

Comparison of Critical Thinking Types between Groups and Pairs

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ABSTRACT

This quantitative study investigated how different types of critical thinking are associated with group work and pair work among 174 university students using a questionnaire with 44-item under three sections. Findings show learners most strongly apply evaluative and people-oriented thinking skills when solving complex problems and judging others' ideas. Collaborative communication is highly characterised by shared goals, trust and learning from mistakes in group work, meanwhile explanation, idea exchange and shared responsibility are strongest in pair work. Strong positive relationships were found between critical thinking and group work ($r=.651$) as well as pair work ($r=.573$), with no significant differences across academic clusters. The results indicate that both collaborative formats support critical thinking through complementary interaction patterns. The findings further reveal that learners demonstrate consistent use of thought-oriented, action-oriented and people-oriented thinking across collaborative contexts. Group work encourages collective problem solving, flexible processes and mutual trust, while pair work promotes focused dialogue, knowledge construction and shared responsibility between partners. Overall, the patterns suggest that collaborative learning environments provide supportive conditions that stimulate higher order thinking, communication and engagement among university learners. These results reinforce the importance of carefully designed collaborative tasks that balance interaction structure and learner participation in different learning situations across university classrooms and academic courses in higher education contexts today and beyond globally for diverse learners worldwide today effectively and efficiently. The study suggests that deliberately structured group and pair activities should be integrated across disciplines to enhance students' problem-solving and critical thinking skills in higher education settings.

Keywords: Critical thinking, problem-solving skills, self-determination, group work, pair work

INTRODUCTION

Background of Study

In contemporary education, students are required to participate actively rather than absorb information passively. Developing critical thought is therefore a primary teaching aim. This skill equips learners to evaluate content, assess underlying premises, and reach reasoned conclusions. One established approach for building this ability is collaborative learning, where students work jointly to build understanding through discussion and shared tasks. Here, individuals with mixed skill levels combine efforts to achieve a common learning outcome. According to Johnson, Johnson and Smith (2014), collaborative activities encourage deeper cognitive processing because learners must articulate ideas, challenge assumptions, and negotiate meaning.

There are two common formats for this which are group work and pair work. Group work typically involves three or more learners sharing diverse perspectives, which can stimulate creative and practical thinking through idea exchange and problem-solving discussions (Gillies, 2016). In contrast, pair work allows for a more concentrated dialogue, which frequently aids careful analysis and reflective conversation, since both partners

remain actively involved (Storch, 2002). In either format, each participant must contribute for the activity to succeed.

Regarding team function, Belbin's (2013) team role theory describes how critical thinking in groups develops through a mix of thinking roles, action roles, and people roles. Belbin also highlights that effective team reasoning depends not only on an individual's cognitive ability but also on how members participate, communicate, and fulfil their responsibilities.

Even though extensive research on group work has been conducted over the last decade, the relevance of studying this topic remains high. This is due to shifts in educational practice and a growing focus on cooperation which keep this subject current. Additionally, because employers consistently seek graduates who can solve problems and work well with others, research in this area holds continued value for both theory and practice.

Statement of Problem

In recent years, pair work and group work have become essential components of collaborative learning. These approaches are used extensively in classrooms to promote interaction, engagement and higher-order thinking skills. Research shows that students' critical thinking skills significantly improved while their communication apprehension significantly reduced when they engaged in group-based projects or discussions (Dias-Oliveira et al., 2024). At the same time, their communication and teamworking skills also improved tremendously.

The two common collaborative formats are pair work and group work and various studies that revolved around critical thinking have been conducted on both formats. Lintner, Diviak and Nekardova (2024) suggested that group composition, in terms of who the group members consist of, has an influence towards interaction dynamics and communication norms, hinting that different communication styles or critical thinking approaches may be adopted by learners in pair work and group work. Fan et. al (2025) noted that a bigger group size could foster greater collective critical thinking skills while Alzubi, Nazim and Ahamad (2024) found a positive link between multiple collaborative learning methods and learners' learning skills and social interaction.

However, the relationship between the types or patterns of critical thinking and specific collaborative approaches, specifically pair work versus group work settings, has not been thoroughly examined and it is still unclear whether these different formats of collaborative learning influence the types of critical thinking learners make use of as well as the ways they communicate. Therefore, this present research examines how learners use different types of critical thinking skills in pair work versus group work and whether there is any relationship between the critical thinking types and the collaborative methods used.

Objective of the Study and Research Questions

This study is done to explore critical thinking types for group work and pair work. Specifically, this study is done to answer the following questions;

RQ 1 - How do learners use different types of critical thinking skills?

RQ 2 - How do learners identify their group work communication?

RQ 3 - How do learners identify their pair work communication?

RQ 4 - Is there a relationship between critical thinking types and group work? (H1- There is no relationship between critical thinking types and group work)

RQ 5 - Is there a relationship between critical thinking types and pair work? (H2- There is no relationship between critical thinking types and pair work)

RQ 6 - Is there a significant difference for critical thinking types for group work and pair work across clusters? (H3- There is no significant difference for critical thinking types for group work and pair work across clusters)

LITERATURE REVIEW

Self-Determination Theory

Self-Determination Theory (SDT) is a comprehensive macro-theory of human motivation, development, and wellness that was established in the 1970s by Edward Deci and Richard Ryan and has been refined over decades of consistent research (Deci & Ryan, 2008; Deterding et al., 2025). This theoretical framework observes human motivation, personality development, and the well-being of individuals in a systematic method whereby the focus is on situations that either strengthen or impede self-determined behaviours across different domains of life (Nunes et al., 2024; Vansteenkiste et al., 2010). The self-determination theory also emphasizes that autonomy, competence, and relatedness are basic psychological needs whereby if the social environments support these needs, it can strengthen the individual's motivation (Deci & Ryan, 2008). When these basic psychological needs are satisfied and met, it leads to increased perseverance, improved learning, and a more holistic well-being of the individual as they will be more likely to be more engaged in any activities they are involved in (Deci et al., 1999). In contrast, when these needs are hindered, the individual may experience amotivation; lacking interest, drive and purpose which could lead to the difficulty of starting or finishing activities (Deci & Ryan, 2008). Below is a summary of how group work supports the three basic psychological needs.

Autonomy

The ability to take initiative and have a sense of ownership in one's own actions. Experiences cannot be externally controlled, whether by rewards or punishments, rather they must be built from self-interest and value (Ryan & Deci, 2020). Having autonomy gives the students choice and control over the roles that they play, the goals that they can set to achieve, the approaches to take, and the sense of ownership that they can foster in the learning process of group work (Alturki & Aldraiweesh, 2024; Escandell & Chu, 2021; Fang & Chiu, 2025; Grenier, Gagne, & O'Neill, 2024; White, Bennie, Vasconcellos, Cinelli, Hilland, Owen & Lonsdale, 2021).

