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# Group dynamics and argument mapping in university students' dialogical argumentation

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This study investigates how argument diagrams and group size affect argumentative interactions among university students completing academic tasks. Argumentation, essential in educational psychology, helps resolve sociocognitive conflicts through critical engagement and verbal interaction. The quasi-experimental design involved 100 first-year Psychology and Psychopedagogy students, some of whom used an argument mapping tool. Data analysis revealed that mediation improved argument generation and integration but not co-construction or opposition. Non-mediated groups showed higher levels of co-construction and opposition. The findings suggest that visual tools enhance dialogical argumentation, although the study's limitations include a small sample and lack of non-verbal data. Future research should explore these dynamics in diverse contexts.

**Keywords**: Dialogical Argumentation. Technological Mediation. Group Size. Sociocognitive Conflict.

**Dinâmicas de grupo e mapeamento de argumentos na argumentação dialógica de estudantes universitários**

Este estudo investiga como diagramas de argumentos e o tamanho do grupo afetam as interações argumentativas entre estudantes universitários que realizam tarefas acadêmicas. A argumentação, essencial na psicologia educacional, ajuda a resolver conflitos sociocognitivos por meio de engajamento crítico e interação verbal. O desenho quase-experimental envolveu 100 estudantes do primeiro ano de Psicologia e Psicopedagogia, alguns dos quais utilizaram uma ferramenta de mapeamento de argumentos. A análise de dados revelou que a mediação melhorou a geração e a integração de argumentos, mas não a co-construção ou a oposição. Grupos não mediados apresentaram níveis mais altos de co-construção e oposição. Os resultados sugerem que ferramentas visuais aprimoram a argumentação dialógica, embora as limitações do estudo incluam uma amostra pequena e a falta de dados não verbais. Pesquisas futuras devem explorar essas dinâmicas em contextos diversos.

**Palavras-chave:** Argumentação Dialógica. Mediação Tecnológica. Tamanho do Grupo. Conflito Sociocognitivo.

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**Dinámica de grupo y mapeo de argumentos en la argumentación dialógica de estudiantes universitarios**

Este estudio investiga cómo los diagramas de argumentos y el tamaño del grupo afectan las interacciones argumentativas entre estudiantes universitarios que realizan tareas académicas. La argumentación, esencial en psicología educativa, ayuda a resolver conflictos sociocognitivos mediante la participación crítica y la interacción verbal. El diseño cuasiexperimental involucró a 100 estudiantes de primer año de Psicología y Psicopedagogía, algunos de los cuales utilizaron una herramienta de mapeo de argumentos. El análisis de datos reveló que la mediación mejoró la generación e integración de argumentos, pero no la coconstrucción ni la oposición. Los grupos sin mediación mostraron mayores niveles de coconstrucción y oposición. Los hallazgos sugieren que las herramientas visuales mejoran la argumentación dialógica, aunque las limitaciones del estudio incluyen una muestra pequeña y la falta de datos no verbales. Futuras investigaciones deberían explorar estas dinámicas en diversos contextos.

**Palabras clave**: Argumentación dialógica. Mediación tecnológica. Tamaño del grupo. Conflicto sociocognitivo.

## 1 Introduction

Argumentation is a critical skill that has emerged as an essential component in educational contexts, particularly within the field of Educational Psychology. It is defined as a process of verbal interaction that not only aims to propose and defend viewpoints but also assists students in deepening and broadening their understanding of the topic being discussed. It involves the ability to consider multiple perspectives and to critically elaborate on them (Baker *et al.*, 2020; Brummernhenrich *et al.*, 2021). Through the practice of argumentation, individuals engage in dialogues that allow them to confront diverse viewpoints, assess critiques, and ultimately refine their own perspectives. This dynamic process encourages students to evaluate, synthesize, and critically analyze information, fostering deeper comprehension and retention of knowledge (Baker, 2009; Muller Mirza *et al.*, 2009). It contributes to the development of more nuanced perspectives on a specific topic and to the collaborative comprehension of scientific concepts (Baker *et al.*, 2020).

Moreover, argumentation plays a vital role in resolving sociocognitive conflicts, which are often generated in collaborative learning environments. The Sociocognitive Conflict Theory, developed in the 1970s, emphasizes the significance of social interaction in human development. Sociocognitive conflict refers to a situation in which two or more participants encounter differing perspectives when tackling a shared task that requires a joint solution. In this process, differences of opinion emerge not merely as simple disagreements but as starting points for joint

reflection, allowing for the collaborative construction of knowledge (Perret-Clermont, 2022).

The sociocognitive conflict necessitates negotiation and reflection, leading to a more profound understanding of the subject matter. It involves mechanisms such as perspective coordination and decentralization, which are essential for forming shared meanings (Perret-Clermont, 2022; Muller Mirza *et al.*, 2009). The exchange of ideas and the confrontation of differing perspectives are inherent to this process, facilitating the collective construction of meanings (Doise; Mugny, 1984; Psaltis *et al.*, 2009).

For example, in a university setting, students might be assigned to complete a practical task or respond to questions based on a text. When discussing their interpretations, they may initially disagree on key points or approaches. Instead of adhering rigidly to their own interpretations, they have the opportunity to reconsider their perspectives by engaging with their peers' viewpoints. This collaborative exchange of ideas allows for a deeper exploration of the text and the development of a shared understanding.

At the university level, argumentation is not just an academic exercise, but a key tool for resolving sociocognitive conflicts through the expression of information and reasoning related to practical problems. In academic debates or group discussions, students negotiate complex concepts and integrate opposing viewpoints to deepen their understanding. This interaction challenges students to reconsider their ideas and resolve sociocognitive conflicts (Peralta, 2010; Gfeller *et al.*, 2021).

