stages of the model. This information allows readers to judge whether each stage was represented in the instrument.

Table 1. Blueprint of the Student Response Questionnaire

Stage	Indicator	Item numbers	Number of items
Thinking	Presenting information and providing questions to students	1, 2, 3, 4, 7	5
Pairing	Explaining how to form study groups and guiding groups while completing tasks	5, 6, 8, 11	4
Sharing	Evaluating learning outcomes of the material by presenting the results	9, 10, 12, 13, 14, 15	6
Total			15

The table shows that the sharing stage has the most statements (six items), followed by the thinking stage (five items) and the pairing stage (four items). This distribution informs readers that the student questionnaire covered all three stages and gave the most attention to the presentation of results. The benefit for readers is a clear view of content coverage, which supports confidence in the student response data. The blueprint also guides researchers who wish to adapt the questionnaire for other lessons.

Table 2 presents the blueprint of the teacher response questionnaire, which follows the same stages and adds an introduction and a closing component. It lists the indicators, item numbers, and number of items for five components, giving 15 statements in total. The table is included because the teacher's view covers the whole lesson sequence, including the opening and closing phases. Readers can use it to see which parts of the lesson were evaluated from the teacher's perspective.

Table 2. Blueprint of the Teacher Response Questionnaire

Stage	Indicator	Item numbers	Number of items
Introduction	Alignment with learning outcomes (*Capaian Pembelajaran*, CP) and clarity of the material	1, 2, 3, 4, 5	5
Thinking	Presenting information and providing questions to students	6, 7	2

Pairing	Explaining how to form study groups and guiding groups while completing tasks	8, 9, 10, 11	4
Sharing	Evaluating learning outcomes of the material by presenting the results	12	1
Closing	Summarizing the lesson and providing reinforcement or rewards	13, 14, 15	3
Total			15

The table shows five items on alignment with learning outcomes (*Capaian Pembelajaran*, CP) and clarity of the material, two on thinking, four on pairing, one on sharing, and three on closing. This distribution informs readers that the teacher questionnaire gave the largest share to lesson preparation and material clarity. The benefit for readers is that they can compare the teacher and student instruments and see that both address the same three stages. The table also supports transparency in reporting, since each statement can be traced to a component of the lesson.

Observation: Systematic observation was conducted with observation sheets covering two aspects, namely the teacher's implementation of the TPS syntax and students' collaborative skills. The teacher's implementation was scored on 15 items using a scale from 1 to 4, which gives a maximum total of 60. Students' collaborative skills were recorded on six indicators: active participation, working productively, responsibility, flexibility, compromise, and mutual respect. Two observers recorded the data, namely the researcher and a peer, so that the observation did not rely on a single perspective.

Documentation: Documentation was collected as complementary evidence of teachers' and students' activities during the lesson. The documents consisted of photographs and activity records made with recording devices. These records were used to cross-check the questionnaire and observation findings. The documentation therefore helped confirm that the reported behaviors occurred during the lesson.

Instrument Validation and Data Analysis

The response questionnaires were validated by experts who rated nine statements covering instructional aspects, content, and language aspects on a four-point scale. Each aspect contained three statements, and the validation sheet used scores from 1 to 4. Scores were converted into percentages by dividing the total obtained score by the maximum possible score and multiplying by 100. All results were interpreted descriptively.

RESULT

Instrument Validation

Table 3 summarizes the experts' assessment of the response questionnaires before they were used. The table lists how many statements received each score from 1 to 4 and the resulting percentage. It is presented first because the quality of the instruments affects

the credibility of the response data. Readers can use it to judge whether the questionnaires were suitable for the lesson.

Table 3. Summary of Questionnaire Validation Results

Scale	Number of statements rated
1	0
2	0
3	2
4	7
Percentage	94%

Validators rated two statements with a score of 3 and seven statements with a score of 4, which yielded 34 out of a maximum of 36 points, equal to 94%. No statement received a score of 1 or 2, which shows that none of the nine statements was judged as unsuitable. This evidence benefits readers because it indicates that the questionnaires covered instructional, content, and language aspects adequately before data collection. The result also gives readers a basis to trust the teacher and student responses reported later.