Competence

The ability to develop a feeling of mastery where one can succeed and grow in life. Well-constructed environments that provide growth prospects, ideal challenges, and constructive feedback are optimal to satisfy the need for competence (Ryan & Deci, 2020). If collaborative environments (group work) provide feedback that is constructive and clear, group members will be able to feel more capable and efficient in mastering achievable goals (Alturki & Aldraiweesh, 2024; Escandell & Chu, 2021; Fang & Chiu, 2025; Grenier, Gagne, & O'Neill, 2024; White, Bennie, Vasconcellos, Cinelli, Hilland, Owen & Lonsdale, 2021).

Relatedness

The ability to develop a sense of belonging and connection with others in a social environment. Showing respect and care towards others support this basic need (Ryan & Deci, 2020). Team members that are able to build strong and supportive relationships will be able to increase engagement in communication and foster a positive and collaborative teamwork which will yield constant successful results (Alturki & Aldraiweesh, 2024; Escandell & Chu, 2021; Fang & Chiu, 2025; Grenier, Gagne, & O'Neill, 2024; White, Bennie, Vasconcellos, Cinelli, Hilland, Owen & Lonsdale, 2021).

Group Work Development Model

Tuckman (1965) Group work development model describes group development as a series of stages, namely forming, storming, norming, and performing, which are characterized by different social interactions and task demands. These stages influence how learners interact, share idea and approach problem-solving. As such, the model provides a useful framework to examine whether different collaborative formats, such as group work and pair work, are associated with different types of critical thinking (Chang & Brickman, 2018).

Forming and storming stages

In the forming stages, group members normally focus on social adjustment and task clarification rather than deep analysis. Studies suggest that in larger groups, discussion may remain descriptive, with limited evaluation of ideas, which may restrict higher-order thinking skills (Fenwick & Parsons, 1999). During storming stages, disagreement over ideas and roles commonly occurs in group work. It may encourage evaluation and reflection, but it can hinder participation if not well managed. In pair work, interaction tends to be more focused and less affected by over-disagreement, and potentially supporting inferential thinking and basic problem-solving, even though it may be dominated by one and might limit balanced reasoning (Gagne & Parks, 2013; Levine & Moreland, 2020).

Forming and performing stages

In the norming stage, shared rules and roles begin to guide the discussion. These structures may support analytical and evaluative thinking by encouraging members to give justification and consider other viewpoints. At the performing stage, group work may allow learners to combine different perspectives, supporting synthesis and evaluate complex tasks (Winguists & Larson, 1998). In contrast, pair work relies on informal coordination and close interaction, which may encourage deeper explanation and integration of ideas, particularly in tasks requiring focused reasoning (Hitchcock, 2018).

Overall, both group work and pair work can support critical thinking, and the type of thinking encouraged may vary depending on group size and developmental stage. However, findings across studies are not entirely consistent, as effective collaboration depends on factors such as task design, group dynamics, and instructional support (Webb et al., 2013).

Past Studies

Many studies have been done to investigate group work interactions or collaborations in learning. Schermeier, Deiglmayr and Rummel (2025) assessed the collaboration quality in hybrid compared to face to face and remote settings among 180 university students at two German universities. The students were assigned randomly to either face to face, remote or hybrid collaboration modes of learning. To determine the collaboration quality, the authors used self-reported learner perceptions and external observer ratings across three dimensions, namely learner participation, interaction quality and quality of the collaborative product. It was found that students had stronger interaction quality in hybrid conditions compared to the other two settings and remote learners reported a lower level of mutual understanding than those in the hybrid and in the face to face conditions.

A study by Lintner, Diviak and Nekardova (2024) looked at the factors influencing interaction dynamics in classroom group work among 145 Czech lower-secondary students in 62 small groups. Using class visitations and video recordings, the researchers were able to work on 806 minutes of recorded materials. The study revealed that students tended to initiate interactions with others that they had interacted with before or with their own friends. It was also found that students with high levels of literacy tended to initiate interactions and interacted more in group work.

Alexandru (2025) conducted a qualitative research on 188 second year undergraduate software engineering students in the School of Informatics of the University of Edinburgh to assess student perceived group effectiveness and attitude towards teamwork. Results indicated a slight overall increase in students' perception towards their groups' effectiveness and a positive attitude towards teamwork. At the same time, more students also preferred working in a team than working alone although some high achiever students expressed feelings of inequality and unfairness with regards to efforts to offer equal chances of success in the assignment given.

A study examining the relationship between various characteristics which contribute to effective project teams and subsequently and successful project teams in IT organisations was carried out by Arora, Gajendragadkar and Neelam in 2023. 110 IT professionals took part in the quantitative study and it was found that there was an interdependence between team purpose and goals, team roles, team processes and team relationships towards

the team’s effectiveness. The researchers also noted positive links between team roles with team relationships and team processes respectively.

Where pairwork interactions are concerned, Rahmat (2025) explored interactions during pair work in a language classroom, drawing on Vygotsky’s (1984) social constructivism theory as the study’s guiding principle. The quantitative study involved 36 respondents and the findings revealed the students were not afraid to ask for help when working in pairs and that they were more open to share and receive new ideas from each other. The respondents also reported that pair work gave them the opportunity to use the target language.

In conclusion, past studies indicate that interactions in both pair work and group work play an important role in ensuring tasks are completed successfully. This is because these collaborative learning methods encourage the exchange of ideas and shared responsibility among learners. Therefore, it is important to see how these methods contribute to the development of learners’ critical thinking skills.

Conceptual Framework of the Study

Group communication provides many benefits to students. While it is true students are able to complete the task faster than doing it alone, group work communication strengthens students’ problem-solving skills. The process of negotiating meaning across encourages students to negotiate ideas and solve problems within the group (Rahmat, 2020). Figure 1 presents the conceptual framework of the study. This study explores group and pair work discussions and how the discussions influence learners' critical and problem-solving skills. This study combines variables from critical thinking by Belbin (2013). The constructs for critical thinking skills and problem-solving (i) thought-oriented, (ii) action-oriented and (iii) people-oriented. Next, the variables group work by Bateman, et.al (2022) is supported by constructs such as (i) purpose and goals (PG), (ii) roles (R), (iii) team processes (TP), (iv) intergroup relations (IR), (v) passion and commitment (PC) and (vi) skills and learning (SL). Lastly, the variable ‘pair work by Baleghizadeh & Farhesh (2014) is supported by constructs such as (i) social instructions, (ii) knowledge construction and (iii) social and cultural context.