By encouraging students to reconsider their viewpoints and engage with scientific material critically, argumentation promotes the development of more complex and reflective thinking. Acting as a mediating tool, argumentation structures thought and facilitates the negotiation of meanings. When confronted with objections and required to defend their viewpoints, students must reconsider and adjust their ideas, leading to a more robust internalization of scientific concepts. This dialogical exchange enriches individual understanding and fosters critical analysis, synthesis of information, and abstraction (Vigotski, 1968/1934).

Therefore, argumentation not only assesses whether students comprehend the concepts taught, but also promotes an active intellectual process essential for the formation of advanced scientific concepts and the development of reflective and

autonomous thinking (Larraín *et al.*, 2019). On one hand, dialogical argumentation has been shown to enhance conceptual understanding. Asterhan & Schwarz (2007) examined the effects of two types of argumentation on university students' conceptual learning: monological argumentation, which involves individual reflection supported by guiding questions, and dialogical argumentation, which consists of guided peer discussions. Their study, conducted with students working in dyads, revealed that both forms of argumentation had a positive impact on conceptual understanding, with dialogical interaction producing the strongest effects.

On the other hand, engaging in argumentative interactions enhances metacognitive and epistemic skills, as learners reflect on their reasoning processes and the validity of their arguments (Leitão, 2000). The epistemic potential of argumentation is strongly influenced by its three core components, as outlined by Leitão (2000): the argument, the counterargument, and the response. Each of these elements plays a crucial role in shaping dialogue among participants. The argument functions as a claim supported by justification, revealing the speaker's understanding of the topic. The counterargument introduces alternative viewpoints that challenge or critique the initial claim, thereby enriching the discussion. The response, which follows the counterargument, involves a re-evaluation of the original position in light of the new perspectives presented during the dialogue. Leitão (2000) identifies four types of responses to a counterargument: total rejection without justification; acceptance of the counterargument and abandonment of one's original position; partial or local agreement without altering one's stance; and an integrative response, in which the initial position is modified in response to the opposition.

In light of the above, argumentative integration would consist of a modification of one's own viewpoint based on the opposing counterargument; this modification can vary in degrees but would not involve abandoning one's stance or critiquing the counterargument. This integration of argument and counterargument is considered essential, demonstrating argumentative intersubjectivity, in contrast to contentious conversations and quick consensus (Felton *et al.*, 2022). Therefore, the triadic structure of argumentation not only facilitates the defense of positions but also promotes the ability to engage in counter-arguments, ultimately leading to a more intricate and organized body of knowledge (Ruiz; Leitão, 2010).

An interesting variable to consider in the study of dialogical argumentation is the size of the group, which significantly affects argumentation dynamics. In smaller

discussions, social relationships directly influence the contributions of members. Groups with strong familiarity may engage in a form of 'playful brutality' in their interactions, whereas in less cohesive groups, members may hesitate to challenge each other due to interpersonal insecurity. Furthermore, psychological safety plays a vital role, enabling students to take risks in their communication, which is essential for engaging in deep and meaningful argumentation (Brummernhenrich *et al.*, 2021).

Recent studies have revealed that the size of a group plays a crucial role in shaping the nature of interactions, with significant distinctions emerging between pairs and groups of three. For instance, Curcio *et al.*, (2019) observed that interactions in dyads tend to be more balanced, although they often feature fewer evaluations and counterarguments. In contrast, other research has shown that triadic interactions tend to exhibit greater asymmetry and more complex cognitive exchanges (Peralta; Roselli, 2017). This variance underscores the idea that larger groups can facilitate social influence processes like normalization and polarization, which ultimately shape the nature of argumentative discussions (Doise; Moscovici, 1985). In essence, larger groups promote the creation of shared meanings and the integration of diverse viewpoints, whereas smaller groups tend to encourage more individualized interactions (Paicheler; Moscovici, 1985).

In the context of education, the optimal size for group collaboration has been a focal point of various studies, including the work of Sugai *et al.* (2018), which explores collaborative argumentation through social networking. Their findings suggest that a group of four individuals is most effective for maximizing interaction and achieving consensus, surpassing the effectiveness of groups of three, which, despite higher levels of interaction, struggled to reach agreements. Furthermore, groups of five were found to experience "social loafing," diminishing the effectiveness of collaboration. In a similar vein, Rannastu *et al.* (2019) studied the effects of group size on collaborative simulations and found that pairs exhibited superior collaboration during inquiry tasks, though there were no notable differences in performance between groups of two and four. These insights imply that while the ideal group size may vary depending on the context and task, it is clear that the size of a group significantly impacts collaborative dynamics and learning outcomes.

Moreover, argument diagrams have emerged as vital tools for supporting argumentation due to their capacity to visually depict the relationships among various elements and movements within an argument (Andriessen; Baker, 2014;

Davies *et al.*, 2021). Argument diagramming serves as a specialized form of externalization, where individuals make their thoughts visible and comprehensible to both themselves and others (Martí, 2000; Piaget, 1982/1996; Vygotsky, 1934/1962, 1978). This process of externalization makes knowledge more accessible and communicable, whether conveyed through spoken, written, or graphic formats, thereby facilitating reflection, evaluation, and modification of one's ideas.

The overarching aim of different mapping techniques is to enhance cognitive processes through visual representation. However, argument mapping has a unique structure that distinguishes it from other types of mapping. For instance, while mind mapping promotes creative thinking through a free-form design, and concept mapping emphasizes hierarchical relationships for deeper comprehension within particular domains, argument mapping concentrates on the inferential connections between propositions to evaluate the validity and soundness of arguments (Davies, 2011).