Teacher Implementation of the AI-Assisted TPS Model

Table 4 presents the observation of the teacher's activities by two observers for each of the 15 observed aspects. The table lists the scores of both observers, the mean per item, the total scores, and the percentage. It is included because it shows how closely the lesson followed the think, pair, and share syntax. Readers can use it to check every score behind the overall percentage.

Table 4. Results of the Observation of Teacher Activities in the AI-Assisted TPS Model

Observed aspect	Observer 1	Observer 2	Mean
The teacher greets the students and begins the lesson with a joint prayer.	4	4	4
The teacher asks about the students' condition and checks attendance.	3	3	3
The teacher explains the chapter title and the learning objectives; the students listen attentively.	4	4	4
The teacher delivers material about Indonesia's landforms and the characteristics of lowland and highland areas using the student textbook and PowerPoint media.	3	3	3
The teacher poses a question related to the material: “What are lowlands and highlands?”	4	4	4
The teacher asks students to think about the answer independently.	3	4	3.5
The teacher forms study groups in pairs with seatmates.	4	4	4
The teacher asks students to express their individual answers.	4	4	4
The teacher asks students to discuss and unify their answers.	4	4	4
The teacher distributes the LKPD and asks students to write their answers on it.	4	4	4
The teacher asks students to exchange answers with another pair or group.	3	4	3.5

The teacher asks students to present the results of their discussion with their partner.	4	4	4
The teacher gives rewards or appreciation to the group that presents well.	3	4	3.5
The teacher concludes the lesson.	4	4	4
The teacher closes the lesson with a joint prayer and greeting.	3	3	3
Total	54	57	55.5
Percentage			92.5%

The total scores were 54 for Observer 1 and 57 for Observer 2, with a mean of 55.5 out of 60, equal to 92.5%. Both observers gave a score of 4 to nine items and a score of 3 to three items, namely attendance checking, material delivery with the textbook and PowerPoint, and closing, while three items received different scores from the two observers. This item-level display lets readers see exactly which teacher actions were consistently rated high and which were rated lower. The table benefits readers who want to examine or replicate the observation, because every score and the source of each total can be checked.

Figure 2 summarizes the teacher's implementation score for each phase of the lesson, calculated from the item scores in Table 4. The opening phase covers items 1 to 4, the think stage items 5 and 6, the pair stage items 7 to 10, the share stage items 11 to 13, and the closing phase items 14 and 15. The figure is included because it condenses fifteen item scores into five phases that match the structure shown in Figure 1. Readers can use it to see quickly which phases were implemented at the highest and lowest levels.