Additionally, this study also investigates if the relationship between group and pair work with critical and problem-solving skills.

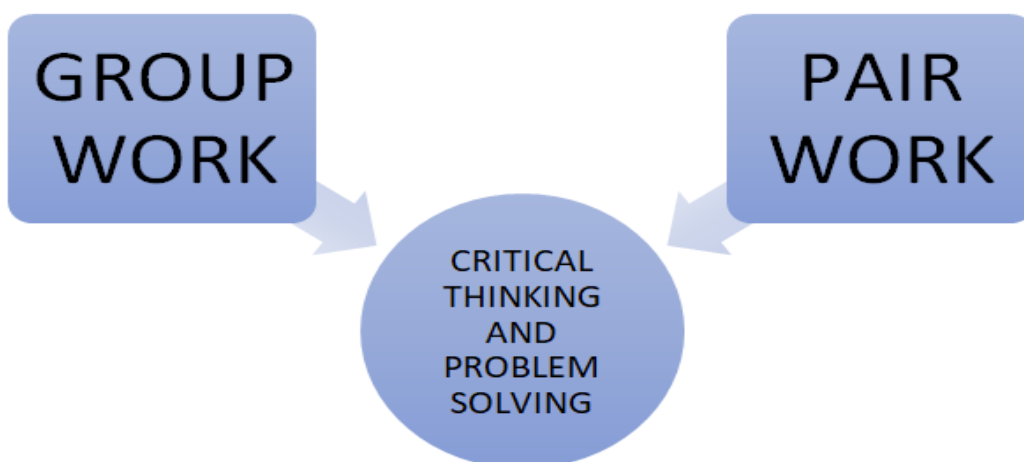


Figure 1- Conceptual Framework of the Study Comparison of Critical Thinking Types with Group and Pair Work

METHODOLOGY

This quantitative study is done to explore critical thinking types for group work and pair work. A convenient sample of 174 participants responded to the survey. The instrument used is a 5 Likert-scale survey and is rooted from Belbin (2013), Bateman, et.al (2002) and Baleghizadeh & Farhesh (2014) to reveal the variables in table 3 below. Table 1 below shows the categories used for the Likert scale; 1 is for Strongly Disagree, 2 is for Disagree, 3 is for Undecided, 4 is for Agree and 5 is for Strongly Agree.

Table 1. Likert Scale Use

1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

Table 2. Distribution of Items in the Survey

SECTION	VARIABLE	CONSTRUCT	ITEM	TOT ITEM	CRONBACH ALPHA
A	CRITICAL THINKING & PROBLEM SOLVING Belbin (2013)	Thought-Oriented	4	10	.788
		Action-Oriented	3		
		People-Oriented	3		
B	GROUP WORK Bateman, et.al. (2002)	Purpose and Goals (PG)	3	22	.962
		Roles (R)	3		
		Team Processes (TP)	3		
		Team Relationships (TR)	4		
		Intergroup Relations (IR)	3		
		Passion and Commitment (PC)	3		
		Skills and Learning (SL)	3		
C	PAIR WORK Baleghizadeh & Farhesh (2014)	Social Interactions	4	12	.943
		Knowledge Construction	4		
		Social & Cultural Context	4		
				44	.967

Table 3. Table 2 shows the distribution of 44 items in the survey, divided into three sections that represent the main variables of the study: Critical Thinking and Problem Solving (Section A), Group Work (Section B) and Pair Work (Section C). The items were adapted from Belbin (2013), Bateman et al. (2002) and Baleghizadeh and Farhesh (2014) so that each section measures specific aspects of thinking and communication in collaborative learning contexts. Section A contains 10 items, Section B contains 22 items and Section C contains 12 items, making the instrument balanced enough to compare individual thinking tendencies with interaction patterns in both groups and pairs.

Section A measures critical thinking and problem solving through three constructs based on Belbin's (2013) team roles, namely thought-oriented (4 items), action-oriented (3 items) and people-oriented (3 items). The thought-oriented items focus on analysing situations and evaluating alternatives before making decisions, reflecting critical thinking as careful judgement and justification of choices (Hitchcock, 2018; Johnson, Johnson & Smith, 2014). The action-oriented items measure creative and practical problem solving such as recognising

patterns and making accurate judgements, which are commonly stimulated through idea exchange in collaboration (Gillies, 2016). The people-oriented items capture how learners evaluate others’ ideas objectively and manage emotions when working with unfamiliar partners, highlighting that effective reasoning in teams depends on communication and interpersonal awareness as well as cognition (Belbin, 2013; Deci & Ryan, 2008).

Section B examines group work communication using 22 items across several constructs: purpose and goals, roles, team processes, team relationships, intergroup relations, passion and commitment, and skills and learning. Shared goals and clear roles provide direction and structure that support deeper collective thinking (Johnson et al., 2014; Arora, Gajendragadkar & Neelam, 2023). Flexible processes, trust and open communication resemble later stages of group development where organised interaction enables analysis and evaluation of ideas (Tuckman, 1965; Chang & Brickman, 2018). Commitment and continuous learning further strengthen collaboration by promoting motivation, constructive feedback and improvement, which fulfil learners’ needs for relatedness and competence in social learning environments (Ryan & Deci, 2020; Grenier, Gagne & O’Neill, 2024).

Section C focuses on pair work through 12 items grouped into social interaction, knowledge construction and social and cultural context. Close two-person interaction encourages help-seeking, relaxed communication and sharing of ideas (Rahmat, 2025). Explaining information to a partner supports deeper understanding and focused reasoning, showing how dialogue in pairs aids knowledge construction (Hitchcock, 2018). Shared responsibility and mutual acceptance between partners reflect the negotiation of meaning that strengthens problem solving and engagement (Rahmat, 2020; Escandell & Chu, 2021). Overall, the distribution of items in Table 2 operationalises how different collaborative formats may foster different patterns of critical thinking and communication.

Table 4. Reliability Levels, Cronbach’s Alpha Ranges, and Their Interpretations

Reliability Level	Cronbach’s Alpha range	Interpretation
Excellent	0.9 and above	Indicates very high internal consistency
Good	0.80-0.89	Reflects strong internal consistency
Acceptable	0.70-0.79	Indicates acceptable internal consistency
Questionable	0.60-0.69	Reflects questionable internal consistency
Poor	Below 0.6	Indicates poor internal consistency

In order to determine the internal reliability of the instrument, reliability analysis is one. Table 3 above shows the distribution and interpretation of Cronbach Alpha range. According to Ahmad et. al (2024), Cronbach Alpha scores between 0.7 to 0.9 is considered acceptable to excellent.