Argument diagrams serve as powerful instruments for clearly organizing claims, evidence, and counterarguments, greatly improving the argumentation process. These visual aids have gained considerable popularity in educational environments, where they are utilized not only to enhance argumentative skills but also to bolster students' critical thinking capabilities.

In school settings, Asterhan *et al.* (2012) examined the effects of different types of online teacher guidance on synchronous group discussions among 14- to 15-year-old students using Digalo, an integrated platform that supports the collaborative diagramming of arguments. Epistemic guidance improved the quality of arguments, while interactional guidance increased participation. Gender differences were also observed, with girls contributing more complex and diverse perspectives than boys.

In the university context, research conducted by Zheng *et al.* (2023) indicates that the use of online whiteboards with argument scaffolding promotes self-regulation and group co-regulation, resulting in more effective written arguments. This finding highlights the value of argument diagrams in fostering collaborative learning contexts.

Similarly, Eftekhari & Sotoudehnama (2018) demonstrated that using software for argument mapping significantly enhances the understanding and retention of argumentative information. Their results suggest that computer-assisted methods

can effectively reduce cognitive load, thus making the learning experience more manageable and efficient. By transforming complex information into visual formats, students find it easier to navigate and comprehend intricate argumentative structures.

Additionally, research by Darmawansah *et al.* (2022) and Chounta *et al.* (2017) further emphasizes the advantages of collaborative argument mapping. Darmawansah *et al.* (2022) found that employing a strategy based on collective reflection in argument mapping not only clarified and organized arguments but also increased the lexical complexity of oral discourse. This highlights how collaborative approaches can enrich discussions and produce more sophisticated argumentative exchanges.

Chounta *et al.* (2017) supported this finding by showing that groups working together produced more intricate and comprehensive argument diagrams compared to individuals working alone. Their research suggests that collaboratively generating argument diagrams leads to a deeper understanding of argumentative concepts, thus showcasing the benefits of group interactions in the learning process.

In a related study, Schwarz & Asterhan (2011) investigated how e-moderation of multiple synchronous discussions could be implemented and sustained in educational settings. Using a technological platform that supports collaborative reasoning through features such as argument map visualization, participation indicators, and remote intervention tools, they evaluated both the quality of the discussions and student participation among university students. Their findings showed that carefully designed moderator interventions significantly improved both participation and the quality of reasoning. While technology played a key role in enabling effective e-moderation, the study emphasized that pedagogically informed moderation was essential to achieving meaningful learning outcomes.

Lastly, the practice of argument diagramming has been associated with metacognitive processes, which are critical for effective argumentation and counter-argumentation. Ferrero & Letzen (2018) found that argumentative network diagrams positively influence metacognitive activity, suggesting their potential to enhance self-awareness during argumentative processes. Conversely, Lafuente Martínez & Álvarez Valdivia (2016) did not find significant improvements in metacognitive processes when graphics were compared to traditional text. Despite this

discrepancy, the existing research underscores the effectiveness of learning systems that incorporate argument diagrams, pointing to their potential to enhance the educational experience (Andriessen; Baker, 2014).

In conclusion, the previously discussed background highlights that both argument diagrams and group size are variables that can impact dialogical argumentation. However, no studies have yet explored these variables concurrently. Therefore, this study aims to analyze how technological mediation through argument diagrams and the size of groups affect the argumentative interactions among university students engaged in resolving an academic task.

## 2 Methodology

### 2.1 Design

A quasi-experimental design was employed to address the research objective. The design included two independent variables: 1) Group Size, with the values of a) Dyad and b) Triad; and 2) Technological Mediation, with the values of a) With Mediation and b) Without Mediation. The dependent variable in this study was the quality of dialogic argumentation, which was analysed based on the dimensions elaborated upon in the data analysis section.

The study consisted of three distinct phases: a pre-test, a dyadic interaction phase, and a post-test. Both the pre-test and post-test were conducted individually, allowing for the evaluation of participants' prior knowledge as well as their individual opinions. During the dyadic interaction phase, pairs or triads were formed by randomly assigning subjects to these groups. Each participant was randomly assigned the role of Participant 1, Participant 2, or Participant 3. It is important to note that, although the assignment of cases to each condition was conducted randomly, this study was inherently quasi-experimental, carried out within a naturalistic context.

### 2.2 Participants

A total of 100 first-year students (comprising 20 dyads and 20 triads) from Psychology and Psychopedagogy programmes at universities in Argentina participated in the study. The participants had an average age of 20.47 years (SD =

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4.01). In terms of gender, the sample was predominantly female, with 90.00% identifying as women and 10.00% as men. Of the sample, 89.74% were enrolled in private institutions, while the remaining students were attending public institutions. The most frequently reported educational qualifications of their mothers, fathers, or guardians were: completed secondary education (36.05%) and completed higher education (33.32%). As mentioned earlier, the sample included 20 dyads (40 participants) and 20 triads (60 participants), who were randomly allocated to each respective condition. Table 1 presents the sociodemographic data corresponding to each condition (dyads and triads).

