Co-construction of academic concepts: How facilitator scaffolding for student pairs shapes interaction dynamics

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This study examined the interactive dynamics between researchers and participants during the co-construction of academic concepts. Embracing a socio-constructivist approach, messages, categories, and correlations were scrutinised across multiple activity segments. The study involved 12 pairs of university students and a facilitator-researcher. The researcher intervened in the interaction by scaffolding, including (a) alternating the participation of subjects; (b) understanding and evaluating the partner; and (c) dissenting between positions. At no point did the researcher act as a teacher or explain concepts, nor did the researcher evaluate content. The researcher's messages influenced participants' responses, generating distinct interaction patterns: some responded directly, while others engaged in deeper explorations and reflections. Open-ended questions prompted diverse responses and deeper reflections, whereas more specific inquiries limited the breadth of responses. Two profiles of dyadic interaction emerged: one displayed a progressive internalisation of questions, reflecting greater autonomy; the other revealed more direct and less reflective responses. Correlations underscored the researcher's influence on interactive dynamics. These findings highlight how selective intervention by the researcher shapes interaction dynamics, impacting the depth and breadth of responses, emphasising the importance of questioning strategies, and the relevance of fostering collaborative environments that promote autonomy and reflection.

Introduction

This study explores the co-construction process among university student pairs concerning an academic concept (Asterhan & Babichenko, 2015; Hull & Saxon, 2009; Rapanta & Felton, 2022). This process is fundamentally sociocognitive, involving the construction of new knowledge within a framework of social interaction (Castellaro & Peralta, 2020). The focus lies on aspects of sociocognitive interaction aimed at sustaining and fostering basic social interaction among individuals, which underpins the co-constructive nature of the process, such as:

- *participation*, namely the communicational alternation between individuals (Denessen et al., 2008; Rudsberg et al., 2016; Yun & Kim, 2015)
- *comprehension and evaluation* of the other (Harney et al., 2017; Rodríguez et al., 2022; Zhu & Carless, 2018)
- *dissent and confrontation* among individuals' ideas (Andriessen et al., 2003; Baker, 2009; Leitão, 2000).

More specifically, our study analyses the scaffolding process (Van de Pol et al., 2010; Wood et al., 1976) provided by an external agent, in this case, the researcher, regarding these three fundamental aspects of interaction.

On one hand, participation refers to the expression of opinions and active listening among individuals during dialogic interaction. On the other hand, understanding and evaluating others involves participants' capacity to comprehend and value their peers' opinions during interaction. Lastly, interventions of dissent and confrontation among ideas constitute the presentation of alternative arguments and expression of disagreement during interaction (Andriessen et al., 2003; Baker, 2009; Denessen et al., 2008; Hull & Saxon, 2009; Leitão, 2000; Peralta & Roselli, 2021; Yun & Kim, 2015; Zhu & Carless 2018).

Research on participation, understanding, evaluation of different perspectives, as well as the confrontation between individuals' ideas, is crucial as they are fundamental pillars in the authentic creation of shared knowledge among individuals. Firstly, reciprocal participation of each participant is necessary to conduct effective constructive dialogue (Peralta & Roselli, 2021). Secondly, mutual evaluation is an expression of cognitive decentration that allows individuals to acknowledge the existence of different perspectives and develop different viewpoints to examine them, thereby promoting deeper understanding (Peralta et al., 2012). Finally, this recognition of discrepancies and alternative stances implies metacognitive work, reflecting upon alternative stances, one's own, and their foundations, establishing a solid ground for conceptual co-construction, thereby fostering new exchanges (Psaltis et al., 2009).

This is a relationship that occurs spontaneously in any collective work, for instance, between two peers (a dyad). However, is it possible for an external agent to the dyad (such as a researcher or educator) to intervene in this interactive dynamic of co-constructing an academic concept? How could this intervention take place? In what manner does this influence occur on interactive dynamics? Could profiles of dyads be identified based on the form the interactive dynamics adopt during the activity, stemming from the intervention of the external agent? The intervention of this external agent (in this study, the researcher) in the interactive dynamics of the dyad can be understood through the traditional concept of scaffolding, a concept linked to Vygotsky's sociocultural theory (1978).

Scaffolding can be conceived as specific support offered within the zone of proximal development (Belland, 2014; Margolis, 2020; Van de Pol et al., 2019). It is characterised by its adaptability or contingency, gradual fading over time, and the progressive transfer of learning or task responsibility to the student. Fundamentally, the essence of scaffolding lies in its contingency, meaning that the support adjusts to the student's understanding, a crucial feature for effective scaffolding to occur (Hardy et al., 2022; Van de Pol & Elbers, 2013; Van de Pol et al., 2010; Wibowo & Dyson, 2021).Specifically, the scaffolding provided by the researcher under analysis here is based on the aforementioned three basic components: alternating participation, understanding and evaluating others, and dissent among positions. It should be noted that the researcher's intervention being studied here

is not based on explaining concepts or correcting potential errors made by the dyad members but rather on sustaining and fostering the underlying interactive dynamics. In other words, the intervention does not imply any form of teaching or conceptual support since there's no external offering of guidance or facilitative knowledge orientation. This speaks to a constructive effect of collaboration, which diverges from the traditional concept of tutoring or teaching effects.