Table 5. Table 2 also shows the reliability of the survey. The analysis shows a Cronbach alpha of .788 for Critical Thinking, .962 for Group work, and .943 for pair work. The overall Cronbach Alpha for all 44 items is .967; thus, revealing a good reliability of the instrument chosen/used. Further analysis using SPSS is done to present findings to answer the research questions for this study.

FINDINGS

Demographic Analysis

According to Zienefuss, et.al (2021), researchers report demographic data in percentages to establish sample representatives, and allow for generalizability to a larger population. The reporting also provides an overview of participants’ characteristics. Percentages offer a clear and understandable picture of the sample makeup.

Table 6. Percentage for Demographic Profile

Question	Demographic Profile	Categories	Percentage (%)
1	Gender	Male	32%
		Female	68%
3	Cluster	Science & Technology	50%
		Social Sciences & Humanities	50%

Table 7. Table 4 displays the demographic profile of gender and field cluster of the sample population. There were more responses from female students (68%) compared to male students (32%), due to the imbalanced ratio of male and female students in each of the targeted clusters. However, the study was able to obtain a balanced number of respondents from both the Science and Technology cluster (50%) and the Social Sciences and Humanities cluster (50%), which helped increase the reliability rate of the questionnaire.

Descriptive Statistics

Why is there a need to report the mean and standard deviation? According to Vetter (2017), Mean (M) represents the average, or centre of a data set. Standard deviation (SD) indicates the typical distance of individual observations from the mean which shows the data’s variability or spread. A low SD means the data points are clustered close to the mean while a high SD indicates they are more spread out. It is good to have a high SD.

Findings for Critical Thinking

This section presents data to answer research question-1 -How do learners use different types of critical thinking skills?

Table 8. Mean for Thought-Oriented (TO)

ITEM	Mean	SD
TOQ1 When suddenly asked to consider a new project, I am able to take an independent and innovative look at most situations.	3.78	0.79
TOQ2 In seeking satisfaction through my work, I like to make critical discrimination between alternatives.	3.63	0.83
TOQ3 When trying to solve a complex problem, I like to weigh up and evaluate a range of suggestions thoroughly before choosing.	4.12	0.74
TOQ4 When suddenly asked to consider a new project, I approach the problem in a carefully analytical way	3.40	0.74

Table 9. oriented critical thinking skill of the respondents. Out of the four items, item TOQ3 had the highest mean with a score of 4.12. All the respondents agreed that the evaluation process before making a decision is important to help solve a complex problem. Meanwhile, other items had generally neutral stances by the respondents, with the second highest mean being item TOQ1 taking an independent and innovative look when considering a new project (3.78), followed by TOQ2 making discriminations between choices to seek satisfaction through work (3.63), and the lowest mean being item TOQ4 analytically approaching a problem when considering a new project (3.40). All in all, the respondents are neutral when using the thought-oriented critical thinking skill when seeking satisfaction in their work and considering new projects, however, they all agree that they use this particular skill when trying to solve complex problems.

Table 10. Oriented (AO)

ITEM	Mean	SD
AOQ1 In seeking satisfaction through my work, I tend to have a creative approach to solve problem solving.	3.99	0.69
AOQ2 In carrying out my day-to-day work, I tend to see pattern in solving problems where others would see items as unconnected.	3.81	0.61
AOQ3 I take a considerable amount of time to make judgement but most often, the judgement made is accurate.	3.63	0.74

Table 11. oriented critical thinking skills of the respondents. Among the three items, AOQ1 has the highest mean score of 3.99, indicating that respondents agree they used a creative approach to solve problems in seeking satisfaction in their work. Additionally, AOQ2 has a slightly lower mean score of 3.81, suggesting that respondents tend to recognise patterns in problem-solving that others may overlook. Meanwhile, AOQ3 has the lowest mean score of 3.63, which implies that respondents take ample time to make judgements and their judgements are generally accurate. Overall, the respondents tend to think creatively, recognise patterns, and make careful decisions, although their confidence in their judgements varies.

Table 12. Oriented (PO)

ITEM	Mean	SD
POQ1 I can see how ideas and techniques can be used in perceiving new relationships.	4.02	0.64
POQ2 I analyse other people’s ideas objectively, by evaluating both advantages and disadvantages	4.21	0.64
POQ3 If I am suddenly given a difficult task with limited time and unfamiliar people, my feelings seldom interfere with my judgement.	3.57	0.90

Table 13. oriented skills related to critical thinking. POQ2 shows the highest mean score of 4.21, showing the respondents evaluate both the advantages and disadvantages of others’ views when analysing them objectively. In addition, POQ1 also shows a high mean score of 4.02, which implies that respondents can recognise how ideas and techniques can be applied in building new relationships. In contrast, POQ3 has a lower mean score of 3.57, which indicates that the respondents agree that emotions rarely interfere in making judgements for difficult and unfamiliar situations. The higher standard deviation for POQ3 suggests that there are greater differences among respondents in managing their emotions under pressure. Overall, the respondents demonstrate strong people-oriented thinking skills, but emotional control in difficult situations varies widely.

Findings for Group Work

This section presents data to answer research question 2- How do learners identify their group work communication?

Table 14. Mean for Purpose and Goals (PG)

ITEM	Mean	SD
PGQ1 Our team has a meaningful, shared purpose.	4.40	0.71
PGQ2 We are strongly committed to a shared mission.	4.30	0.78
PGQ3 We set and meet challenging goals.	4.37	0.74

Table 15. highest mean with 4.37.

Table 16. Mean for Roles (R)

ITEM	Mean	SD
RQ1 Team members clearly understand their roles.	4.00	0.74
RQ2 When an individual's role changes, an intentional effort is made to clarify it for everyone on the team.	4.23	0.62
RQ3 Everyone values what each member contributes to the team	4.28	0.70

Table 17. Table 9 shows the means for roles. Item RQ3, team members valuing each member’s contribution, has the highest mean with 4.28. Item RQ2, an intentional effort being made to clarify to all team members when a person’s role changes, comes second with 4.23 while item RQ1, team members understanding their roles clearly, has the lowest mean with 4.00. All in all, all items have nearly the same mean scores, indicating that the respondents agreed that roles play a significant factor in group work communication.

Table 18. Table 10 Mean for Team Processes (TP)

ITEM	Mean	SD
TPQ1 We address and resolve issues quickly.		
TPQ2 Our team works with a great deal of flexibility so that we can adapt to changing needs.	4.16	0.74
TPQ3 When we choose consensus decision-making, we do it effectively.	4.12	0.66

Table 19. Table 10 displays the means for team processes. Item TPQ2, team members having flexibility that they adapt to changing needs, has the highest mean with 4.16. Item TPQ3, team members choosing consensus decision making and doing it effectively, has the lowest mean with 4.12. The small difference between the means indicates that the respondents agreed that team processes are an important aspect where group work communication is concerned.