**Table 1 -** Sociodemographic data by condition

| **Condition** | **With mediation** | | **Without mediation** | |
|---|---|---|---|---|
| | **Age (Average y SD)** | | | |
| **dyads** | 21.40, SD=5.68 | | 19.10, SD=1.91 | |
| **triads** | 21.20, SD=4.28 | | 20.20, SD=3.36 | |
| | **Gender (% total)** | | | |
| | **Female** | | **Male** | |
| **dyads** | 85.00 | | 15.00 | |
| **triads** | 93.33 | | 06.66 | |
| | **Type of institution (% total)** | | | |
| | **Public** | **Private** | **Public** | **Private** |
| **dyads** | 7.69 | 17.95 | 0.00 | 25.64 |
| **triads** | 0.00 | 25.64 | 2.56 | 20.51 |
| | **Most commonly reported educational level of guardians (% total)** | | | |
| | **high school diploma** | **college diploma** | **high school diploma** | **college diploma** |
| **dyads** | 7.56 | 6.39 | 8.14 | 8.72 |
| **triads** | 36.11 | 8.72 | 7.56 | 11.6 |

Note. Table created by the authors based on study data.

## 2.3 Materials and procedure

The activity in which the students participated was academic and written, specifically focusing on the participants' area of study. This choice was grounded in

the understanding that the type of task influences students' argumentative competence, as it motivates and engages them with specific knowledge (Peralta *et al.*, 2023). The theoretical content of the activity aligned with the academic programmes of the participants' university studies. More specifically, it is closely related to the foundational theories underpinning various therapeutic approaches, such as cognitive-behavioural and psychoanalytic theories, which constitute part of the first-year curriculum employed by the students. The activity was conducted outside regular class hours, and students were informed that their participation would not impact their course attendance or evaluation.

The task presented a scenario involving a complex problem concerning a child diagnosed with autism spectrum disorder, necessitating consideration of two distinct therapeutic approaches: cognitive-behavioural and psychoanalytic. Each participant was assigned a role advocating for one of these approaches, without explicitly naming the therapies, and was subsequently asked to defend their positions during the ensuing discussion. In instances where triads were formed, two participants were assigned the same stance while one was given the opposing view, ensuring that the number of pairs with two participants defending one position was equivalent to those defending the other stance.

The incorporation of role-playing was intended to stimulate heightened engagement and comprehension, as previous research indicates that role-playing can enhance perspective-taking, argumentation, and reduce cognitive load (Ho *et al.*, 2009; Salminen; Marttunen, 2018). It was also designed to encourage mixed socio-cognitive conflict by assigning each participant an opposing viewpoint, thereby provoking dialogical argumentation. It is crucial to note that while the effects of assigned roles on argumentation are not universally accepted in the literature (Baker; Schwarz, 2019; Gronostay, 2016; Lilly, 2012; Salminen; Marttunen, 2018), this study capitalises on the potential of role-playing to induce emotional commitment and foster richer argumentation.

Participants' prior knowledge and personal opinions regarding the two psychotherapies and autism spectrum disorder were assessed through a written pre-test that posed the question, "Which therapy would you recommend for treating autism spectrum disorder and why?" Furthermore, as first-year Psychology and Psychopedagogy students, it was anticipated that they possessed a foundational understanding of these topics. This existing knowledge served as a content basis for

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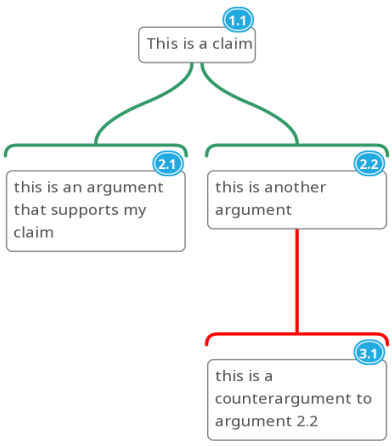
the task, as well as a written explanation of the therapeutic approaches. A post-test was also administered, featuring the same questions as the pre-test.

As previously mentioned, the procedure comprised three primary phases. Initially, all participants completed an individual written pre-test. In the second phase, subjects were grouped into pairs to collaboratively read the assigned task. Prior to commencing their collaborative interaction to resolve the task, they were instructed to dedicate ten minutes to preparing their arguments and positions. Subsequently, they worked individually again to complete the written post-test.

For the experimental condition involving mediation through argument mapping, the 10-minute preparation time utilized a technological tool called MindMup. This is a web-based application accessible online via a computer and/or tablet. Following the dimensions established by Bresciani & Eppler (2018), this tool allows for the graphical representation of arguments, counterarguments, and responses in a tree format, commonly utilised in various argument mapping tools (see Figure 1). Furthermore, it provides a straightforward, clear, and visually appealing depiction of these elements and their interrelations, centred around one or more assertions for discussion. The created maps appear in high resolution, but users can modify and expand any element immediately upon clicking. Lastly, this tool facilitates collaboration; however, within the context of this study, it was utilised individually to prepare participants before they engaged with their partners.

The study complied with ethical guidelines, including informed consent, data anonymity, and confidentiality. Face-to-face interactions were audio-recorded for subsequent transcription.

**Figure 1** – Example of argument map created with MindMup




Note. Figure created by the authors

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## 3 Data Analysis

The interactions were recorded in audio format and subsequently transcribed. The quantitative data analysis was conducted using the R programming language alongside the RStudio software, version 2024.04.2. The analytical framework employed for examining dialogic argumentation was implemented on two distinct levels: microanalytical and molar.

The microanalytical framework adopted in this study is grounded in a processual perspective of dialogic argumentation, which draws from the analytical traditions that emphasize the epistemic potential of discursive exchanges in collaborative contexts (Larraín *et al.*, 2020; Leitão, 2000). Specifically, the analysis was inspired by the triadic model of argumentation as semiotic tools for reflective thinking and knowledge construction (Leitão, 2000, 2001), and further informed by Larraín *et al.*'s (2020) dialogic coding scheme. The chosen unit of analysis—discursive movements—is consistent with this approach and defined as discrete segments of discourse that fulfill specific dialogic and argumentative functions (Felton *et al.*, 2022).