This distinction is linked to different levels of teacher regulation over students (Wood et al., 1978). A high level of control or regulation might involve, for instance, providing a hint or the answer. Conversely, a low level of control or regulation is exemplified by posing an open question. Additionally, this control can focus on content or knowledge, or on the processes or actions students undertake (Wibowo & Dyson, 2021). In this context, the type of scaffolding undertaken in this study aligns with the lower level of control or process-oriented regulation, exemplified by strategically posed open-ended questions aimed at sustaining and fostering interactive dynamics, thus promoting an environment conducive to collaboration and shared learning (Margolis, 2020).

In contrast to the participants' self-regulation in an interaction, Roselli (2016) discussed heteroregulation as an external guiding principle for activity and communication, aiming to ensure the collaboration. This concept refers to a specific type of scaffolding that aims to regulate various aspects such as group composition, symmetry of participation, role alternation, reciprocal listening and evaluation, coordination of actions, plurality of perspectives, reasoned participation, and balanced distribution of available time. In this manner, external regulation enhances cognitive collaboration by stimulating the negotiation of meanings and the search for consensus, as opposed to merely social regulation of discrepancies.

Previous studies

There are various precedents investigating the effect of scaffolding or regulation by an external agent to the dyad, which can be either the researcher or the teacher. There is evidence demonstrating that scaffolding is effective for student learning (Van de Pol et al., 2019). More specifically, when oriented towards teaching students to speak and reason, greater advancements in individual reasoning measures are achieved compared to students who have not received such teaching (Mercer et al., 2004).

Gillies (2011) analysed the types of questioning strategies teachers use to encourage thinking, problem-solving, and reasoning during discussions in small groups. Firstly, the *Ask to Think Tell-Why* model is based on the teacher guiding the application of structured questions and providing guidance to delve into the answers, enabling students to learn to formulate questions that connect prior knowledge with new information to develop new understandings.

On the other hand, in the *Cognitive Tools and Intellectual Roles* model, the teacher acts as a facilitator and guide, teaching students to apply these strategies and overseeing their

effective implementation in group interaction. These cognitive strategies include predicting, questioning, summarising, and clarifying, to address problems and develop understandings. They then applied these strategies by playing various roles in discussions.

The results indicated that, among the variety of questioning strategies teachers used, those requiring children to provide reasons, establish connections, or think metacognitively were the most effective in generating sustained reciprocal dialogical interactions, which are cognitively demanding. These teacher interventions challenged students to consider alternative ideas and perspectives or to connect information. Furthermore, the teacher's intervention allowed students themselves to appropriate this way of using language to reason and solve problems in their interactions.

On the other hand, van Braak et al. (2021) examined the individual participation of students in the context of instructional support from teachers, during 150 lessons in four pre-vocational education classes across four different schools in the Netherlands. Teachers organised their lessons in a way that independent work in the seat was a primary activity but did not receive specific instructions or training in providing adaptive support. The authors hypothesised that teachers' adaptive support is related to students' behavioural participation, understood as the link between learning opportunities offered and actual learning. This concept refers to student participation, effort, attention, attendance, initiation of actions, and time devoted to the task. However, the analyses indicate that there was no evidence of teacher-student dyadic effects on student behavioural participation, and the extent to which teacher support in teacher-student dyadic interactions was adaptive did not predict student engagement levels immediately after these interactions.

On another note, there are studies addressing the effects of scaffolding in student dyadic interactions in experimental contexts. Roselli (2016) addressed illustrations of the effects of heteroregulation in three studies. The first study tackled the effects of regulating symmetric participation, reciprocal evaluation, and coordination of actions in logical play tasks with 10 pairs of first-year students in the middle cycle. The intervention revealed significant improvements in the quality of collaborative exchange, even in purely logical problem-solving tasks. Additionally, the pairs experienced notable cognitive advancement, demonstrating learning transferable to non-playful academic situations. In the previous research, the dialogical interaction of regulated and non-regulated pairs during the learning of a modularised text was analysed. External regulation showed benefits in terms of cognitive economy, temporal efficiency, and level of symmetry in participation. Although the achieved learning was not directly evaluated, it was emphasised that external regulation can positively influence the dynamics of the collaborative learning process (Roselli, 2016).

Moreover, studies are observed analysing the effects of scaffolding on students' subsequent learning. Peralta et al. (2012) assessed written productions and achieved learning in university student dyads, comparing three groups: an experimental one with researcher intervention in sociocognitive conflict, another collaborative without intervention, and a third group of individual students. The regulation aimed to promote the emergence of sociocognitive conflicts and argumentative interaction in interactions

between dyads of 120 physics and psychology university students. The researcher's intervention aimed to promote symmetry, mutual evaluation, and explicitation of cognitive differences. It encouraged both subjects to consider themselves equivalent and to contribute cognitively to the task. Furthermore, dissent among participants was encouraged and made explicit as part of the sociocognitive conflict (CSC). During this process, the researcher asked questions such as: 'Do you agree with what your partner said?'; 'Is it correct to analyse the problem in that way?' and 'Do you think that's complete?' The results demonstrated that external regulation improved the quality of written productions and facilitated individual learning as dyads receiving the sociocognitive conflict incentive scored higher than those in the collaboration-only group and individuals working alone. Additionally, their productions were superior in terms of clarity, epistemic correctness, originality, and comprehensiveness.