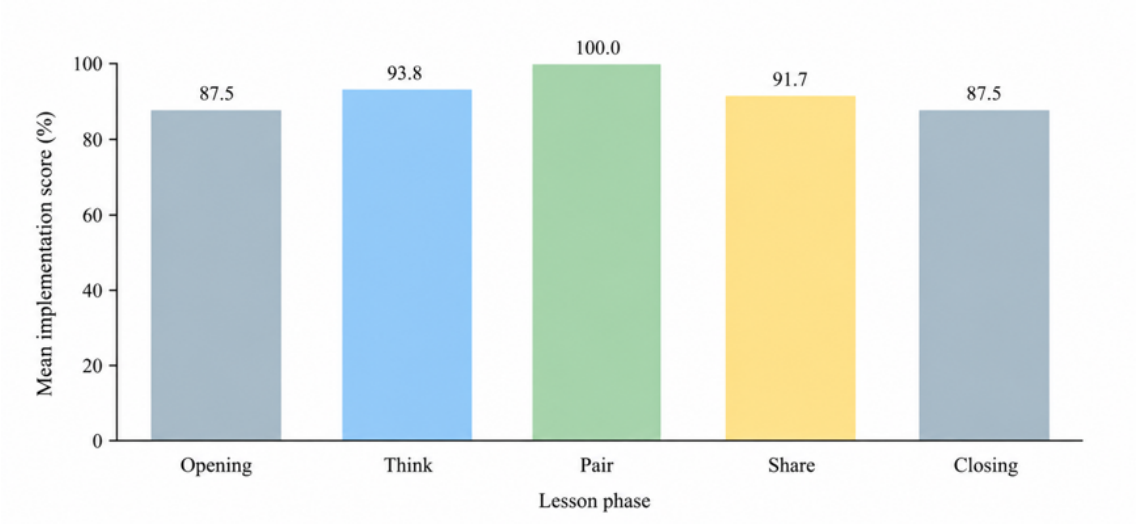


Figure 2. Mean Implementation Score of the Teacher by Lesson Phase (%)

Figure 2 shows that the pair stage reached 100%, followed by the think stage at 93.8%, the share stage at 91.7%, and the opening and closing phases at 87.5% each. These phase percentages equal the mean item scores of each phase divided by the maximum score of 4. The figure benefits readers by locating the lower scores in the

opening and closing phases, which prepares them for the interpretation in the Discussion. It also helps teachers identify the phases that need the most attention when they plan the lesson.

Teachers' and Students' Responses

The responses of teachers and students indicated that the AI-assisted Think-Pair-Share (TPS) learning model was positively received during the implementation of IPAS learning. The questionnaire instruments used to collect these responses had been validated by experts, achieving a validation score of 94%. These findings suggest that the learning model was considered acceptable by the participants and suitable for supporting classroom learning activities. However, positive responses should be interpreted as evidence of participants' perceptions and experiences rather than direct evidence of improved learning outcomes.

From the teachers' perspective, the TPS structure provided an organized framework for facilitating collaborative learning. The think stage allowed students to develop initial ideas independently, while the pair stage encouraged them to exchange opinions, discuss information, and compare their understanding with a partner. The share stage provided opportunities for students to communicate their conclusions to the wider class. This sequence helped teachers organize learning activities that encouraged participation, discussion, and the sharing of ideas. The integration of AI-assisted media also offered an additional resource for presenting learning content and supporting classroom discussions.

From the students' perspective, the learning activities provided opportunities to express individual ideas, listen to peers, and participate in collaborative discussions. The use of AI-assisted media may have helped make the learning material more accessible and provided a shared reference for discussing the characteristics of Indonesia's lowlands and highlands. Through pair and whole-class discussions, students could compare their interpretations, respond to different viewpoints, and contribute to group learning. These experiences were consistent with the collaborative purpose of TPS, although the available findings did not establish that AI assistance alone produced these responses or improved students' collaborative skills.

The positive questionnaire responses were also considered alongside the classroom observation findings, which indicated a teacher implementation score of 92.5% and a mutual respect score of 96%. Together, these results suggest that the learning model was implemented as planned and that respectful interaction was evident during the observed activities. Nevertheless, questionnaire responses and observation scores represent different aspects of the learning process and should not be treated as interchangeable measures. Further studies could examine teachers' and students' responses in greater depth, include more detailed questionnaire results, and investigate whether these positive perceptions are sustained across different topics, classroom settings, and periods of implementation.

Students' Collaborative Skills

Figure 3 presents the percentage of students' collaborative skills for each of the six indicators recorded by the observers. The indicators are active participation, working productively, responsibility, flexibility, compromise, and mutual respect among group members. The figure is included because it answers the third research question directly. Readers can use it to see the profile of students' collaborative behavior across all indicators.

