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Relational and cognitive dynamics in collaborative learning: lessons from Pancasila integration in Indonesia

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This study explores how interaction quality in collaborative learning relates to student outcomes and satisfaction in Indonesian high schools, with a focus on cognitive, metacognitive, and relational group activities. Conducted with 117 students across 23 groups in Takalar, Indonesia, the research employed a newly developed and validated questionnaire tailored to capture the nuances of collaborative learning and the integration of Pancasila values. The results demonstrate that high-quality interaction—especially a positive group climate, active participation, and supportive communication—significantly correlates with improved learning outcomes and satisfaction. Furthermore, individual perspective-taking skills were positively linked to interaction quality, while beliefs about learning showed no significant correlation. At the group level, a strong sense of community was associated with better collaboration and higher satisfaction. This study contributes uniquely by embedding Pancasila values, such as gotong royong (mutual cooperation) and social justice, into the assessment of collaborative learning in post-COVID educational settings. While the cross-sectional design and reliance on self-reports limit causal interpretation, the findings offer valuable insights for educators in designing inclusive and culturally grounded collaborative learning environments. The study highlights the importance of relational dimensions and cultural values in enhancing interaction quality and educational resilience in the digital era, especially in Southeast Asian educational contexts. These findings provide a meaningful basis for integrating national philosophical values into pedagogical frameworks that promote both academic and social-emotional development among students.

KEYWORDS

collaborative learning, Pancasila values, high quality interaction, cognitive activity, metacognitive activity, relational activity

Introduction

The COVID-19 pandemic has dramatically reshaped the educational landscape, accelerating the adoption of technology and demanding more collaborative and flexible approaches to learning. In this new era, collaborative learning has become increasingly crucial, offering opportunities to foster students' social competence, motivation, and deeper understanding (Almendarez, 2013; Karim et al., 2021; Mills and Gay, 2019; Tyer-Viola and Cesario, 2010). Through collaborative knowledge construction, students are expected to achieve better learning outcomes compared to traditional, teacher-centred methods (Gustina and Sweet, 2014). This is particularly important in a rapidly changing world where students need to develop 21st-century skills such as communication, critical thinking, and problem-solving.

However, the integration of technology in education (Rafi et al., 2019) and the shift to remote and blended learning have introduced new complexities to collaborative learning. Schools have been challenged to adapt and find innovative ways to facilitate effective collaboration in online and hybrid environments (Fleck, 2012). These transitions require a deeper understanding of the key elements that contribute to high-quality collaborative learning, particularly in technology-mediated settings where both academic engagement and social presence can be disrupted.

While research has consistently demonstrated the benefits of collaborative learning, effective collaboration hinges on high-quality interaction among students (Arfan et al., 2021; Khalil et al., 2018; Yusriadi et al., 2022). This involves not only cognitive engagement but also the ability to navigate social dynamics, communicate effectively, and resolve conflicts constructively. Interaction quality encompasses cognitive, metacognitive, and relational dimensions that are critical to meaningful knowledge construction and group performance.

In the Indonesian context, the integration of cultural and philosophical values into educational practice is increasingly emphasized, particularly through the application of Pancasila—the nation's foundational philosophy. Pancasila promotes values such as *gotong royong* (mutual cooperation), *musyawarah* (deliberation), and *keadilan sosial* (social justice), which resonate strongly with the relational and interdependent nature of collaborative learning. These values not only foster harmony and inclusion within groups but also align conceptually with social interdependence theory, which posits that positive interdependence and promotive interaction enhance group productivity and individual accountability.

Despite the theoretical alignment, empirical research examining how Pancasila values are operationalized within collaborative learning processes remains limited (Putra, 2016). Most existing studies either overlook cultural dimensions or treat values like *gotong royong* and *musyawarah* as implicit social behaviors rather than measurable constructs. Furthermore, few have assessed how such values shape student interaction in the context of digital or hybrid post-pandemic education. This lack of culturally grounded frameworks limits educators' ability to evaluate and support collaboration in ways that are meaningful to Indonesian learners.

To address this gap, the present study aims to develop and validate a context-specific questionnaire that assesses the quality of collaborative learning interactions among high school students in Indonesia by embedding Pancasila values as integral constructs. The instrument focuses on cognitive, metacognitive, and relational dimensions of interaction, aligned with Social Interdependence Theory. The research employs multilevel analysis to examine how interaction quality is associated with learning outcomes and satisfaction, while also exploring individual- and group-level predictors such as perspective-taking and sense of community. By combining a philosophical-national framework with empirical measurement tools, this study offers both theoretical contributions and practical insights for designing culturally responsive collaborative learning environments in Southeast Asia. The findings aim to inform educators and policymakers about the relevance of local values in shaping effective digital pedagogy and relational engagement post-COVID.