Another study that examined the effects of external regulation on argumentation was carried out by Peralta & Roselli (2021). Their aim was to investigate the style, competence, and argumentative dialogicity among 48 first-year university students from various social science courses at public universities in Argentina. The main results regarding researcher assistance or intervention indicated that following the researcher's intervention, subjects displayed an equitable distribution between argumentative styles based on personal experiences and their own assessment of facts. Meanwhile, subjects without intervention expressed arguments based on a binary position. Additionally, subjects working in assisted pairs showed greater incorporation of counter-argumentation in their individual writings compared to the control group. Conversely, subjects who did not receive assistance had a more even distribution between the use and non-use of counter-argumentation in their individual writings. Finally, after assistance, a significant improvement in subjects' participation in interactions was observed, meaning there was an increase in the flow of opinions in response to the presented situation. Although participation was lower compared to the experimental group, the capacity for evaluation (expressing agreements and disagreements) increased in the unassisted pairs.

Similarly, Constantino-González & Suthers (1994) analysed the effect of using a pedagogical agent to support collaboration in computer-mediated learning environments in Mexico. The agent tracked each student's participation level during the collaborative activity and compared individual solutions with the group solution to highlight discrepancies in real time. The results showed that students found the presence of the agent helpful in guiding their interactions and promoting discussion. Both studies underscore the key role of technological mediation—whether through argument maps or pedagogical agents—in fostering reflection, meaningful interaction, and joint knowledge construction.

Lastly, there are works that addressed the analysis of variables likely to mediate scaffolding effects. Van de Pol et al. (2019) examined how the effect of contingent support for student learning is mediated by the extent to which students utilise teacher support in small group work. They analysed lessons from seven eighth-grade secondary education teachers on the European Union, where students undertook various tasks to understand the European Union's influence on their daily lives, and the motives and development of

the European Union. In this study, the authors aimed to shed light on a potential mechanism that could explain how scaffolding affects learning: students' acceptance of teacher support. Students' acceptance referred to whether they applied or disregarded teacher support in their interactions. The results showed that students' acceptance of teacher support was more effective for the learning of small groups of students than ignoring the support. However, the level of students' acceptance of teacher intervention was low. In a subsequent qualitative analysis, the authors sought to explain why students ignored contingent support and identified the abrupt fading of support as a possible cause (Van Braak et al., 2021). Hence, they suggested that a smooth and timely transition from teacher-student interaction to student-student interaction is crucial.

On the other hand Tuzinkievicz et al. (2025) analysed how the technological environment and mediation through argument diagramming tools influenced argumentative interactions among university students. Eighty-two students, organised in dyads, discussed an academic task in different settings (face-to-face, chat, and video call), with and without technological mediation. Mediation through argument mapping promoted the development of new arguments, suggesting that this tool facilitated the externalisation of thought and reflective analysis. While the face-to-face setting favoured greater integration of opposing viewpoints and joint proposals, graphic mediation stood out for enhancing the quality of argumentation, showing its potential as a resource to strengthen metacognitive and collaborative processes in knowledge construction.

Recent literature on collaborative learning in higher education has widely documented the use of small groups, typically composed of about six students, where the facilitator is not physically present during the activities (Homayouni, 2022; Kelly et al, 2020; Kraatz et al., 2020; Dowling Long & Long, 2023; Maphalala & Mpofu, 2020; Morcom, 2022; Ouyang et al., 2021; Rahmiadji et al., 2023). In contrast, our study focuses on interactions within dyads—that is, pairs of students—supported by the active and physical presence of a facilitator during the sessions. This configuration enables detailed observation of scaffolding processes and allows for immediate and adaptive intervention by the facilitator, aspects that have not been thoroughly explored in previous research within this context. By focusing on dyads with in-person facilitation, this work offers a novel perspective on collaborative dynamics and the role of the facilitator in university learning environments.

Objectives and hypotheses

The current study addresses the co-construction process of an academic concept among pairs of university students of psychology, working under the scaffolding of an external agent (researcher). The concept that students aim to build was new to both ("psychological tests"). The overarching goal was to analyse variations in the dyad's interactive dynamics stemming from the researcher's scaffolding. This scaffolding process involved three basic aspects: fostering alternation in participants' engagement, comprehension evaluation of each other, and dissent between positions. The dyad's interactive dynamics are considered across two dimensions: conceptual (participants'

contributions related to the concept under construction) and intersubjective (participants' contributions to social task support, encouraged by the researcher).

The specific objectives were:

(a) differentiate the interventions of the dyad and the researcher during the task of co-constructing an academic concept ("psychological tests").
(b) analyse the distribution of these contributions (from the dyad and the researcher) throughout the activity (segments).
(c) examine the influence of the researcher's contributions (scaffolding) on the dyad's interactive dynamics (conceptual and intersubjective).
(d) identify dyadic profiles based on the manner in which the interactive dynamics unfold during the activity, stemming from the researcher's interventions.