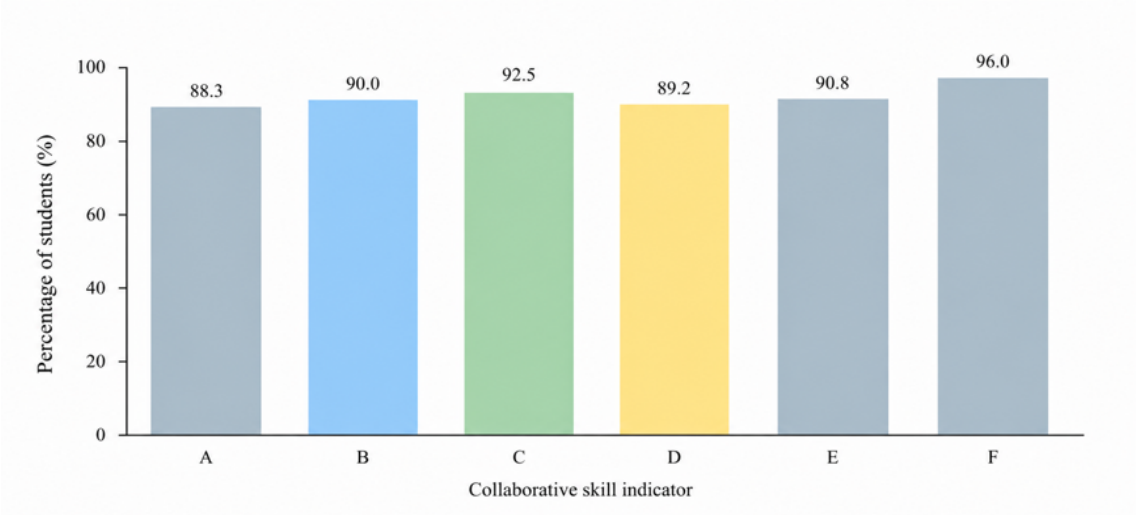


Figure 3. Percentage of Students' Collaborative Skills by Indicator

Description: A = active participation; B = working productively; C = responsibility; D = flexibility; E = compromise; F = mutual respect among group members.

Figure 3 shows that the mutual respect indicator (F) reached 96%, and the figure displays the percentage of the remaining indicators A to E in the same format. Documentation records in the form of photographs and activity records were used to cross-check these observations and showed that students collaborated, respected differing opinions, took responsibility for group tasks, and showed flexibility during discussions. The figure benefits readers by presenting all six indicators together, which allows them to compare indicators within the same lesson. The cross-check with documentation helps readers judge that the percentages reflect behaviors that were recorded in the classroom.

DISCUSSION

Implementation of the AI-Assisted TPS Model

The teacher's implementation reached 92.5%, with the pair stage at 100% and the opening and closing phases at 87.5% each. A plausible explanation is that the think, pair, and share stages give the teacher clearly defined actions, whereas attendance checking, material delivery, and closing, which received lower scores, involve transitions that are less tightly scripted. Veldman et al. (2020b) found that primary school teachers differed significantly in their level of cooperative learning

implementation and that teachers who implemented it successfully felt more able to regulate student behavior, which suggests that teacher facilitation is a key element in the success of cooperative learning and is consistent with the high scores on stage-related actions. Research by Le et al. (2018) linked obstacles to collaboration with how teachers set goals, provided instruction, and assessed collaboration, although their teacher education context in Vietnam differs from a primary school IPAS lesson.

These results suggest that consistent facilitation of the syntax can be regarded as a condition for collaboration, and observed teacher actions alone provide limited information on the quality of student interaction, a limitation that Adl-Amini et al. (2024) also noted for teacher-focused observation. The lower scores on material delivery with the textbook and PowerPoint also indicate that the phase in which media are introduced may need more attention in a lesson that uses AI-based media. Teacher training can therefore address transition and delivery phases, particularly because elementary school teachers have reported difficulty in embedding cooperative learning in the curriculum (Buchs et al., 2017), and observation sheets can add items that describe how AI-based media are used at each stage. Such adjustments are realistic for schools because they extend an existing observation routine.