Table 20. Mean for Team Relationships (TR)

ITEM	Mean	SD
TRQ1 Team members appreciate one another’s unique capabilities.	4.18	0.66
TRQ2 Team members are effective listeners.	4.15	0.70
TRQ3 Communication in our group is open and honest.	4.15	0.67
TRQ4 Members of our team trust each other.	4.19	0.75

Table 21. highest mean at 4.18. Finally, items TRQ2, team members being effective listeners, and TRQ3, communication in the group being open and honest, both respectively have the lowest mean with 4.15. Overall, each item has nearly the same level of mean score with one another and therefore indicates that all respondents agree that different positive aspects and characteristics are important when it comes to building a good team relationship.

Table 22. Mean for Intergroup Relations (IR)

ITEM	Mean	SD
IRQ1 We are able to resolve conflicts with other teams collaboratively.	4.04	0.73
IRQ2 We communicate effectively with other groups.	4.11	0.69
IRQ3 Our collaborations with other teams are productive, worthwhile, and yield good results.	4.14	0.69

Table 23. highest mean score, at 4.11. Lastly, item IRQ1, the ability to resolve conflicts with other teams collaboratively, obtains the lowest mean score, at 4.04. In general, all respondents agree that it is easy to communicate and resolve conflicts with other groups, especially when it involves cooperating on tasks to produce good results.

Table 24. Mean for Passion and Commitment (PC)

ITEM	Mean	SD
PCQ1 Working on our team inspires people to do their best.	4.14	0.68
PCQ2 People are proud to be part of our team.	4.18	0.69
PCQ3 My team is proud of its accomplishments and optimistic about our work.	4.25	0.71

Table 25. highest mean score at 4.18, which indicates that they are all proud to be working as a team. Lastly, item PCQ1 has the lowest mean score at 4.14, which indicates that they agree that working in a team inspires them to do their best. All in all, the responses show the strong passion and commitment that all the respondents have towards their teamwork as they know it will yield successful results in their studies.

Table 26. Mean for Skills and Learning (SL)

ITEM	Mean	SD
SLQ1 We have the skills we need to do our jobs effectively.	4.11	0.64
SLQ2 We view everything, even mistakes, as opportunities for learning and growth	4.29	0.65
SLQ3 Team members embrace continuous improvement as a way of life.	4.18	0.69

Table 27. highest mean score at 4.18, which indicates that team members agree that embracing continuous improvement is a way of life. Finally, item SLQ1 has the lowest mean score at 4.11, which indicates that team members agree that they have the necessary skills to do their jobs efficiently. To sum up, all of the respondents mutually agree that having skills is important to do tasks well, but it is also as equally important to consistently develop in the learning process.

Findings for Pair Work

This section presents data to answer research question 3- How do learners identify their pair work communication?

Table 28. Mean for Social Interaction (SI)

ITEM	Mean	SD
SIQ1I like learning activities in which students work together in pairs	4.05	0.83
SIQ2 Pair work create a relaxing learning environment.	4.18	0.69
SIQ3 Students give more help to each other during pair work	4.21	0.73
SIQ4 I prefer to work within a pair rather than work alone.	3.98	0.92

Table 29. Table 15 shows the mean for social interaction in pair work communication. Item SIQ3 with the highest mean score of 4.21, suggesting that respondents agree that students help each other during pair work. Moreover, SIQ2 also shows a high mean score of 4.18, indicating that pair work perceives a relaxing learning environment. Item SIQ1 reports a similarly high mean score of 4.05, reflecting respondents' preference for working in pairs when doing learning activities. Meanwhile, SIQ4 has a slightly lower mean score of 3.98, suggesting that most respondents prefer to work alone, this preference varies among individuals, as the standard deviation indicates greater differences. All in all, the respondents identify pair work communication as supportive, relaxing, and cooperative.

Table 30. Mean for Knowledge Construction (KC)

ITEM	Mean	SD
KCQ1 Pair work help students solve tasks better and faster.	4.24	0.74
KCQ2 Pair work help students more chances to exchange ideas with each other.	4.33	0.72
KCQ3 Pair work help students understand information better after explaining it to others.	4.28	0.71
KCQ4 When pairs are well organized, the work gets done fast.	4.38	0.70

Table 31. Table 16 depicts the means for knowledge construction in pair work communication. All items have mean scores above 4.2, which indicates strong agreement. Item KCQ4 has the highest mean score of 4.38, suggesting the respondents believe structured pair work significantly helps work become more efficient. Moreover, item KCQ2, with a mean score of 4.33, highlights that pair work facilitates learners in sharing ideas. Item KCQ3 records a mean of 4.28, showing that explaining the information to others, helps them understand it better. Similarly, Item KCQ1 has a mean score of 4.24, suggesting that pair work improves both quality and speed of task completion. The results reveal that respondents perceive pair work as highly effective for knowledge construction.

Table 32. Mean for Social and cultural context (SCC)

ITEM	Mean	SD
SCCQ1 Students learn more about how to share the responsibilities when working in pairs	4.25	0.72
SCCQ2 I feel more accepted by others after working within a pair	4.15	0.75
SCCQ3 It is important that each person takes responsibility for the learning as well.	4.36	0.68
SCCQ4 I never felt let down by when I work in pairs.	4.05	0.75

Table 33. Table 17 depicts the means for social and cultural context in pair work communication. All items have mean scores above 4.0, which indicates overall agreement. Item SCCQ3 has the highest mean score of 4.36, suggesting the respondents believe each partner must take responsibility for learning. Moreover, item SCCQ1, with a mean score of 4.25, highlights that pair work helps students learn how to share responsibilities. Item SCCQ2 records a mean of 4.15, showing that working in pairs makes respondents feel more accepted by others. Similarly, item SCCQ4 has a mean score of 4.05, suggesting that most respondents do not feel let down by their partners when working in pairs. The results reveal that respondents perceive pair work as supportive in building mutual responsibility and social acceptance.

Exploratory Statistics

According to He (2024), correlation is a statistical technique that shows how strongly two variables are related to each other or the degree of association between the two. It's a common tool for describing simple relationships without making a statement about cause and effect. This section presents data to answer research questions on correlation. To determine if there is a significant association in the mean scores between critical thinking, group work and pair work analyzed, using SPSS for correlations. Results are presented separately in table 11 and 12 below.