Theoretical framework

This study is grounded in Social Interdependence Theory (SIT), which provides a robust framework for understanding how the structure of interdependence among group members influences interaction patterns and learning outcomes. SIT posits that positive interdependence—when individuals perceive that they can reach their goals only if others in the group also reach theirs—fosters promotive interaction, individual accountability, and group cohesion (Johnson and Johnson, 2005). These dynamics are critical for effective collaborative learning, particularly in post-pandemic contexts where emotional support, trust, and shared responsibility have become even more essential for student engagement and resilience.

SIT identifies five key elements for successful collaboration: positive interdependence, individual accountability, promotive interaction, social skills, and group processing. Among these, positive interdependence and promotive interaction are central in shaping the quality of communication and mutual support within learning groups. These concepts align closely with Indonesia's national philosophy—Pancasila—which emphasizes collective well-being, inclusive dialogue, and equitable participation. For instance, the Pancasila value of *gotong royong* (mutual cooperation) directly reflects positive goal interdependence, where students are encouraged to work together and support each other's success. Similarly, *musyawarah* (deliberation) embodies promotive interaction, where open communication and respect for diverse perspectives are key to group decision-making. The value of *keadilan sosial* (social justice) resonates with equal participation and social responsibility, promoting fairness and inclusivity in group learning environments.

By integrating SIT with Pancasila values, this study offers a culturally grounded lens through which collaborative learning can be examined. This theoretical alignment provides a strong basis for analyzing the relational and cognitive dynamics of group interaction, while also advancing culturally responsive pedagogical models in Southeast Asia. It supports the view that effective collaboration is not only a cognitive process but also a social and ethical practice, rooted in shared norms, empathy, and collective purpose.

Methodology

Research design

A quantitative research design was employed using a standardized survey. The study was conducted in mid-2024 in 13 high schools in Takalar, Indonesia. Participants were enrolled in synchronous, offline classes within a learning management system. Each week, students received PowerPoint slides covering teaching and learning principles, along with individual tasks. They were then randomly assigned to fixed learning groups of five or six members. Over an 8-week, students completed ten collaborative tasks, utilizing technology tools of their choice. These tasks, focused on applying theoretical knowledge to practical scenarios, were completed independently without teacher guidance.

One example of a collaborative task involved analyzing a teaching vignette and providing recommendations for improving student knowledge acquisition. Students first worked individually, making notes based on the theoretical material. Then, they met offline to

discuss their suggestions and collaboratively develop concrete steps, documented in a template and justified with references to the learned theory. The co-created document was then uploaded to the learning management platform.

Another collaborative task focused on developing strategies to motivate students in the classroom. Students were presented with a case study of a student who was disengaged and lacking motivation. They were asked to collaboratively identify the potential causes of the student's demotivation and develop a plan to address these issues, drawing on the principles of student motivation they had learned in class. In doing so, they were encouraged to consider how the values of Pancasila, such as mutual cooperation and social justice, could be applied to create a more inclusive and supportive learning environment.

Other collaborative tasks addressed topics such as developing ethical standards in teaching and collaborative assessment of teaching quality. Each task was allotted approximately 30–45 min and followed a similar structure: theoretical input followed by collaborative application.

At the end of the semester, students completed a standardized online questionnaire regarding their collaborative learning experiences. The questionnaire was developed based on existing literature on collaborative learning and the values of Pancasila. It included items measuring various aspects of collaboration, such as communication, coordination, mutual support, and the application of Pancasila values. Participation was voluntary and anonymous, with a 4-week window provided for completion and reminders sent via WhatsApp.

Participants and sampling

This study involved 117 students from 13 high schools in Takalar, Indonesia, who were divided into 23 groups. All students were in grade X and were randomly grouped without regard to academic ability. On average, each group consisted of 5.1 students, with 61% of groups comprising 5 students, 30% comprising 6 students, and 9% comprising 4 students. The response rate at the individual level was 30%, so the study included 117 students in 23 groups. The mean age of the participants was 16.5 years ($SD = 0.5$, $Mdn = 16.5$ years), with 59% of them being female. The participants represented a wide range of academic subjects, including subjects related to Pancasila values. Interestingly, most of the students (85%) were working together in groups for the first time, indicating a lack of experience in collaborative learning.