Students' Collaborative Skills

The mutual respect indicator reached 96%, which shows that students displayed respectful behavior toward group members during the lesson. A possible explanation lies in the structure of the three stages, because the think stage gives each student time to form an idea, the pair stage requires listening and unifying answers, and the share stage requires listening to other groups' presentations. Veldman et al. (2020a) observed more positive and less negative group work behavior among Grade 1 pupils in schools using cooperative learning than among pupils in control schools, which is consistent with this interpretation. Research by Silva et al. (2022) with fourth graders reported that cooperative learning with TPS and RoundTable was more effective than traditional teaching for critical thinking, which suggests that structured peer talk at this age can serve different outcomes.

Different patterns may be reported in other settings, since Adl-Amini et al. (2024) found large differences in implementation quality across German classrooms, with only 2 of 30 observed teachers implementing all the basic elements of cooperative learning. The level observed here should therefore be interpreted in relation to the Indonesian primary school setting and the topic of landforms. Le et al. (2018) reported free-riding and a lack of collaborative skills as obstacles, and the individual think stage followed by pair work may reduce opportunities for free-riding, although this study did not test that mechanism. For practice, TPS can serve as an entry point for teaching social skills explicitly, which is relevant for IPAS, because Veldman et al. (2020b) found that teachers differed most in teaching students the cooperative behaviors that group work requires.

The Role of AI Support

The observation sheet did not include items specific to the AI-based media, so the contribution of AI cannot be separated from the TPS structure and the teacher's facilitation. A plausible explanation is that AI-based media functioned as an additional resource within each stage of an already structured interaction, a configuration that resembles the worksheet-guided chatbot interactions reported by Tai and Chen (2024) for elementary EFL learners. Research by Lobo-Quintero (2025) reported that chatbot scaffolding within TPS among university computer science students was associated with productivity gains and greater thematic diversity, and de Araujo et al. (2024) reported that secondary school dyads with a collaborative conversational agent shared their thoughts more often than dyads without it. Those studies differ from the present one in learner age, outcome, type of AI, and design, so their results are not directly comparable with the present findings.

Edwards et al. (2025) reported that an AI agent prototype did not facilitate shared regulation as hoped, which they attributed to mixed perceptions of reliability and unclear roles, and Tegos et al. (2016) reported that a directed agent intervention was more effective than an undirected one for individual knowledge acquisition and explicit reasoning. These findings indicate that the benefit of AI depends on how its role is defined, and Chiu et al. (2024) found that students' motivation and competence in learning with a chatbot depended on teacher support and student expertise. Because Fan et al. (2025) and Darvishi et al. (2024) reported signs of dependence on AI assistance among university students, the AI function in the think stage should leave room for students' own reasoning. The practical implication is to specify the function of AI at each stage, keep teacher moderation, and monitor how students use the media.

Teachers' and Students' Responses

Teachers and students responded positively to the model, which indicates acceptance of the lesson design by the people who used it. A plausible explanation is that the model combines a clear task structure with media that students can use during the think, pair, and share stages. Tai and Chen (2024) reported that elementary school learners found chatbot-assisted speaking practice enjoyable, motivating, and engaging, which is in line with the positive responses observed here. In addition, Lee et al. (2022) reported higher learning attitude and motivation among college students who used an AI-based chatbot for after-class review.

Positive responses should be interpreted carefully, since questionnaire data reflect what respondents report and do not demonstrate learning gains, and Adl-Amini et al. (2024) found that teachers' self-reported implementation quality was rather high while observed implementation quality was low. The positive responses also agree with the observation results, because the teacher implemented the syntax at a high level and students displayed respectful behavior. For schools, this implies that teacher readiness to design and moderate AI-assisted activities should be developed together with the

introduction of the media (Ayanwale et al., 2022; Chiu et al., 2024). Such preparation can support consistent use of the model when it is applied in other classes.