Findings for Relationship between critical thinking types and group work

This section presents data to answer research question 4 -Is there a relationship between critical thinking types and group work? (H1- There is no relationship between critical thinking types and group work)

Table 34. Correlation between critical thinking types and group work

		CRITICAL THINKING	GROUP WORK
CRITICAL THINKING	Pearson (Correlation)	1	.651**
	Sig (2-tailed)		<.001
	N	170	170
GROUP WORK	Pearson (Correlation)	.651**	1
	Sig (2-tailed)	<.001	
	N	170	170

**Correlation is significant at the 0.01 level (2-tailed)

Table 35. Table 18 shows there is an association between critical thinking types and group work. Correlation analysis shows that there is a high significant association between critical thinking types and group work ($r=.651^{**}$) and ($p=.000$). According to He (2024), coefficient is significant at the .05 level and positive correlation is measured on a 0.1 to 1.0 scale. Weak positive correlation would be in the range of 0.1 to 0.3, moderate positive correlation from 0.3 to 0.5, and strong positive correlation from 0.5 to 1.0. This means that there is also a strong positive relationship between critical thinking types and group work. Null hypothesis is rejected.

Findings for Relationship between critical thinking types and pair work

This section presents data to answer research question 5-Is there a relationship between critical thinking types and pair work? (H2- There is no relationship between critical thinking types and pair work)

Table 36. Correlation between critical thinking types and pair work

		CRITICAL THINKING	PAIR WORK
CRITICAL THINKING	Pearson (Correlation)	1	.573**
	Sig (2-tailed)		<.001
	N	170	170
PAIR WORK	Pearson (Correlation)	.573**	1
	Sig (2-tailed)	<.001	
	N	170	170

**Correlation is significant at the 0.01 level (2-tailed)

Table 37. Table 11 shows there is an association between critical thinking types and pair work. Correlation analysis shows that there is a high significant association between critical thinking types and pair work ($r=.573^{**}$) and ($p=.000$). According to He (2024), coefficient is significant at the .05 level and positive correlation is measured on a 0.1 to 1.0 scale. Weak positive correlation would be in the range of 0.1 to 0.3, moderate positive correlation from 0.3 to 0.5, and strong positive correlation from 0.5 to 1.0. This means that there is also a strong positive relationship between critical thinking types and pair work. Null hypothesis is rejected.

Inferential Statistics

According to He (2024), there are three main functions of a T-test and ANOVA. Firstly, both are done to compare means. This test is also done to determine if the average scores (mean) or values of two groups, or one group against a known value, are different enough to be considered statistically meaningful and are not just due to random chance. Secondly, T-test and ANOVA are done to test hypotheses. Researchers use t-tests and ANOVA to test hypotheses about means, such as whether a new treatment significantly impacts a variable or if there's a difference in performance between two distinct groups. Lastly, T-test and ANOVA are done to identify significant differences. The output of a t-test provides a p-value (significance value). If this p-value is below a predetermined threshold (often 0.05), it indicates a statistically significant difference, allowing researchers to draw conclusions about the populations from which their samples were drawn.

Findings for Significant Difference for all factors across Clusters

This section presents data to answer research question 6: Is there a significant difference for critical thinking types for group work and pair work across clusters? (H3- There is no significant difference for critical thinking types for group work and pair work across clusters)

Table 38. T-test for critical thinking types for group work and pair work across clusters

		Levene's Test for Equality of Variances		Independent Samples Test							
		F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						One-Sided p	Two-Sided p			Lower	Upper
CRITICAL_THINKING	Equal variances assumed	.001	.969	-1.788	168	.038	.076	-.11765	.06578	-.24751	.01222
	Equal variances not assumed			-1.788	167.594	.038	.076	-.11765	.06578	-.24751	.01222
GROUP_WORK	Equal variances assumed	.041	.841	-.609	168	.272	.544	-.04866	.07996	-.20652	.10920
	Equal variances not assumed			-.609	167.291	.272	.544	-.04866	.07996	-.20653	.10920
PAIR_WORK	Equal variances assumed	.010	.919	.044	168	.483	.965	.00392	.09010	-.17395	.18179
	Equal variances not assumed			.044	167.525	.483	.965	.00392	.09010	-.17395	.18179

With reference to table 12, a one way ANOVA was conducted to examine the effects of critical thinking types for group work and pair work across clusters. The analysis in table 16 shows there is no significant difference for critical thinking ($F=0.001$, $p=0.076$) types for group work ($F=0.041$, $p=0.544$) and pair work ($F=0.010$, $p=0.965$) across clusters. The null hypothesis is therefore accepted.

CONCLUSION

Summary of Findings and Discussion

RQ1: How do learners use different types of critical thinking skills?

The findings show that learners use all three types of critical thinking, namely thought-oriented, action-oriented and people-oriented thinking, but to different degrees depending on the situation. For thought-oriented thinking, the strongest agreement is on carefully evaluating several suggestions before choosing a solution ($M=4.12$). In contrast, approaching a new problem in a carefully analytical way records a lower level of agreement ($M=3.40$), while taking an independent and innovative look ($M=3.78$) and making critical discrimination between alternatives ($M=3.63$) remain around the neutral to agree range. This indicates that deep evaluation is most strongly triggered by complex problems rather than by new or routine tasks. Such behaviour reflects critical thinking as reasoned judgement through weighing alternatives (Hitchcock, 2018) and supports the claim that collaborative contexts push learners to justify and scrutinise ideas (Johnson, Johnson, & Smith, 2014).

For action-oriented thinking, learners generally agree that they use creative approaches to solve problems ($M=3.99$) and can see patterns others may miss ($M=3.81$). Taking time to make judgements that are usually accurate records a slightly lower mean ($M=3.63$). This shows that practical creativity and pattern recognition are commonly used, even if confidence in slow, deliberate judgement is more moderate. This pattern is in accordance with research showing that idea exchange in collaboration stimulates creative and practical problem solving (Gillies, 2016) and that collaborative project work enhances critical thinking and communication together (Dias-Oliveira et al., 2024).

People-oriented thinking records the highest overall means. Learners strongly agree that they analyse others' ideas objectively by weighing advantages and disadvantages ($M=4.21$) and can see how ideas and techniques build new relationships ($M=4.02$). However, emotional control under pressure is more varied ($M=3.57$), indicating that unfamiliar and time-pressured situations challenge some learners' judgement. This supports Belbin's (2013) view that effective team reasoning depends on how individuals respond to others, not only on individual cognition. Overall, learners' critical thinking is situational: deep evaluation is strongest for complex tasks, creative and pattern-based thinking appears in everyday work, and interpersonal evaluation is widely practised but emotionally demanding, consistent with findings that collaborative settings strengthen but also shape the type of critical thinking used (Fan et al., 2025; Lintner, Diviák, & Nekardová, 2024).