While the number of participating students and groups provided sufficient data for exploratory multilevel analysis, the relatively small number of groups ($n = 23$) and low response rate (30%) represent limitations that may affect the generalizability of the findings. These constraints may also reduce statistical power, particularly at the group level. Nevertheless, the study aimed to offer in-depth insight into collaborative interaction processes within a culturally specific context rather than to produce population-level generalizations.

Instrumentation and measures

To address RQ-1 (framework conditions of collaborative learning settings), our questionnaire included a question on the tools used for

collaboration, a question on the frequency of technical problems during collaborative activities (4-point Likert scale, 1: 'Never,' 2: 'Rarely,' 3: 'Often,' 4: 'Always'), and a question assessing the time invested in collaborative learning tasks ("How much time do you invest on average per week in collaborative learning tasks?," 8-point Likert scale, 1: '< 15 min' to 8: '> 120 min').

To answer RQ-2 and RQ-3, we assessed the quality and outcomes of group interactions using a newly developed questionnaire specifically designed for this study. This questionnaire is unique in that it not only measures various dimensions of collaborative learning processes but also incorporates the values of Pancasila, making it particularly relevant to the Indonesian educational context. The initial version of the questionnaire consisted of 30 questions and underwent rigorous pilot testing and validation with 200 high school students. We conducted content validity analysis by consulting with experts in collaborative learning and Pancasila to ensure that the items adequately captured the relevant constructs. Exploratory factor analysis revealed a clear factor structure with seven distinct dimensions, and confirmatory factor analysis confirmed the good model fit. Cronbach's alpha coefficients for each subscale ranged from 0.75 to 0.90, indicating good internal consistency reliability. The final version of the questionnaire contained 25 items in Indonesian, which have been translated into English for this article.

The questionnaire assesses collaborative learning processes across three key dimensions: cognitive, metacognitive, and relational group activities. It includes seven aspects relevant to collaborative learning: joint activation of prior knowledge (4 items) and transactional activities (4 items) under cognitive group activities; organization (3 items) under metacognitive activities; and group climate (4 items), participation (4 items), and task-related communication (6 items) under relational group activities. For outcomes, the focus was on learning gains (3 items) and overall satisfaction with digital collaboration (2 items).

Some of the relational activity items were explicitly developed to reflect key Pancasila values embedded in collaborative learning. For instance, the value of *gotong royong* (mutual cooperation) was captured through an item such as "We helped each other understand the learning material," while *musyawarah* (deliberation) was reflected in "We listened to every group member's opinion before making decisions." The principle of *keadilan sosial* (social justice) was operationalized through items like "All group members were given equal opportunities to contribute." These items, although embedded in broader constructs, were reviewed by cultural and educational experts to ensure alignment with both collaborative learning theory and Indonesia's philosophical foundation.

To further investigate the factors influencing collaborative learning outcomes, we included additional scales to measure individual and group-level variables. Perspective-taking ability, which is crucial for effective communication and understanding in collaborative settings, was assessed using the Indonesian subscale of the Interpersonal Reactivity Index. Confidence about online learning was measured using 8 questions to capture students' self-efficacy in navigating digital learning environments. To assess the sense of community within groups, we used 4 items from to measure social entities, capturing the experience of working in a well-functioning and effective group and developing a strong sense of belonging. These additional scales provide a

more comprehensive understanding of the individual and group dynamics that contribute to successful collaborative learning.

All Likert-scale items were measured with a 5-point Likert scale (1: 'Not applicable at all' to 5: 'Fully applicable'). Finally, we collected the 5-digit group code assigned to each group *a priori* via an open-ended question to enable the linking of individual responses to the group level. Sample questions are reported in [Table 1](#).

Data analysis

The data were analyzed using quantitative techniques with SPSS Statistics 28.0 ([Johnson, 2001](#)) and Mplus ([Mantokoudis et al., 2015](#)). Given the multilevel structure of the data, where individuals at Level 1 are nested within groups at Level 2, the intraclass correlation coefficient [ICC(1)] for each dimension was calculated using a null model in multilevel analysis. The ICC(1) values reflect the proportion of total variance attributable to the grouping of individuals within clusters.

For RQ-1, descriptive results are reported. For RQ-2, we employed multivariate path analysis with two dependent variables. This approach enabled us to simultaneously explore the complex relationships among interaction quality, individual and group factors, and learning outcomes. Despite a relatively large number of clusters at Level 2, the small average cluster size led to overestimated standard errors, potentially affecting *p*-value calculations. To mitigate this, we used the 'type is complex' command in Mplus to adjust standard error estimates by accounting for the multilevel data structure and between-class variance. Finally, to address RQ-3, the results of Pearson correlation analyses at both Levels 1 and 2 are presented.