Method

Participants

For this study, non-probabilistic and incidental samples were assembled. Participants were approached in accessible university classes, having obtained prior permission from the course professors. The selection of participants was based on the outcomes of a general questionnaire they were required to complete, determining their level of knowledge on the topics to be addressed in the working sessions. In total, 24 psychology students (12 pairs) collaborated, working together and scaffolded by the researcher. The average age was 18 years old, predominantly female.

Instruments

Firstly, a general pre-test on "psychological tests" was designed to evaluate subjects' overall knowledge about the topics in question and to exclude those who had any level of previous knowledge on the subject matter. Secondly, an activity regarding "psychological tests" was devised, comprising a general prompt, the body of text divided into sections, with each section further segmented into paragraphs. In subsequent analysis, each constitutive element of the task (to be described below) was regarded as a "segment" within the activity sequence.

Point 1 was titled "What is a test and what are its main characteristics", and it consisted of:

- Paragraph 1: the origin of the word "test" and its history (SEGMENT 1).
- Paragraph 2: the test as a psychological measuring instrument (SEGMENT 2).
- Paragraph 3: the test as a synthesis of the experimental and clinical methods (SEGMENT 3).
- Paragraph 4: the main characteristics of a psychometric test (SEGMENT 4).
- Summary of Point 1: the task involved requesting a synthesis of the topics covered in the previous four paragraphs belonging to Point 1 (SEGMENT 5).

Point 2 was titled "Requirements that a test must meet" and it included:

- Paragraph 5: validity and reliability (SEGMENT 6).
- Paragraph 6: three factors contributing to reliability (SEGMENT 7).
- Paragraph 7: basic principles to achieve high reliability (SEGMENT 8).
- Summary of Point 2: the task involved requesting a synthesis of the topics covered in the previous three paragraphs belonging to Point 2 (SEGMENT 9).
- Final reflection on the use of tests in psychology: advantages and disadvantages, possibilities, and limitations (SEGMENT 10).

The instructions requested participants to carefully read each paragraph of the text and collaboratively formulate a summary at the end of each paragraph. Similarly, they were asked to produce a summary at the end of each Point. It was explicitly stated that the summaries should not be a verbatim copy of the source text but an original production.

Procedure

Firstly, students underwent a general knowledge questionnaire regarding the forthcoming topics (pre-test). The purpose of this questionnaire was to exclude those subjects with prior knowledge of the subject matter.

Subjects were randomly paired into dyads and scheduled for work sessions outside class hours. The work sessions involved collaborative learning situations in pairs. Simultaneously, the scaffolding provided by the researcher aimed to support and favour fundamental aspects of interaction, primarily related to its regulation: (a) alternating the participation of subjects; (b) understanding and evaluating the partner; (c) dissenting between positions. It is essential to clarify that at no point did the researcher act by teaching and/or explaining concepts, nor evaluating contents.

All participants were informed that they had 90 minutes to complete the activity. This time frame was chosen as it typically matches the duration of a practical class at the university. All sessions were audio recorded for subsequent analysis.

Participants were informed about the activity's objectives within the scope of the research, as well as its anonymous and voluntary nature. They were explicitly informed of their right to suspend participation at any moment and request the removal of their data from the current project. Additionally, they signed the corresponding informed consent form, which ensured anonymity and the use of information for research purposes only.

Data analysis

Complete interactions were transcribed, and each message sent by the participants—Subject 1, Subject 2, and the researcher—was analysed. Messages from the dyad participants could be classified into any of the proposed categories, whereas those from the researcher were limited to messages related to (a) alternation of subject participation,

(b) understanding and evaluating the partner, or (c) dissent between positions. The category system used is listed in Table 1.

Table 1: Category system

Category	Definition	Sender	Type of message analysed
Contribution (C)	Introduction of a new idea not discussed before. A subject begins sharing a new idea related to task resolution	Subject 1 and/or 2	Conceptual
Verification (V)	Request for information about the meaning of a contribution or elaboration.		Conceptual
Clarification (CL)	Clarification of an idea.		Conceptual
Acceptance (ACC)	Judgment of a contribution as intelligible and/or correct, always after clarification.		Evaluation
Agreement (AG)	Expression of agreement with a contribution		Disagreement
Disagreement (DIS)	Expression of disagreement with a contribution		Disagreement
Elaboration (E)	Adding information or summarising previous information (does not introduce a new topic)	Researcher Subject 1 and/or 2	Conceptual
Agreement question (AQ)	Questions directed at a subject to express their agreement (or not) ("Do you agree with what your partner said?";"Do you agree with what I said?")		Disagreement
Understanding questions - contribution (UQC)	Understanding questions leading to a contribution ("How did you understand this?").		Participation
Closed response understanding questions (UQCR)	Understanding questions with a closed response ("Did you understand?")		Participation
Request for contribution (RC)	Request for a subject to make a new contribution ("What can you add to what your partner said?"; "Could you add something?")		Participation
Request for evaluation (RE)	Request for a subject to evaluate what was expressed ("What do you think about what your partner said?"; "Is what I said okay?")		Evaluation

Descriptive analyses were conducted using the aforementioned categories and correlations were examined to determine the influence of the researcher's scaffolding (for further clarity, these latter analyses are detailed in the results).