The initial step involved categorizing those discursive movements that were deemed irrelevant to the study as non-relevant. Subsequently, the relevant movements were coded using the following categories, which focused on the distribution of the fundamental components of dialogic argumentation. The basic units of coding were identified as discursive movements, defined as follows (inspired by Leitão, 2000):

1. Arguments:

a) New arguments: Refers to the formulation of new arguments that have not been previously utilized.

b) Used arguments: Refers to the exact or nearly exact repetition of arguments that have already been presented.

2. Co-construction (Gronostay, 2016; this category is added in this article):

a) Agreement: Expressions of explicit agreement between participants.

b) Continuation: Messages that continue the idea put forth by the interlocutor.

c) Elaboration of one's own position: Any form of explanation, description, or elaboration of one's own proposed solution to the issue at hand.

d) Elaboration of another's position: Questions, explanations, or repetitions of another participant's proposal (as long as they are not arguments), aimed at understanding it.

e) Elaboration of a combined position: When participants choose a solution that combines their two viewpoints, this category is used to categorize such discursive movements.

3. Opposition (with the sub-discursive movements indicated by Gronostay, 2016):

a) Disagreement: Expressions of disagreement with another's messages.

b) Counterargument: Arguments aimed at defending one's own position and attacking that of the interlocutor, once the interlocutor has presented their own arguments.

c) Refutation: Assertions that dismiss the validity of what the interlocutor is presenting.

4. Integration:

a) Pre-opposition: Before receiving opposition to one's own position, the participant anticipates possible objections or weaknesses in their viewpoint, integrating these into their perspective while still defending it.

b) Post-opposition: After receiving opposition, the participant notes what their interlocutor has said and incorporates it into their defense of their position, setting aside cognitive biases, acknowledging negative aspects of their stance, and thereby strengthening their defense.

At the molar level, a broader contextual study of the interactions was undertaken, which encompassed the type of interaction sustained by either the dyad or the triad. The basic unit of coding at this level was the overall interaction as recorded by the dyad throughout the activity. The categories defined for this analysis were as follows (inspired by Gronostay, 2016):

1. Social

2. Epistemic:

a) Unilateral.

b) Responsive.

c) Critical.

The categories for the molar examination emerged from the preceding microanalytical analysis. In instances where at least one integration discursive movement was identified, these interactions were classified as critical. Conversely, interactions that exhibited any form of opposition were categorised as responsive. Interactions that solely contained unilateral arguments were designated as unilateral, while those that did not incorporate any of these discursive movements were considered social, as they predominantly featured co-construction and irrelevant movements.

For the microanalytical analysis (discursive movements), relative counting of units was employed for each category. This relative approach necessitated dividing the absolute count of each category by the total number of units produced by the dyad during the interaction, resulting in a value ranging from 0 to 1. This adjustment was imperative due to the variable duration of complete interactions exhibited by the dyads. Average and median values for each category were compared across different conditions.

To assess statistical differences between the conditions, independent samples t-tests were used when the assumption of normality was met, as determined by the Shapiro-Wilk test. For variables that did not meet the normality assumption, the Mann-Whitney test was applied. In the molar analysis, associations between categorical variables were examined using the Chi-squared test with Monte Carlo simulation.

## 4 Results

### 4.1 Microanalysis of interactions

Initially, from a microanalytical perspective, an exploration of the distribution of arguments, co-construction, opposition, and integration was conducted, along with an examination of the sub-movements that comprise these categories. Table 2 presents descriptive statistics for the various types of discursive movements. A comparison among these discursive movements reveals that levels of co-construction are the highest, followed by arguments, opposition, and, lastly, integration.

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Focusing on the general discursive movements, it is observed that arguments are predominantly presented at higher levels within the mediation group, with even more pronounced levels within the dyad group. Similarly, integration was notably more prominent in the mediation group, particularly among the triads. In contrast, co-construction achieved greater heights within the non-mediation group and among the triads.

Regarding opposition, no direct relationship between dyads or triads and mediation was established. However, it is notable that the highest level of opposition was observed within dyads without mediation, followed by triads with mediation.

**Table 2 -** Descriptive statistics of arguments, co-construction, opposition, and integration (and sub-categories) by condition

| | **Condition** | **With mediation** | | **Without mediation** | |
|---|---|---|---|---|---|
| **Discursive movement** | **Group size** | **Average** | **SD** | **Average** | **SD** |
| **Argument** | **2** | 18,79 | 7,76 | 33,94 | 13,81 |
| | **3** | 17,52 | 10,35 | 24,18 | 11,56 |
| New argument | **2** | 17,57 | 6,50 | 32,69 | 13,58 |
| | **3** | 16,53 | 9,84 | 21,38 | 10,56 |
| Used argument | **2** | 1,21 | 2,37 | 1,25 | 1,88 |
| | **3** | 0,99 | 2,13 | 2,80 | 3,88 |
| **Coconstruction** | **2** | 55,84 | 8,71 | 46,82 | 19,35 |
| | **3** | 63,67 | 11,75 | 41,18 | 9,95 |
| Agreement | **2** | 8,42 | 6,56 | 11,81 | 9,10 |
| | **3** | 10,49 | 10,86 | 10,79 | 7,04 |
| Continuation | **2** | 7,48 | 8,76 | 2,82 | 5,22 |
| | **3** | 6,28 | 5,29 | 2,32 | 3,19 |
| Elaboration of own's viewpoint | **2** | 24,71 | 7,81 | 20,94 | 7,56 |
| | **3** | 28,36 | 11,41 | 14,17 | 7,47 |
| Elaboration of others' viewpoints | **2** | 8,93 | 4,77 | 7,95 | 6,09 |
| | **3** | 7,17 | 6,33 | 7,80 | 4,69 |
| Elaboration of shared proposal | **2** | 6,30 | 6,95 | 3,31 | 4,54 |
| | **3** | 11,37 | 11,49 | 6,11 | 6,05 |