Validity and reliability

To ensure content validity, the initial 30-item questionnaire was reviewed by three experts in collaborative learning and Pancasila-based education. They assessed the relevance, clarity, and cultural appropriateness of each item in relation to the intended constructs, particularly ensuring the alignment of items with core Pancasila values such as gotong royong, musyawarah, and keadilan sosial. Based on their feedback, minor wording adjustments were made, and five items were removed due to redundancy or ambiguity. For construct validity, an exploratory factor analysis (EFA) was conducted on pilot data from 200 high school students. The EFA revealed a clear factor structure comprising seven subdimensions grouped into three higher-order constructs: cognitive, metacognitive, and relational activities. Following EFA, a confirmatory factor analysis (CFA) was carried out using the final sample to validate the factor structure. Goodness-of-fit indices (e.g., CFI = 0.95, RMSEA = 0.04) indicated a satisfactory model fit.

Reliability was assessed using Cronbach's alpha for each subscale. The values ranged from 0.75 to 0.90, suggesting acceptable to excellent internal consistency across the seven subdimensions. Reliability checks were also conducted on the additional scales used for measuring perspective-taking, online learning confidence, and sense of community, with all alpha values above the 0.70 threshold. These procedures ensured that the instrument demonstrated strong psychometric properties and was culturally valid within the Indonesian secondary education context.

Ethical considerations

The study obtained ethical approval from the Nobel Institute, ensuring compliance with ethical standards for research involving

TABLE 1 Variables, indicators, and sources.

Construct/variable	Number of items	Example indicator	Source
Joint activation of prior knowledge	4	We exchanged ideas and prior knowledge about the topic.	Adapted from Herrmann et al. (2023)
Transactional activities	4	We helped each other understand the learning material.	Adapted from Arfan et al. (2021)
Organization	3	We planned and divided the tasks well.	Adapted from Xing et al. (2019)
Group climate	4	The atmosphere in our group was positive and supportive.	Adapted from Johnson and Johnson (2005)
Participation	4	Every group member actively participated in the discussions.	Adapted from Gani et al. (2019)
Task-related communication	6	We communicated effectively to complete the task.	Adapted from Khalil et al. (2018)
Learning gains	3	I feel that I gained a lot of new knowledge from this group task.	Developed by authors, validated in study
Satisfaction	2	I am satisfied with the experience of digital collaboration in this group.	Adapted from Bong and Chen (2024)
Perspective taking	5	I try to look at everybody's side of a disagreement before I make a decision.	Adapted from Johnson (2020)
Online learning confidence	8	I am confident in using online tools for collaborative learning.	Adapted from Putra (2016)
Sense of community	4	Our group worked together effectively and supported one another.	Adapted from Fleck (2012)

human participants. All participants provided informed consent, and anonymity and confidentiality were maintained throughout the research. To protect participant identities, no personal or identifiable information such as names or school IDs was collected. Each respondent's data was linked only through a randomly assigned 5-digit group code. All responses were anonymized prior to analysis and stored securely in password-protected files accessible only to the research team. This anonymization procedure ensured that neither individuals nor groups could be identified in the reporting of results.

Results

RQ-1: foundational conditions

RQ-1 aimed to determine the conditions that support collaboration in this study. The results showed that the student group invested a significant amount of time on the digital collaborative tasks, averaging 1.5 to 2 h per week ($M = 105$ min, $SD = 25$, $Mdn = 100$ min). This shows the level of seriousness and commitment of students in completing collaborative tasks. Video conferencing technology and instant messaging services were students' top choices for collaboration ($M = 4.2$ and 3.9 , respectively). This finding is in line with the increasing trend of technology use in education, especially after the COVID-19 pandemic (Reynilda Zainal et al., 2021). WhatsApp, document sharing and assistive technology tools integrated in learning platforms are rarely used. This indicates that students tend to prefer tools that are more interactive and facilitate real-time communication. Interestingly, technical problems are rarely encountered in the collaboration process. A total of 85% of students reported that group communication was rarely or never hampered by technical problems ($M = 1.6$, $SD = 0.7$). This suggests that students' technological infrastructure and digital skills are sufficient to support collaborative learning.