RQ2: How do learners identify their group work communication?

Learners identify effective group communication first through a clear shared purpose and common goals. Having a meaningful shared purpose records the highest agreement ($M=4.40$), followed closely by setting and meeting challenging goals ($M=4.37$) and strong commitment to a shared mission ($M=4.30$). This shows that direction and collective intent are central to how learners understand good group communication. Shared goals are known to drive deeper cognitive engagement in cooperative learning (Johnson et al., 2014).

Role clarity and appreciation are also strongly recognised. Valuing each member's contribution records the highest mean within this construct ($M=4.28$), followed by clarifying role changes ($M=4.23$) and understanding one's own role ($M=4.00$). This indicates that organised and transparent communication supports teamwork, in line with evidence that team effectiveness depends on interdependent roles linked to processes and relationships (Arora, Gajendragadkar, & Neelam, 2023).

In terms of processes and relationships, flexibility to adapt to change records $M=4.16$ and effective consensus decision making ($M=4.12$). Trust among members is high ($M=4.19$), as is appreciation of unique capabilities

($M=4.18$), while effective listening and open communication both record $M=4.15$. These near-equal high means suggest a stable, supportive communication climate, resembling the norming and performing stages where trust enables analytical and evaluative discussion (Tuckman, 1965; Chang & Brickman, 2018). Productive collaboration with other teams is also recognised ($M=4.14$), along with effective cross-team communication ($M=4.11$) and collaborative conflict resolution ($M=4.04$), supporting the role of negotiated meaning in problem solving (Rahmat, 2020).

Learners further associate group work with pride and growth. Being proud and optimistic about team accomplishments records the highest mean in this area ($M=4.25$), followed by pride in belonging to the team ($M=4.18$) and inspiration to do one's best ($M=4.14$). Viewing mistakes as opportunities for learning is especially strong ($M=4.29$), alongside embracing continuous improvement ($M=4.18$) and confidence in team skills ($M=4.11$). These findings reflect environments that support competence and relatedness, key needs in Self-Determination Theory (Ryan & Deci, 2020; Grenier, Gagné, & O'Neill, 2024), and are consistent with studies showing that structured, supportive teamwork improves interaction quality and attitudes towards collaboration (Alexandru, 2025; Schermeier, Deiglmayr, & Rummel, 2025).

RQ3: How do learners identify their pair work communication?

Learners generally describe pair work as supportive and comfortable. Helping each other during pair work records the highest mean in social interaction ($M=4.21$), followed by creating a relaxing environment ($M=4.18$) and liking activities done in pairs ($M=4.05$). Preference for pairs over working alone is slightly lower and more varied ($M=3.98$), showing individual differences in comfort with close collaboration. These patterns match findings that pair interaction encourages help-seeking and openness (Rahmat, 2025; Storch, 2002).

Pair work is most strongly associated with knowledge construction. When pairs are well organised, work gets done fast ($M=4.38$), exchanging ideas is facilitated ($M=4.33$), explaining information improves understanding ($M=4.28$), and tasks are solved better and faster ($M=4.24$). All means above 4.2 indicate strong agreement that dialogue and mutual explanation are key learning mechanisms. This supports views of critical thinking as explanation and justification (Hitchcock, 2018) and findings that collaboration improves critical thinking development (Fan et al., 2025).

In social and cultural terms, learners emphasise shared responsibility. Believing each partner must take responsibility records the highest mean ($M=4.36$), followed by learning to share responsibilities ($M=4.25$), feeling more accepted ($M=4.15$), and not feeling let down by partners ($M=4.05$). This reflects strong relatedness and mutual accountability, central to motivation and engagement in Self-Determination Theory (Deci & Ryan, 2008; Escandell & Chu, 2021), and aligns with evidence that collaborative learning improves both academic and social interaction (Alzubi, Nazim, & Ahamad, 2024). Variation in some items is consistent with prior work showing that pair dynamics differ across partners and contexts (Gagné & Parks, 2013; Lintner et al., 2024).

RQ4: Is there a relationship between critical thinking types and group work? (H1)

Correlation analysis shows a strong positive relationship between critical thinking and group work ($r = .651$, $p < .001$), therefore H1 is rejected. This means that learners who report higher use of thought-, action- and people-oriented thinking also report stronger group communication across purpose, roles, processes, relationships and learning. High mean scores for shared goals (M up to 4.40), trust ($M=4.19$) and learning from mistakes ($M=4.29$) suggest that structured, supportive group environments are closely linked with active critical thinking.

This finding supports the view that cooperative learning requires learners to articulate, challenge and integrate ideas, thereby activating critical thinking (Johnson et al., 2014; Gillies, 2016). It is also in accordance with studies where improvements in teamwork occur together with gains in critical thinking (Dias-Oliveira et al., 2024).

From a motivational perspective, such teams satisfy autonomy, competence and relatedness, which enhance engagement and quality of thinking (Deci & Ryan, 2008; Ryan & Deci, 2020). Recent SDT-based team research likewise links motivated, well-functioning teams with stronger cognitive engagement (Grenier et al., 2024;

Deterding et al., 2025). Overall, the strong association reinforces evidence that collaboration quality predicts cognitive outcomes (Schermeier et al., 2025).

RQ5: Is there a relationship between critical thinking types and pair work? (H2)

A significant positive relationship is also found between critical thinking and pair work ($r = .573$, $p < .001$), leading to rejection of H2. Learners who use critical thinking more frequently also report stronger pair communication, particularly in knowledge construction where all means are very high ($M=4.24-4.38$) and in shared responsibility (up to $M=4.36$).

Close dialogue in pairs enables learners to co-construct understanding through explanation and questioning (Rahmat, 2025), which supports evaluative and justificatory thinking (Hitchcock, 2018). This aligns with evidence that collaborative explanation patterns in pairs are linked with better thinking and learning outcomes (Storch, 2002; Fan et al., 2025).

Although slightly weaker than the group correlation, the relationship remains strong, indicating that both collaborative formats support critical thinking. The supportive and accepting climate of pairs (means around 4.05–4.21) also strengthens motivation through relatedness (Deci & Ryan, 2008; Escandell & Chu, 2021). This is consistent with findings that multiple collaborative methods enhance both learning and social interaction (Alzubi et al., 2024).

RQ6: Is there a significant difference for critical thinking types for group work and pair work across clusters? (H3)

No significant differences are found between the Science & Technology cluster and the Social Sciences & Humanities cluster for critical thinking, group work or pair work (all $p > .05$), therefore H3 is accepted. This means that similar mean patterns of strong agreement in group goals (around 4.30–4.40), pair knowledge construction (around 4.24–4.38) and people-oriented thinking (up to 4.21) appear across both clusters.