| | | | | | |
|---|---|---|---|---|---|
| **Opposition** | **2** | 21,56 | 6,65 | 11,15 | 7,59 |
| | **3** | 11,68 | 6,45 | 19,91 | 15,99 |
| Refutation | **2** | 10,48 | 5,46 | 7,66 | 7,37 |
| | **3** | 7,16 | 7,18 | 9,10 | 11,06 |
| Counterargument | **2** | 8,62 | 4,80 | 3,08 | 3,24 |
| | **3** | 3,58 | 3,42 | 7,57 | 9,19 |
| Disagreement | **2** | 2,46 | 3,83 | 0,41 | 1,23 |
| | **3** | 0,93 | 2,05 | 3,24 | 8,28 |
| **Integration** | **2** | 3,81 | 3,52 | 8,08 | 5,45 |
| | **3** | 7,13 | 4,16 | 14,73 | 8,51 |
| Integration previous to opposition | **2** | 0,66 | 1,86 | 2,78 | 3,55 |
| | **3** | 1,80 | 3,82 | 8,69 | 8,80 |
| Integration post opposition | **2** | 3,15 | 3,69 | 5,31 | 4,75 |
| | **3** | 5,33 | 4,90 | 6,04 | 6,61 |

**Note.** Table created by the authors based on study data. Percentages may not add up to 100% due to rounding

Comparative mean tests were conducted among various groups based on the presence of mediation and group size. The groups compared included: dyads with mediation versus dyads without mediation; triads with mediation versus triads without mediation; dyads with mediation versus triads with mediation; dyads without mediation versus triads without mediation; dyads with mediation versus triads without mediation; and dyads without mediation versus triads with mediation. The significant differences identified are detailed below, categorized by the specific discursive movement:

1. Total Argument: A significant difference was observed between dyads with mediation and those without, indicating that the mediation group exhibited a higher level of total arguments ($t(11.765) = -2.83$, $p$ 0.05). A Cohen's d of 1.33 indicated a large effect size, suggesting that technological mediation had a substantial impact on the number of arguments produced.

2. New Argument: A significant difference emerged between dyads with and without mediation, with the mediation group demonstrating a greater average of

new arguments (t(11.765) = -2.98, p 0.05). The effect size was large, with Cohen's d = 1.39, indicating a substantial difference between the two conditions.

These movements are related to the introduction of new points or arguments in the debate, as reflected in the exchanges where participants are presenting their perspectives on autism therapies. For example, in one mediated dyad, the first participant presented a new argument for using stimulus-reward systems for autism therapy: "For me, through the application of certain stimuli and rewards, the child will be able to establish a relationship between concepts, objects, and situations" [translated from Spanish by the authors]. In another mediated dyad, another participant put forth a new argument: "I believe that through the application of certain stimuli and rewards, things can be done much more quickly..." [translated from Spanish by the authors].

3. Co-construction: A significant difference was identified between triads with and without mediation, revealing that the non-mediation group had a higher average (t(16.95) = 4.51, p 0.05). This difference was practically substantial, with a very large effect size (Cohen's d = –2.06). The negative value indicates that the non-mediated triads outperformed the mediated ones in terms of co-construction.

4. Elaboration of own's viewpoint: A significant difference was detected between triads with mediation and those without, with the non-mediation group again showing higher averages (t(15.622) = 3.24, p 0.05). This was also supported by a very large effect size (Cohen's d = –1.46), indicating that non-mediated triads engaged in elaboration of their own positions to a substantially greater extent than mediated triads.

5. Continuation: A significant difference was established between groups with and without mediation (dyads and triads), with the non-mediation group presenting higher averages (W = 97, p 0.05). This was accompanied by a medium effect size (r = –0.35), suggesting that continuation moves were moderately more frequent in non-mediated groups compared to mediated ones.

The non-mediated interactions in triads often involved elaborating on or expanding one's own and others' perspectives to build a more comprehensive understanding of the situation and proposed approaches, without yet presenting explicit arguments. For instance, one participant proposed: "Well, first, what I would do is observe him, and then, based on that observation, be able to verbalize, to

express (it's unclear). For example, let's say we have a situation where he's frustrated because he can't solve something that's being asked of him at school. [...] So, we need to try to verbalize that situation, [...]. We help give emotional meaning to the situation. "[translated from Spanish by the authors]. Another participant asked their interlocutor for clarification regarding the position they were supporting: "And what do you mean by token economy?" [translated from Spanish by the authors].

6. Total opposition: A significant difference was revealed between dyads with mediation and those without, with the non-mediation group showing higher averages (W = 9.5, p 0.05). This was associated with a large effect size (r = –0.56), indicating that dyads without mediation engaged in opposition moves significantly more than those with mediation.

7. Counter-argumentation: A significant difference was observed between dyads with mediation and those without, where averages were greater for the non-mediation group (W = 12, p 0.05). This was accompanied by a large effect size (r = –0.51), indicating that non-mediated dyads used counterarguments significantly more frequently than mediated ones.