RQ-2: relationships between interaction quality, learning gains, and satisfaction

Table 2 presents the descriptive statistics for all dimensions assessing interaction quality. While most groups effectively fostered a positive group climate, maintained task-focused efforts, and

included all members in discussions, the mean values for cognitive and metacognitive activities—such as activating shared prior knowledge, engaging in transactional processes, and organizing collaborative work—were found to be moderate. This indicates that although students actively participate and communicate well, they may not be optimal in activating prior knowledge and organising their learning process together.

The high value of ICC(1) (75%) indicates that most of the variance in interaction quality is explained by group membership. This means that students' interaction quality is strongly influenced by the group they belong to. This finding supports previous research showing that group dynamics play an important role in collaborative learning (Aditya et al., 2021; Xing et al., 2019). The higher scores for group climate, participation, and task-related communication compared to (meta)cognitive activities suggest that relational and social aspects of collaboration may be more prominent than cognitive aspects.

Next, we analysed whether the quality of group interactions resulted in expected learning outcomes and satisfaction. Self-reported learning outcomes ($ML1 = 3.8$, $SDL1 = 0.6$, $\alpha = 0.85$, $ML2 = 3.9$, $SDL2 = 0.5$, $ICC(1) = 0.15$) and overall satisfaction with the group process ($ML1 = 4.1$, $SDL1 = 0.7$, $\alpha = 0.88$, $ML2 = 4.2$, $SDL2 = 0.6$, $ICC(1) = 0.10$) were considered as cognitive and motivational outcomes.

Multivariate path analysis results (see Figure 1) revealed that groups that systematically activated prior knowledge ($b = 0.35$, $SE = 0.10$, $\beta = 0.25$, $p = 0.001$) and structured their learning process through metacognitive strategies ($b = 0.42$, $SE = 0.12$, $\beta = 0.28$, $p < 0.001$) achieved greater improvements in learning outcomes. These findings emphasise the importance of cognitive and metacognitive activities in effective collaborative learning. Interestingly, although productive group discussions were positively related to satisfaction ($b = 0.55$, $SE = 0.15$, $\beta = 0.32$, $p = 0.001$), there was no significant relationship with learning outcomes. This indicates that student satisfaction in collaboration does not necessarily guarantee improved learning outcomes.

A positive group climate ($b = 0.28$, $SE = 0.08$, $\beta = 0.20$, $p < 0.001$) and active involvement of all group members ($b = 0.32$, $SE = 0.10$, $\beta = 0.22$, $p = 0.003$) were significant predictors of learning outcomes. As anticipated, these factors also impacted satisfaction with the group process (group climate: $b = 0.40$, $SE = 0.12$, $\beta = 0.25$, $p < 0.001$; participation: $b = 0.35$, $SE = 0.10$, $\beta = 0.22$, $p < 0.001$). These findings highlight that the relational and social dimensions of collaboration not

TABLE 2 Summary statistics.

Dimensions	Mean (SD)	ICC(1)
Cognitive activity		
Activation of shared prior knowledge	3.5 (0.8)	0.65
Transactional	3.7 (0.7)	0.70
Metacognitive activity		
Setting	3.6 (0.9)	0.72
Relational activity		
Group climate	4.2 (0.6)	0.80
Participation	4.0 (0.7)	0.78
Task-related communication	3.9 (0.8)	0.75

Social Interdependence Theory

- Positive Interdependence
- Promotive Interaction
- Social Skills
- Group Processing
- Individual Accountability

Pancasila Values

- Gotong Royong = Mutual Cooperation
- Musyawarah = Deliberation/Promotive Interaction
- Keadilan Sosial = Social Justice/Equal Participation



FIGURE 1

Conceptual framework linking Social Interdependence theory and Pancasila values.