Results

A total of 4833 messages were recorded, classified within the aforementioned categories (Table 2). As expected, the most frequent messages corresponded to contributions (C),

i.e., the presentation of ideas, followed by agreements (AG) and agreement questions (AQ).

Table 2: Distribution of messages by sender (Subjects-Researcher)

Message type	Subject		Researcher		Total	
	f	%	*f*	%	*f*	%
C	1938	53.15	0	0	1938	40.10
V	122	3.35	0	0	122	2.52
CL	91	2.50	0	0	91	1.88
ACC	30	0.82	0	0	30	0.62
AG	893	24.49	0	0	893	18.48
DIS	125	3.43	0	0	125	2.59
E	428	11.74	0	0	428	8.86
AQ	2	0.05	234	19.71	236	4.88
UQC	1	0.03	115	9.69	116	2.40
UQCR	3	0.08	103	8.68	106	2.19
RC	1	0.03	643	54.17	644	13.33
RE	12	0.33	92	7.75	104	2.15
Total	3646	100	1187	100	4833	100

Note: Cells with values of 0 (zero) correspond to categories not applicable to the Researcher

Observation reveals that categories primarily associated with the researcher's role (AQ, UQC, UQCR, RC and RE) were scarcely used by the subjects, despite their availability to use them. Overall, the frequency distribution mirrors the general total described earlier, where contributions (C) represent 53.15% and agreements (AG) 24.49%, with elaboration (E) being the most used category by the subjects, at 11.74%. Concerning the researcher's role, the most frequent message is again RC, but the considerable number of AQ stands out, representing 19.71%. Based on the aforementioned, there's a clear contrast between the group of messages originating from the subjects and those from the researcher. The only exception was RE, which, although prevalent in the researcher, showed some presence (f=12) among the subjects.

Throughout the task, which included 10 activity segments (7 paragraphs, 2 synthesis Points, and 1 final reflection), a higher frequency of messages is evident in segments 1, 4, and 8, corresponding to the researcher's interventions.

Figure 1 and Table 4 illustrate the average distribution of messages from both participants and the researcher across the activity segments. These values were calculated based on the average of the 12 dyads.

Table 3: Distribution of messages distinguished by sender across activity segments

Segments	Subjects		Researcher		Total	
	f	%	*f*	%	*f*	%
Segment 1	494	13.55	180	15.16	674	13.95
Segment 2	390	10.7	139	11.71	529	10.95
Segment 3	315	8.64	106	8.93	421	8.71
Segment 4	595	16.32	226	19.04	821	16.99
Segment 5	271	7.43	20	1.68	291	6.02
Segment 6	285	7.82	96	8.09	381	7.88
Segment 7	379	10.39	152	12.81	531	10.99
Segment 8	577	15.83	220	18.53	797	16.49
Segment 9	118	3.24	7	0.59	125	2.59
Segment 10	222	6.09	41	3.45	263	5.44
Total	3646	100	1187	100	4833	100

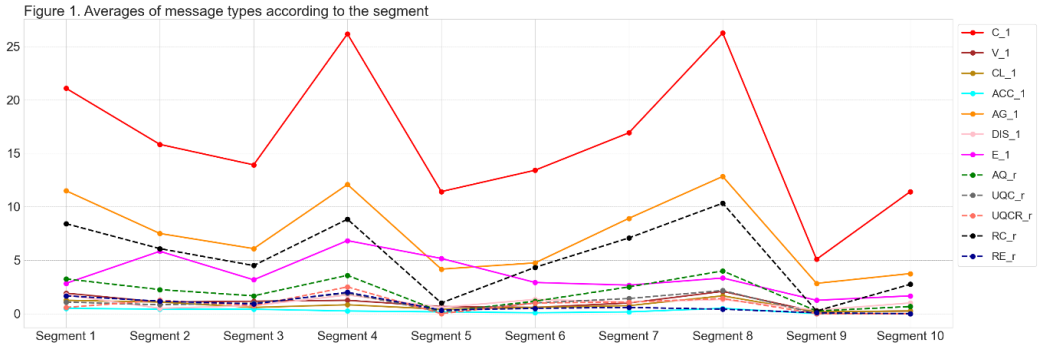

Figure 1: Distribution of average values of specific categories during the activity. "_1" indicates participant sending and "_r" indicates researcher sending. Use web or PDF reader 'zoom in' function to read.