Participants in non-mediated interactions in dyads more frequently expressed disagreement or challenged the points made by others. For instance, one participant stated: "I don't agree with you at all. I mean, to me, what's happening to him has nothing to do with how he was raised." [translated from Spanish by the authors]. Another participant questioned their interlocutor's proposal to apply a behavioral approach to the case, saying: "Well, I don't think we should expect an autistic child to behave exactly like a child without the disorder." [translated from Spanish by the authors]. In another case, disagreement was accompanied by a more elaborated counterargument: "I think that, given the child's characteristics, that wouldn't be the best kind of therapy, because we should be focusing more on his subjectivity, on what he's interested in. With this token economy, we're just imposing something external—something we believe is good for him—when actually we should be trying to get to know him better and see in what situations he feels more comfortable." [translated from Spanish by the authors].

8. Total Integration of Interaction:

a) Between groups with and without mediation, levels were significantly higher in the mediation group (W = 244.5, p 0.05). This was accompanied by a moderate-to-

large effect size (r = 0.42), indicating that groups with mediation exhibited higher levels of integration than those without mediation.

b) Between dyads with mediation and dyads without, the mediation group also showed higher levels (W = 71.5, p 0.05). This difference was also accompanied by a moderate-to-large effect size (r = 0.43), suggesting that mediated dyads reached higher levels of integration than their non-mediated counterparts.

c) In comparisons between triads with mediation and dyads without mediation, higher levels were found in the triad mediation group (W = 65, p 0.05). When comparing triads with mediation to dyads without mediation, the difference was associated with a large effect size (r = 0.63), indicating that the combination of group size and mediation significantly enhanced integrative discursive moves.

9. Pre-Opposition Integration:

a) A significant difference was reported between groups with and without mediation, with higher levels in the mediation group (W = 227.5, p 0.05); This statistically significant difference was accompanied by a medium effect size (r = 0.38), suggesting that groups with mediation engaged in pre-opposition integration more frequently than those without mediation.

b) There was also a significant difference between triads with mediation and dyads without, with higher levels in the mediation group (W = 69, p 0.05). The comparison revealed a large effect size (r = 0.52), indicating that the combination of group size and mediation notably increased the presence of integration prior to opposition.

In mediated interactions, more participants considered weaknesses or potential objections to their own positions, or incorporated elements from their interlocutors' opposing views while defending their perspectives. For example, one participant anticipated a possible objection to their stance, while also referencing the argument map they had created: "What I briefly wrote to support my idea is that, well, individuals need to be able to identify themselves or recognize their individuality, but always within a family and social structure. [...] The downside I see in this kind of treatment is that not all children have access to [...] this kind of interdisciplinary network, with different professionals, to help them achieve cognitive development and work through the issue." [translated from Spanish by the authors].

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Another participant, responding to their interlocutor's cognitive-behavioral proposal—centered on the idea of adaptation—said: "Right, that's why I agree with the idea of adaptation, but doing it in a way that's short-term... I don't really like that. [...] I'd like him to be able to adapt as much as possible, to connect with others and have his own identity. I think we should focus more on that. Of course, acceptance is really important, but I think being able to relate to others is too, so maybe we could go in that direction." [translated from Spanish by the authors].

## 4.2 Molar Analysis of Interactions

In terms of the type of interaction, a notably higher frequency of critical argumentation was identified, comprising 76.92% of the total interactions. The analysis conducted on the relationships between group size and the type of total interaction revealed a statistically significant association (X-squared = 6.8455, p 0.05). The effect size was moderate to large, with Cramér's V = 0.42, suggesting that the type of interaction varied meaningfully depending on group size.

It was observed that a substantial majority of the interactions occurring within triads were classified as critical (94.74%). In contrast, although dyadic interactions also showed a predominance of critical types, this was somewhat less pronounced, with 60% of interactions falling into this category and a variety of other interaction types. Conversely, no significant associations were found between mediation and the type of interaction, nor among the different groups categorized by their combined conditions.

**Table 3 –** Descriptive statistics of general interaction type by condition

| | **Condition** | **With mediation** | **Without mediation** |
|---|---|---|---|
| **Type of interaction** | **Group size** | **% total** | **% total** |
| **Critical** | **2** | 12,82 | 17,95 |
| | **3** | 23,08 | 23,08 |
| **Responsive** | **2** | 7,69 | 5,13 |
| | **3** | 2,56 | 0,00 |
| **Social** | **2** | 5,13 | 2,56 |

**Note.** Table created by the authors based on study data. Percentages may not add up to 100% due to rounding

Notably, critical argumentation occurred more frequently in triadic groups than in dyadic groups. To illustrate this pattern, two cases—one from a dyadic group and one from a triadic group—are presented.

In the dyadic case, Participant 1 defends a behavioral approach, arguing that a child with autism can improve through the use of reinforcements and rewards, which would help develop planning skills and adherence to social norms, thus facilitating adaptation to the environment. In contrast, Participant 2 disagrees with this perspective and proposes that the child should be supported in discovering personal meaning in objects and experiences. According to this view, therapy should aim to stimulate the child's internal motivations and subjective world. Participant 1 rejects this approach, asserting that it would not lead to measurable improvements. Despite their opposing views, the participants reach a pragmatic agreement: Participant 1 will carry out the treatment following the behavioral approach, while both acknowledge their disagreement and remain open to evaluating the method's effectiveness in future sessions.

In contrast, the discussion within the triadic group reveals a more complex argumentative dynamic. The three participants explore diverse perspectives on how to approach therapy for a young child with autism. Participant 1 advocates for a behavioral model based on positive reinforcement via a token economy, emphasizing its potential to enhance language development, cognitive abilities, social interaction, and behavioral regulation. Participant 2 initially supports the cognitive-developmental benefits of this model but raises concerns about the potential emotional dependence on rewards, which could undermine the child's intrinsic motivation and long-term autonomy. Participant 1 acknowledges this critique and incorporates it into her position by highlighting the importance of gradually phasing out the use of external rewards as the child matures.