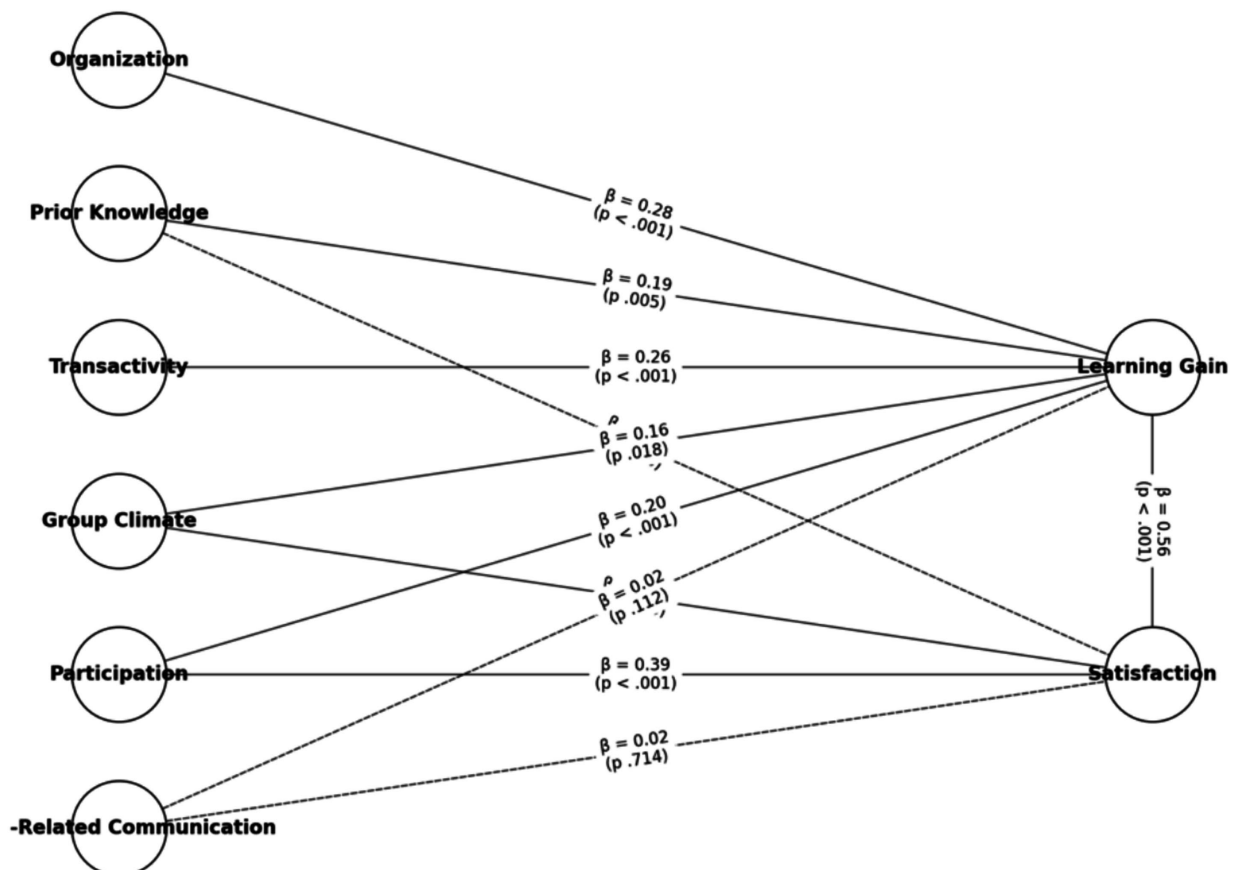


FIGURE 2

Path analysis of interaction quality and its impact on learning outcomes and satisfaction.

only enhance satisfaction but also play a role in improving learning outcomes (see Figure 2).

The independent variables accounted for 35% of the variance in learning outcomes and 42% of the variance in satisfaction. Because the estimated path model was saturated (degrees of freedom = 0), traditional model fit indices such as RMSEA, CFI, or TLI are not applicable and therefore not reported. In a saturated model, all parameters are estimated, and the model by definition fits the data perfectly without degrees of freedom left for testing model-data discrepancy. Importantly, task-related communication did not significantly predict either learning outcomes ($\beta = 0.09$, $p = 0.27$) or satisfaction ($\beta = 0.06$, $p = 0.35$), despite its relatively high mean score ($M = 3.9$). This non-significant relationship remained consistent even after adjusting for multilevel clustering. We retained this result in our

model and discuss possible contextual or measurement-based explanations in the Discussion section.

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TABLE 3 Associations between interaction quality and individual as well as group-level predictors.

Construct	Perspective-taking ability	Beliefs about learning	Sense of community
Individual level			
Cognitive activities			
Joint activation of prior knowledge	0.30**	0.10	—
Transactional activities	0.25**	0.08	—
Metacognitive activities			
Organization	0.28**	0.12	—
Relational activities			
Group climate	0.35**	0.15	0.60**
Participation	0.32**	0.12	0.55**
Task-related communication	0.20**	0.05	—
Learning outcomes			
Learning gain	0.40**	0.20	—
Satisfaction	0.45**	0.18	0.70**
Group level			
Cognitive activities			
Joint activation of prior knowledge	—	—	0.25
Transactional activities	—	—	0.20
Metacognitive activities			
Organization	—	—	0.30*
Relational activities			
Group climate	—	—	0.75**
Participation	—	—	0.65**
Task-related communication	—	—	0.35*
Learning outcomes			
Learning gain	—	—	0.40**
Satisfaction	—	—	0.60**

* $p < 0.05$; ** $p < 0.01$.