Table 4: Average values of specific categories during the activity

Segments	Subjects							Researcher				
	C	V	E	AG	ACC	DIS	CL	RC	RE	AQ	UQC	UQCR
Segment 1	21.08	1.92	2.83	11.50	0.50	1.75	1.25	8.42	1.67	3.25	1.08	0.58
Segment 2	15.83	1.08	5.83	7.50	0.42	0.50	1.08	6.08	1.17	2.25	0.83	1.25
Segment 3	13.92	1.17	3.17	6.08	0.42	0.75	0.58	4.50	0.92	1.67	1.00	0.75
Segment 4	26.17	1.25	6.83	12.08	0.25	1.75	0.83	8.83	2.00	3.58	1.92	2.50
Segment 5	11.42	0.67	5.17	4.17	0.17	0.58	0.42	1.00	0.33	0.17	0.17	0.00
Segment 6	13.42	0.58	2.92	4.75	0.08	1.33	0.58	4.33	0.50	1.17	1.00	1.00
Segment 7	16.92	1.00	2.67	8.92	0.17	1.08	0.75	7.08	0.58	2.50	1.42	1.08
Segment 8	26.25	2.08	3.33	12.83	0.50	1.33	1.67	10.33	0.42	4.00	2.17	1.42
Segment 9	5.08	0.17	1.25	2.83	0.00	0.33	0.17	0.25	0.08	0.25	0.00	0.00
Segment 10	11.42	0.25	1.67	3.75	0.00	1.00	0.25	2.75	0.00	0.67	0.00	0.00

Initially, the majority of messages were concentrated in the first segment from all involved participants, including the researcher. Subsequently, a decrease in the researcher's participation is observed while the participants increase their involvement across different categories. Two additional peaks of high message frequency are identified in the fourth and eighth segments. This suggests an activity profile based on three key moments of researcher intervention: at the beginning, managing regulatory aspects, and later on in segments 4 and 8.

The previous analysis, based on average values, was complemented by a more detailed examination of each dyad's dynamics. From this, two operating patterns during the activity were identified:

- Six dyads exhibit peaks of researcher intervention in specific moments, accompanied by a strong presence of C (issued by the participants) in those same intervals.
- Six dyads display peaks of researcher intervention with the presence of C, AG, and E (issued by the participants) in those same intervals.

The first profile, composed of dyads showing marked participation mainly through contributions (C) at specific moments, could be interpreted as a more direct response to the researcher's prompts. This behaviour might indicate adherence to given guidelines, showing compliance, but possibly with less flexibility in adaptation or conceptual deepening. These dyads might strictly adhere to instructions, potentially limiting their capacity to explore new approaches or adapt to changes in the research process, as they are more focused on meeting immediate expectations rather than exploring and expanding ideas at a deeper level.

On the other hand, the second profile, evident in the dyads not only responding to the researcher's requests with contributions (C) but also exhibiting notable levels of agreements (AG) and elaboration (E), especially towards the end of the activity, might indicate an internalisation of the researcher's prompts. This internalisation suggests that these dyads are not just complying with surface-level instructions but have understood and assimilated the objectives and structure of the activity at a deeper level. Consequently, they might not only respond to immediate demands but also apply and extend those instructions in a more autonomous and reflective manner. This level of internalisation indicates a higher ownership of content and a more holistic understanding of the activity's purposes, allowing them to surpass the re-searcher's initial expectations.

To further comprehend the impact of the researcher's intervention in the internalisation of the dynamics by the participants, we conducted a correlation analysis (Figure 2). This involved relating all messages issued by the researcher in each segment to the messages issued by the participants collectively in the immediate subsequent segment. The presence of a significant correlation implies that the specific researcher's intervention, with a certain message type at a given Point in the interaction, relates to the emission of a particular message by the dyad in an immediate subsequent moment (Table 5). Segments 8 and 9, whose immediate subsequent segment was considered Segment 10, represent the final reflection presented in the activity immediately after Point 2 without intervening content.

Both segments 8 and 9 were considered as immediately preceding Segment 10, which represented the final reflection where no additional content was included in between.

Table 5: Positive correlations between researcher categories in one segment and participant category in an immediate subsequent segment

Researcher messages	Dyads messages	Correlation	p-value
Segment 1 UQC	Segment 2 DIS	0.67	0.01
Segment 5 UQC	Segment 6 CL	0.92	0.00
Segment 5 UQC	Segment 6 AG	0.78	0.00
Segment 5 UQC	Segment 6 C	0.79	0.00
Segment 5 UQC	Segment 6 DIS	0.72	0.00
Segment 5 UQC	Segment 6 V	0.92	0.00
Segment 6 RC	Segment 7 AG	0.64	0.02
Segment 6 RC	Segment 7 C	0.65	0.02
Segment 8 RC	Segment 10 CL	0.66	0.01
Segment 8 RC	Segment 10 V	0.66	0.01
Segment 8 UQCR	Segment 10 CL	0.58	0.04
Segment 8 UQCR	Segment 10 V	0.58	0.04
Segment 9 RC	Segment 10 CL	0.72	0.00
Segment 9 RC	Segment 10 V	0.72	0.00

As evidenced, the Understanding and Contribution Questions (UQC) posed by the researcher are shown to have a significant effect on interaction dynamics, giving rise to a wide range of responses from the dyads, including DIS, CL, AG, C, and V. Similarly, the Request for Contribution (RC) has elicited responses such as C, AG, CL, and V from the participants, while to a lesser extent, the Understanding Questions Closed-Response (UQCR) have shown influence in the interaction. One hypothesis that could explain this phenomenon is that the Understanding and Contribution Questions (UQC) from the researcher, by offering an openness in the interaction, create a conducive space for dyads to explore and elaborate their responses more diversely. These questions likely invite deeper reflection from the participants, allowing them not only to better comprehend the content but also to express their ideas more freely and extensively. In contrast, Request for Contribution (RC) might direct participants' attention toward presenting specific or concrete ideas requested by the researcher, limiting the breadth of responses. While Understanding Questions Closed-Response (UQCR), by providing predefined options to respond, could restrict participants' ability to more broadly express their viewpoints or reflections.