Limitations and Future Research

Several limitations should be considered when interpreting these findings. The study used a descriptive design without pretest, posttest, or comparison group, so changes in collaborative skills and causal effects cannot be established. The study covered one lesson topic, so generalization to other topics, classes, and longer implementation periods is limited. Agreement between the two observers was not reported, and Adl-Amini et al. (2024) illustrate one way to address this by checking interrater agreement with Krippendorff's alpha when at least two observers rate a lesson. Questionnaire data reflect perceptions, and the observation sheet did not capture AI-specific behaviors. Future research can apply quasi-experimental designs with comparison groups, similar to the comparisons used by Veldman et al. (2020a) and Tai and Chen (2024), and include several classes and subjects. Additional observation items for AI use and reports of observer agreement would strengthen the evidence. Longer implementation periods would show whether the observed collaborative behaviors persist.

CONCLUSION

This study examined an AI-assisted TPS cooperative learning model in primary school IPAS learning. In response to the first research question, teachers and students reported positive responses, and the response instruments were rated highly valid by experts. In response to the second research question, the teacher's implementation demonstrated a high level of fidelity, with the strongest performance on the core think, pair, and share actions. In response to the third research question, mutual respect emerged as a strong indicator of collaborative skills, alongside positive results across the other indicators. These descriptive findings are consistent with the view that structured peer interaction supported by AI-based media can accompany high levels of observed collaborative behavior. Because the study had no comparison group and the observation did not isolate AI use, the contribution of AI and the causal effect of the model remain to be tested. Teachers can use the procedure as a structured starting point, with clear AI functions and teacher moderation at each stage. Future studies are encouraged to test the model using experimental designs across more diverse contexts and subjects.

AI Use Statement

The authors used AI tools, if applicable, for language editing and proofreading. The authors take full responsibility for the manuscript's content.

Author Contributions

ASD: contributed to research implementation and manuscript drafting. NLJ: contributed to research methodology and data analysis. IPR: coordinated the study and led manuscript preparation. AS: contributed to data interpretation and critical revision. HBI: provided academic supervision and manuscript review. All authors approved the final manuscript.

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Conflict of Interest
The authors declare no conflict of interest.

REFERENCES

Adl-Amini, K., Völlinger, V. A., & Eckart, A. (2024). Implementation quality of cooperative learning and teacher beliefs: A mixed methods study. *European Journal of Psychology of Education, 39*(3), 2267-2281. https://doi.org/10.1007/s10212-023-00769-3

Alsmadi, M. A., Tabieh, A. A. S., Alsaifi, R. M., & Al-Nawaiseh, S. J. (2023). The effect of the collaborative discussion strategy think-pair-share on developing students' skills in solving engineering mathematical problems. *European Journal of Educational Research, 12*(2), 1123-1135. https://doi.org/10.12973/eu-jer.12.2.1123

Ayanwale, M. A., Sanusi, I. T., Adelana, O. P., Aruleba, K. D., & Oyelere, S. S. (2022). Teachers' readiness and intention to teach artificial intelligence in schools. *Computers and Education: Artificial Intelligence, 3*, Article 100099. https://doi.org/10.1016/j.caeai.2022.100099

Buchs, C., Filippou, D., Pulfrey, C., & Volpé, Y. (2017). Challenges for cooperative learning implementation: Reports from elementary school teachers. *Journal of Education for Teaching, 43*(3), 296-306. https://doi.org/10.1080/02607476.2017.1321673

Chiu, T. K. F., Moorhouse, B. L., Chai, C. S., & Ismailov, M. (2024). Teacher support and student motivation to learn with Artificial Intelligence (AI) based chatbot. *Interactive Learning Environments, 32*(7), 3240-3256. https://doi.org/10.1080/10494820.2023.2172044

Choi, H. J., & Mantik, O. (2017). The effect of scaffolded think-group-share learning on Indonesian elementary schooler satisfaction and learning achievement in English classes. *International Electronic Journal of Elementary Education, 10*(2), 175-183. https://doi.org/10.26822/iejee.2017236113