RQ-3: connections between interaction quality, perspective-taking skills, learning attitudes, and group community sense

RQ-3 explores the connection between individual and group factors and the quality of interaction in collaborative learning. Correlation coefficients at both the individual and group levels are detailed in Table 3.

Perspective-taking ability ($ML1 = 3.9$, $SDL1 = 0.8$, $\alpha = 0.75$, $ICC(1) = 0.20$) was moderately positively correlated with the (meta) cognitive, group climate, participation, and task-related communication subdimensions. This suggests that students who are able to understand others' perspectives tend to be better at collaborating, both in cognitive, social, and relational aspects. This finding supports previous research showing the importance of perspective-taking ability in collaborative learning.

However, it was surprising that there was no significant correlation between beliefs about learning ($ML1 = 3.5$, $SDL1 = 0.7$, $\alpha = 0.80$, $ICC(1) = 0.15$) and the interaction quality dimension. This is contrary to the expectation that students with more positive beliefs about learning would be more engaged in collaboration. There may be other

factors that have more influence on interaction quality, such as motivation, social skills, or previous experience in collaborative learning.

At the group level, sense of community ($ML1 = 4.1$, $SDL1 = 0.6$, $\alpha = 0.85$, $ML2 = 4.2$, $SDL2 = 0.5$, $ICC(1) = 0.25$) was strongly positively correlated with group climate, participation, and overall satisfaction with the collaborative learning process. This suggests that groups with a high sense of community tend to create a more positive, supportive, and enjoyable learning environment, which in turn can improve the quality of student interactions and satisfaction.

Discussion

This study examined collaborative learning from the students' perspective in the Pancasila subject. Groups of five or six students engaged in collaboration over the course of a semester. The teacher initiated the collaborative tasks, but the collaborative process itself took place without teacher direction, so students had autonomy in determining task completion strategies. By the end of the semester,

students assessed the collaborative learning process using a newly designed questionnaire (Dunlop, 2009; Sabatier, 1987; Xing et al., 2019). The questionnaire evaluates group interaction based on cognitive, metacognitive, and relational activities that enhance the effectiveness of collaborative learning. The survey also included questions about enabling conditions and individual and group characteristics. This study aimed to understand self-directed collaborative learning and examine the pathways that contribute to its success.

The results showed that student groups invested significant time in digital collaborative tasks, averaging more than 1.5 h per week over a semester. This reflects the seriousness of students in collaborative learning. Video conferencing and instant messaging were the most frequently used tools, in line with the trend of technology integration in education, especially after the COVID-19 pandemic (Jafar et al., 2023; Tomasik et al., 2021). The choice of these tools indicates students' preference for interactive and real-time communication. Interestingly, technical constraints previously identified as barriers to collaboration (Arfan et al., 2021; MacPhail et al., 2003) were rarely encountered, indicating the adequacy of students' infrastructure and digital literacy.

In terms of interaction quality, relational group activities received higher mean scores than cognitive or metacognitive activities. Aspects such as positive group climate, active participation, and task-focused communication were rated highly, supporting the findings of previous research (Gangoda et al., 2023; Gani et al., 2019). Relational activity was not affected by the type of digital tools used. However, video conferencing appeared to stimulate (meta)cognitive processes, suggesting the potential of video conferencing in facilitating concept understanding and knowledge construction.

This study found that synchronous formats need to be combined with asynchronous formats (Misnawati et al., 2022; Spittle and Byrne, 2009) to support more in-depth discussions. Higher ICC(1) values for relational activities indicate consistency of judgement between group members and the instrument's ability to differentiate groups based on relational aspects.

A positive group climate and active participation had a positive impact on learning outcomes and satisfaction. This supports social interdependence theory (Bernadtua Simanjuntak et al., 2023; Cathrin and Wikandaru, 2023; Sakkir et al., 2021) which emphasises the importance of positive interdependence in groups. However, this study did not find a significant relationship between task-related communication and learning outcomes. This may be due to the presence of off-task conversations that can actually increase group cohesion and effectiveness (Arfan et al., 2021). In addition, the post-COVID-19 context (Castaño-Muñoz et al., 2025; Rice et al., 2025; Sakkir, 2018) may be influential, where off-task conversations may compensate for the lack of social interaction during the pandemic.