If participants, as the interaction progresses, issue messages that were not explicitly solicited by the researcher, this could reflect a process of learning and progressive internalisation. The questions posed by the researcher, especially those encouraging reflection and free expression of ideas (RC and UQCR), could act as catalysts for skill development and knowledge acquisition. Over time, participants might have internalised and assimilated this interactional form, enabling them to respond more autonomously and spontaneously, even without a specific request from the researcher. This phenomenon would reflect a deeper and more autonomous appropriation of the regulatory aspects of

interaction by the subjects, enabling them to offer richer and more diversified responses without relying solely on the initial guidelines from the researcher.

To confirm that the dyad issued a message as a consequence of the researcher's message in the immediately preceding segment (positive correlations indicated in Table 6), correlations were conducted between those messages within the same segment (refer to Figure 2 illustrating the implemented correlations). If the correlation also shows a positive value, it dismisses the potential effect of the earlier intervention and also the possibility of internalisation of the dynamics by the dyad. If there is no correlation, it is accepted that the researcher's intervention in a previous segment had an impact on the subsequent segment, and the dyads internalized that intervention. Therefore, their messages manifest learning from what the researcher scaffolded, rather than being a mere response to messages of the same type that the researcher is emitting at that moment.

Table 6: Correlations between researcher categories and participant categories within the same segment

Researcher messages	Dyads messages	Correlation	p-value
Segment 2 UQC	Segment 2 DIS	-0.19	not sig
Segment 6 UQC	Segment 6 CL	0	not sig
Segment 6 UQC	Segment 6 AG	0.13	not sig
Segment 6 UQC	Segment 6 C	-0.30	not sig
Segment 6 UQC	Segment 6 DIS	-0.28	not sig
Segment 6 UQC	Segment 6 V	0	not sig
Segment 7 RC	Segment 7 AG	0.65	not sig
Segment 7 RC	Segment 7 C	0.69	0.02
Segment 10 UQCR	Segment 10 CL	-/	-/
Point 2 RC	Segment 10 CL	0.72	0.00
Segment 10 RC	Segment 10 CL	0.56	0.05
Segment 10 UQCR	Segment 10 V	-/	-/
Point 2 RC	Segment 10 V	0.72	0.00
Segment 10 RC	Segment 10 V	0.56	0.05

-/ Given that one of the two variables has no frequency, there is no possibility of establishing correlation.

As can be inferred from the previous table, only UQC (Understanding Questions) messages exerted subsequent influence, in contrast to RC (Request for Contribution) messages, whose impact was not evident. This discrepancy is reflected in the positive and significant correlations between the researcher's messages and the dyads' responses intra-segment. The presence of positive correlations suggests that the dyad's message was generated as a direct response to the associated message issued by the researcher in that same segment (intra-segment), indicating that it was not internalised in the previous interaction process but rather a response to the researcher's request at that moment.

In this regard, the presence of positive and significant correlations between the researcher's messages and the immediate responses of the dyads intra-segment for RC could indicate that these requests prompt direct and specific responses at that moment

without deep internalisation. Conversely, the lack of evident impact from the UQC on immediate intra-segment responses might suggest that these questions require deeper processing or reflection that manifests in later moments of the interaction.

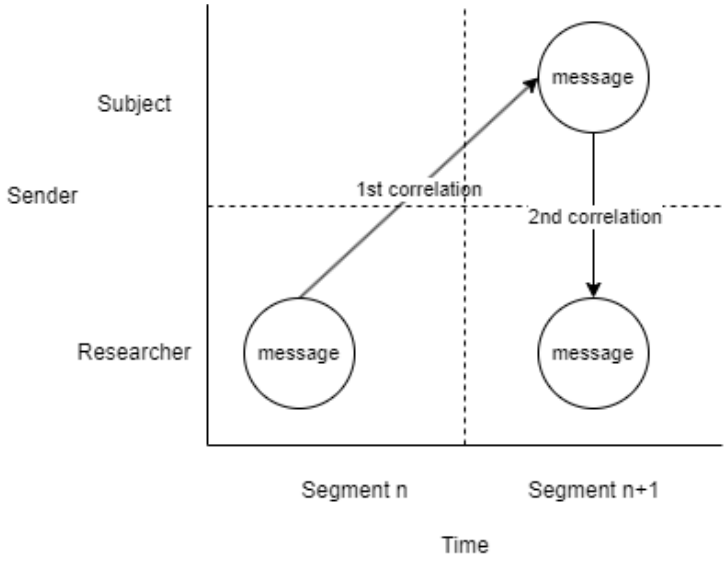

Figure 2: Correlation analysis used to determine scaffolding influence

Discussion and conclusion

The aim of this study was to analyse the variations in the interactive dynamics of dyads based on the researcher's scaffolding. This process encompassed three fundamental aspects: promoting alternation in participant engagement, encouraging mutual understanding and evaluation, and allowing the expression of disagreements between viewpoints. The interactive dynamics of dyads were evaluated considering two dimensions: the conceptual dimension, related to participants' contributions in constructing the concept itself, and the intersubjective dimension, encompassing contributions oriented toward social support for the task, incentivised by the researcher.