This stability suggests that the links between collaboration and critical thinking are general rather than discipline-specific. Self-Determination Theory explains that autonomy, competence and relatedness operate across contexts, producing similar motivational and cognitive patterns in different domains (Ryan & Deci, 2000; Vansteenkiste, Niemiec, & Soenens, 2010).

The result is also in accordance with studies from varied academic fields reporting broadly positive teamwork perceptions and benefits regardless of subject area (Alexandru, 2025; Dias-Oliveira et al., 2024). Hence, well-designed group and pair tasks can foster critical thinking across clusters, supporting collaborative learning as a general pedagogical strategy rather than one limited to specific disciplines.

Implications and Suggestions for Future Research

Theoretical and Conceptual Implications

The findings of this study strengthen the explanatory value of Self-Determination Theory (SDT) in collaborative learning contexts. Learners reported high levels of shared responsibility, mutual trust, pride in team accomplishments and learning from mistakes, as well as strong feelings of acceptance and support in pairs. These patterns directly reflect the three basic psychological needs proposed by SDT: autonomy, competence and relatedness (Deci & Ryan, 2008; Ryan & Deci, 2020). Clear shared goals and valued roles in group work suggest that learners experience a sense of ownership and direction, which aligns with autonomy. Viewing mistakes as opportunities for growth and believing the team has the skills to perform tasks indicate competence-supportive environments. Feelings of trust, acceptance and mutual help in both groups and pairs clearly demonstrate relatedness. When these needs are met, SDT predicts stronger engagement and better quality learning, which is consistent with the strong positive relationships found between collaborative communication and critical thinking.

The results also conceptually extend SDT from individual motivation to collective cognitive processes. Strong correlations between critical thinking and both group work and pair work indicate that motivation-supportive social structures are not only beneficial for engagement but are closely tied to higher-order thinking. This is in line with recent work that applies SDT to team motivation and shows that supportive team climates enhance cognitive and learning outcomes (Grenier, Gagné, & O'Neill, 2024; Deterding et al., 2025). The absence of differences across academic clusters further suggests that these motivational mechanisms operate consistently across disciplines, supporting SDT's claim of domain-general basic needs (Ryan & Deci, 2000; Vansteenkiste, Niemiec, & Soenens, 2010).

In relation to the conceptual framework of the study, the findings empirically support the proposed links between Belbin's critical thinking roles and the communication structures of group and pair work. High use of people-oriented thinking together with strong team relationships and shared responsibility in pairs shows that interpersonal evaluation and social negotiation are central pathways through which collaboration influences thinking (Belbin, 2013; Rahmat, 2020). At the same time, strong knowledge construction in pairs and goal-driven processes in groups demonstrate two complementary routes to critical thinking: focused dialogic explanation in dyads and multi-perspective synthesis in larger groups. This supports theoretical arguments that different collaborative formats foster different but equally valuable forms of higher-order thinking depending on interaction structure and group development stage (Tuckman, 1965; Chang & Brickman, 2018).

Overall, the study conceptually integrates SDT with collaborative interaction models by showing that when communication structures satisfy autonomy, competence and relatedness, they are strongly associated with analytical, creative and interpersonal critical thinking. This positions critical thinking not only as an individual cognitive skill but as a socially supported and motivationally grounded process.

Pedagogical Implications

The results suggest that teaching should move beyond simply placing students into groups or pairs and instead deliberately design the communication structure of collaboration. Since shared purpose and clear roles received very high agreement, instructors should explicitly co-construct group goals with students and clarify responsibilities from the start of the tasks as doing so is likely to strengthen autonomy and engagement, which in turn supports critical thinking.

This is due to learners strongly associated both group work and pair work with learning from mistakes, thus classrooms should normalise error as part of the learning process. Activities that require groups to reflect on failed attempts and propose improved solutions can reinforce competence and continuous improvement (Ryan & Deci, 2020; Fang & Chiu, 2025). Teachers should provide constructive, process-focused feedback to teams rather than only evaluating final products.

The strong knowledge-construction effects in pair work imply that teaching should intentionally include structured explanation tasks in pairs. For example, "explain your reasoning to your partner" or "teach your partner your solution" stages can deepen understanding and activate evaluative thinking (Hitchcock, 2018; Storch, 2002). Pair work is especially suitable for tasks requiring careful analysis and justification, while group work can be used for tasks needing synthesis of multiple perspectives and creative idea generation (Gillies, 2016; Fan et al., 2025).

Since trust, acceptance and mutual help are central to effective collaboration, instructors should cultivate a supportive social climate. Strategies such as rotating roles, peer appreciation activities and guided conflict resolution can strengthen relatedness and productive interaction (Rahmat, 2020; Escandell & Chu, 2021). Attention should also be given to flexible team processes so that groups can adapt their plans, which was positively perceived by learners and is associated with more advanced stages of group functioning (Tuckman, 1965).

In conclusion, collaborative critical thinking should therefore be treated as a general teaching approach for all discipline with consideration to the course's end goal (Dias-Oliveira et al., 2024; Alexandru, 2025).

Suggestions for Future Research

Future studies could examine how specific task types interact with collaborative format. The present findings show strong links between collaboration and critical thinking. However, experimental studies comparing analytical versus creative tasks in pairs and groups could clarify when each format is most effective (Fan et al., 2025).

Longitudinal research is also needed to investigate how learners' critical thinking and collaborative communication develop over time. Tracking the same learners across multiple semesters could reveal whether repeated exposure to structured group and pair work produces lasting gains in critical thinking and motivation, as predicted by Self-Determination Theory (Deci & Ryan, 2008; Nunes, Proença, & Carozzo-Todaro, 2024).

Another direction is to explore micro-interaction patterns inside pairs and groups using observational or network methods. This would complement self-report data and show how help-seeking, explanation and turn-taking actually occur during tasks (Lintner, Diviák, & Někardová, 2024; Storch, 2002).

Future researchers may also investigate how digital or hybrid collaboration environments influence these relationships, since interaction quality can differ across modalities (Schermeier, Deiglmayr, & Rummel, 2025). Comparing face-to-face, online and hybrid pair/group work could identify design features that best support autonomy, competence and relatedness.

Finally, individual differences such as prior achievement, language proficiency or personality could be examined as moderators of collaborative critical thinking. This would help explain why some learners prefer pairs while others thrive in larger groups and would allow more targeted instructional design (Gagné & Parks, 2013; Chang & Brickman, 2018).

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