Darvishi, A., Khosravi, H., Sadiq, S., Gašević, D., & Siemens, G. (2024). Impact of AI assistance on student agency. *Computers & Education, 210*, Article 104967. https://doi.org/10.1016/j.compedu.2023.104967

de Araujo, A., Papadopoulos, P. M., McKenney, S., & de Jong, T. (2024). A learning analytics-based collaborative conversational agent to foster productive dialogue in inquiry learning. *Journal of Computer Assisted Learning, 40*(6), 2700-2714. https://doi.org/10.1111/jcal.13007

Edwards, J., Nguyen, A., Lämsä, J., Sobocinski, M., Whitehead, R., Dang, B., Roberts, A.-S., & Järvelä, S. (2025). Human-AI collaboration: Designing artificial agents to facilitate socially shared regulation among learners. *British Journal of Educational Technology, 56*(2), 712-733. https://doi.org/10.1111/bjet.13534

Fan, Y., Tang, L., Le, H., Shen, K., Tan, S., Zhao, Y., Shen, Y., Li, X., & Gašević, D. (2025). Beware of metacognitive laziness: Effects of generative artificial intelligence on learning motivation, processes, and performance. *British Journal of Educational Technology, 56*(2), 489-530. https://doi.org/10.1111/bjet.13544

Kurjum, M., Muhid, A., & Thohir, M. (2020). Think-pair-share model as solution to develop students' critical thinking in Islamic studies: Is it effective? *Cakrawala Pendidikan, 39*(1), 144-155. https://doi.org/10.21831/cp.v39i1.28762

Le, H., Janssen, J., & Wubbels, T. (2018). Collaborative learning practices: Teacher and student perceived obstacles to effective student collaboration. *Cambridge Journal of Education, 48*(1), 103-122. https://doi.org/10.1080/0305764X.2016.1259389

Lee, Y.-F., Hwang, G.-J., & Chen, P.-Y. (2022). Impacts of an AI-based chatbot on college students' after-class review, academic performance, self-efficacy, learning attitude, and motivation. *Educational Technology Research and Development, 70*(5), 1843-1865. https://doi.org/10.1007/s11423-022-10142-8

Lobo-Quintero, R. (2025). AI-enhanced think-pair-share: A learning analytics approach to foster linguistic creative thinking and collaborative learning. *Journal of Learning Analytics, 12*(2), 19-34. https://doi.org/10.18608/jla.2025.8807

Silva, H., Lopes, J., Dominguez, C., & Morais, E. (2022). Think-pair-share and roundtable: Two cooperative learning structures to enhance critical thinking skills of 4th graders. *International Electronic Journal of Elementary Education, 15*(1), 11-21. https://doi.org/10.26822/iejee.2022.274

Sullivan, G. M., & Artino, A. R., Jr. (2013). Analyzing and interpreting data from Likert-type scales. *Journal of Graduate Medical Education, 5*(4), 541-542. https://doi.org/10.4300/JGME-5-4-18

Tai, T. Y., & Chen, H. H. J. (2024). Navigating elementary EFL speaking skills with generative AI chatbots: Exploring individual and paired interactions. *Computers & Education, 220*, Article 105112. https://doi.org/10.1016/j.compedu.2024.105112

Tegos, S., Demetriadis, S., Papadopoulos, P. M., & Weinberger, A. (2016). Conversational agents for academically productive talk: A comparison of directed and undirected agent interventions. *International Journal of Computer-Supported Collaborative Learning, 11*(4), 417-440. https://doi.org/10.1007/s11412-016-9246-2

Veldman, M. A., Doolaard, S., Bosker, R. J., & Snijders, T. A. B. (2020a). Young children working together: Cooperative learning effects on group work of children in Grade 1 of primary education. *Learning and Instruction, 67*, Article 101308. https://doi.org/10.1016/j.learninstruc.2020.101308

Veldman, M. A., van Kuijk, M. F., Doolaard, S., & Bosker, R. J. (2020b). The proof of the pudding is in the eating? Implementation of cooperative learning: Differences in teachers' attitudes and beliefs. *Teachers and Teaching, 26*(1), 103-117. https://doi.org/10.1080/13540602.2020.1740197