Regarding the first specific objective of differentiating interventions between the dyad and the researcher during the co-construction of an academic concept, discernible patterns were observed in the distribution of contributions. It was noted that contributions (C) were the most frequent category, followed by agreements (AG), while elaboration (E) stood out as a category significantly utilised by participants. Moments of increased communicative activity coincided with the researcher's interventions, mainly in segments 1, 4 and 8. As the researcher's participation decreased, subjects increased their involvement in different categories, showing other peaks of high frequency in segments 4 and 8.

The observation of contribution distribution patterns between the dyad and the researcher during the co-construction of a concept aligns with prior research on scaffolding by an external agent, such as researchers or educators. These studies have shown, consistent with the presented results, that effective scaffolding aimed at teaching reasoning and expression skills can promote notable advancements in student communication (van de Pol et al., 2019; Mercer et al., 2004).

Concerning the second objective, which involved analysing the distribution of contributions throughout the activity, findings show that questions of understanding and contribution (UQC) posed by the researcher elicited a wide range of responses from the dyads, encompassing diverse categories such as DIS, CL, AG, C and V. Similarly, requests for contribution (RC) directed participants' responses toward more specific or concrete ideas, limiting the breadth of responses.

Regarding the third objective to analyse the researcher's influence on interactive dynamics, it was evident that the researcher's UQC questions, by offering openness in interaction, might have encouraged deeper reflection from participants, allowing them to express their ideas more freely and extensively. On the other hand, RCs might have directed participants' attention toward more specific answers requested by the researcher, restricting the breadth of responses. The results align with Gillies' (2011) analysis on the impact of different types of questions in group discussions. Questions of understanding and contribution (UQC) elicited broader and more diverse responses, fostering deeper reflection and a specific interaction profile, whereas requests for contribution (RC) directed responses toward more specific ideas, limiting the breadth of responses. This aligns with the importance of questioning strategies challenging students to consider alternative ideas or connect information, as suggested by the author. Additionally, these findings align with scaffolding theory, as discussed in van de Pol et al. (2019), demonstrating how external support, in this case, the posed questions, affects dyads' responses' breadth and nature.

Regarding the last objective, which involved identifying dyadic profiles based on interactive dynamics, the results point to differentiated profiles in dyadic interaction based on the researcher's interventions. A profile was evidenced where, with understanding and contribution questions (UQC), dyads demonstrated a broader and more diverse exploration in their responses throughout the activity, suggesting a possible progressive internalisation of these requests. This profile reflects a deeper and more autonomous appropriation of the interactive dynamics, even without explicit direction from the researcher. Conversely, a second profile was identified where dyads directly responded to the researcher's requests, without complete internalisation of the interactive dynamics. This profile can be characterised by an immediate and specific response to contribution questions (RC), without demonstrating deep reflection or internalisation of the dynamics, suggesting less autonomy in response to the researcher's guidelines.

Finally, concerning the analysis of intra-segment correlations, it confirms that UQC questions exercised a subsequent influence, whereas RCs had an immediate impact without deep internalisation. These findings support the idea that the researcher's

questions influenced interaction dynamics, suggesting different levels of processing and reflection by the dyads in response to the posed requests at specific moments of the activity. Results suggesting a progressive internalisation of the researcher's interventions over time can be associated with the work of Peralta & Roselli (2021) and Roselli (2016). Both studies showed how external regulation can positively impact learning and the quality of student productions as they internalise the strategies and guidelines presented by the external agent.

The study reveals how the researcher's intervention influences dyadic dynamics, facilitating a wide variety of responses through open questions, contrasting with more specific responses generated by concrete requests. This differentiation suggests that the type of researcher intervention modulates the depth and breadth of interactions. Additionally, two dyadic profiles were identified: one reflecting progressive internalisation of the researcher's interventions, related to more autonomous and profound exploration, while the other profile reveals a more direct response to the requests, implying less reflection and autonomy. These results align with the literature on scaffolding in teaching, showing how questioning strategies can affect the dynamics and quality of responses in collaborative learning environments. The implications suggest that the type of researcher intervention significantly impacts the depth and scope of dyadic interaction, influencing how participants process and respond to the posed requests.

The selective intervention of educators or researchers in collaborative interactions emerges as a key element in modulating the breadth and depth of collective learning. The strategic consideration of the nature of questions posed during these encounters reveals that open-ended inquiries tend to stimulate deeper reflection and autonomous exploration, whereas more specific requests seem to restrict the range and diversity of responses.

These results emphasise the need to provide educators with tools and skills to deploy interrogative strategies that stimulate broader and self-directed critical thinking in students. They also highlight the relevance of fostering self-regulation in students, enabling them to optimise interactions, regardless of the nature of the facilitator's intervention. Ultimately, these findings support the importance of configuring collaborative learning environments that promote autonomy, reflection, and pluralism of perspectives, fundamental elements for cognitive development and knowledge construction in educational contexts.

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