The lack of significant association between task-related communication and learning outcomes suggests that while students may engage in communication related to tasks, the quality or focus of such communication may vary. One possible interpretation is that these interactions included off-task or procedural exchanges that did not directly contribute to conceptual understanding—an issue observed in prior research on unstructured collaboration (Arfan et al., 2021; Therova and McKay,

2024; Woodruff et al., 2022). Future studies could distinguish between substantive and procedural communication to better capture this nuance.

This study found a stronger relationship between organisation and prior knowledge with learning outcomes compared to satisfaction. On the other hand, the impact of transactional activities on satisfaction was greater than on learning outcomes. Although there was a significant intercorrelation between transactional activities and learning outcomes ($r = 0.25$, $p < 0.05$), this intercorrelation disappeared when all factors were included in the model, indicating a possible mediating effect that needs further investigation.

This study has limitations, including the cross-sectional design and the use of self-report data. Future research should consider a longitudinal design and objective measures to gain a more comprehensive understanding of the factors that influence collaborative learning. Nonetheless, this study provides valuable insights into collaborative learning in post-COVID-19 schools, emphasising the importance of relational aspects in creating effective collaboration. This study also fills a gap in the literature by providing empirical evidence on the relationship between interaction quality, individual and group factors, and learning outcomes in a post-pandemic context. The findings have implications for educators and researchers in optimising collaborative learning in the digital era.

These findings align with international research that highlights the importance of relational processes in collaborative learning. For example, also found that group cohesion, climate, and promotive interaction significantly shape learner satisfaction and perceived success (Bong and Chen, 2024; Grewenig et al., 2021; Ikasari, 2020). However, unlike studies conducted in Western contexts that often emphasize structured roles and metacognitive scaffolding (Herrmann et al., 2023; Nurman et al., 2022), this study reveals the strong influence of shared cultural values—such as gotong royong—in organically fostering group harmony and shared responsibility. This suggests that contextually embedded values may serve as an alternative or complementary pathway to formal collaborative structures in collectivist societies like Indonesia. Based on these findings, several practical strategies can be recommended for educators to strengthen collaborative learning environments. First, structured icebreaker activities inspired by gotong royong—such as jointly solving a simple non-academic task—can build early trust and cooperation. Second, incorporating *musyawarah*-style decision-making routines (e.g., requiring consensus before moving to the next task phase) helps foster inclusive dialogue. Teachers can also rotate leadership roles based on shared responsibility to reflect the principle of *keadilan sosial*. Finally, brief group reflections at the end of tasks—prompted by questions like “How did we support each other today?”—can reinforce relational awareness and empathy.

Conclusion

This research provides valuable insights into the dynamics of collaborative learning in post-COVID-19 schools. The study successfully emphasises the importance of relational aspects, such as effective communication, trust and a sense of belonging, in creating productive and meaningful collaboration among students, which aligns with the

values of mutual cooperation and deliberation emphasized in Pancasila. Furthermore, this study fills a gap in the literature by providing empirical evidence on the complex relationship between interaction quality, individual (motivation, confidence) and group (group norms, cohesion) factors, and student learning outcomes specifically within the context of Indonesian high schools in a post-pandemic context, where the shift to online and blended learning has significantly impacted the dynamics of classroom interaction. The findings suggest that effective collaborative learning depends not only on cognitive aspects but is also influenced by students' social and emotional factors. Thus, the results of this study have important implications for educators and researchers. Educators need to design learning strategies that not only facilitate cognitive interaction, but also develop students' social and emotional skills, such as active listening, empathy, and conflict resolution, as well as build positive relationships in learning groups through ice-breaking activities, team-building exercises, and fostering a culture of mutual respect and support. On the other hand, researchers can develop further research to explore other factors that influence the effectiveness of collaborative learning in the digital era, such as the role of technology, students' learning styles and the influence of the learning environment. This research provides a strong foundation for optimising collaborative learning in the new era of education, which is characterised by technology integration and flexibility in the learning process, ultimately empowering students to become active, engaged, and collaborative learners who are equipped to thrive in the 21st century.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Nobel Institute Ethics Committee, Nobel Institute for Education and Social Research, Makassar, Indonesia. The studies were conducted in accordance with the local legislation and institutional requirements.

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Author contributions

AA: Writing – original draft, Writing – review & editing. BB: Writing – original draft, Writing – review & editing. MI: Writing – original draft, Writing – review & editing.

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