Participant 3 introduces a broader perspective, arguing that therapy should focus on self-awareness and problem-solving without rigid structures or externally imposed goals. She warns against the stigmatization of neurodivergent individuals and advocates for a more natural and individualized developmental process. This position prompts Participants 1 and 2 to critically reflect on the potential long-term limitations of a strictly behaviorist approach.

As the discussion evolves, the three participants begin to integrate aspects of each other's viewpoints. They recognize the short-term utility of reinforcement-based strategies, particularly during early developmental stages, while also emphasizing the need for flexibility and future adjustment. Ultimately, they reach a collective agreement to adopt a hybrid therapeutic approach that combines structured reinforcement with more open-ended, child-led forms of stimulation. At the same time, they express openness to shifting toward Participant 3's perspective as the child gains greater autonomy.

## 5 Discussion

The primary aim of this study was to investigate the impact of technological mediation, specifically through the use of argument diagrams, alongside the influence of group size on the dialogical argumentative interactions of university students. The relevance of this study lies in the need to understand how specific condition, namely technological mediation and group size, affect the joint construction of knowledge through dialogical argumentation in university settings.

Argumentation is widely recognized as a key discursive practice in academic and professional training, as it fosters critical thinking, metacognitive reflection, and the appropriation of complex concepts (Baker *et al.*, 2020; Larraín *et al.*, 2020). From a socioconstructivist perspective, sociocognitive conflict functions as a central mechanism for cognitive development, as it introduces disequilibrium that drives decentering, coordination of perspectives, and the co-construction of new meanings (Castellaro; Peralta, 2020; Perret-Clermont, 2022). Within this framework, dialogical argumentation emerges as a privileged means for resolving sociocognitive conflicts, enabling not only the expression of ideas but also their epistemic transformation through confrontation and mutual evaluation (Asterhan; Schwarz, 2007; Kuhn, 2015).

Previous research has shown that technological tools such as argument diagrams enhance these processes by facilitating the externalization and visual organization of ideas, thereby promoting clarity, integration of perspectives, and reflective thinking (Andriessen; Baker, 2014; Zheng *et al.*, 2023). Additionally, group size has been identified as a key factor in the quality of argumentative interaction: while dyads tend to foster symmetrical participation, triads often generate richer and more complex dynamics, with increased opportunities for the integration of divergent viewpoints (Peralta; Roselli, 2017; Doise; Moscovici, 1985). Accordingly,

investigating the combined impact of technological mediation and group size is essential for designing educational environments that maximize the epistemic potential of argumentation and foster the critical appropriation of knowledge.

The findings from the study indicate that both technological mediation and group size exert significant effects on students' dialogical argumentation. Specifically, it was noted that students who engaged with technological tools for mediation displayed a greater capacity for generating arguments and demonstrated improved integration of arguments and counterarguments. However, it is noteworthy that mediation did not appear to facilitate the emergence of discursive movements of co-construction or opposition. It can be inferred that the clear structuring of perspectives and arguments contributed positively to the identification and retention of the supporting arguments (Darmawansah *et al.*, 2022; Eftekhari; Sotoudehnama, 2018). Furthermore, within the group lacking mediation, the high incidence of co-construction may have somewhat mitigated the absence of arguments.

Additionally, the utilization of argument maps, by enabling the externalization of both arguments and counterarguments, likely facilitates a greater propensity for students to integrate diverse perspectives in subsequent discussions rather than merely opposing them, as was the case within the group that did not employ mediation. This finding suggests that technology may promote a wider variety of engagement methods in argumentative dialogue, which aligns with studies highlighting the structuring role of diagrams in argumentation.

Regarding group size, the results did not reveal any overarching trends, with the exception of instances of integration. Notably, a greater tendency to integrate diverse perspectives was observed, corroborating prior research that has identified a richer quality of argumentative interactions within triadic groupings (Peralta; Roselli, 2017). This finding can be complemented by the molar analysis, which associated triads with critical type interactions, while dyads were observed to engage in more responsive and social resolutions. Such differences imply that larger groups provide more opportunities for the confrontation and coordination of differing viewpoints. However, it is essential to consider that, as noted in the literature, an increased group size may adversely affect the symmetry of participation and likely the cognitive gains of individual participants (Curcio *et al.*, 2019). It also requires considering emotional aspects that may influence the dynamics of larger groups (Brummernhenrich *et al.*, 2021).

In terms of the combination of group size and technological mediation, it was observed that dyads without technological mediation produced a higher frequency of opposition compared to the other groups. It can be posited that group size, which tends to encourage more individualistic interactions (Paicheler; Moscovici, 1985), coupled with the absence of a visual organization of arguments, led students to engage more in counter-argumentation, refutation, and expression of disagreements. Such dynamics, lacking subsequent integration, may compromise effective negotiation of meanings (Bresciani; Eppler, 2018; Munneke *et al.*, 2007).

The significance of the results of the present study lies in their potential pedagogical applications. Technological mediation, particularly through visual tools such as argument diagrams, may serve as an effective strategy to enhance dialogical argumentation in educational settings. This approach not only facilitates interaction among students but also encourages reflection and the development of essential metacognitive skills necessary for higher education (Ferrero; Letzen, 2018). Furthermore, the use of triadic groupings, as demonstrated in this study, could prove to be an effective configuration for maximizing sociocognitive conflict and fostering richer, more collaborative discussions.

An important factor that could influence the interactions is the prior knowledge of the participants. Research has shown that students with more knowledge on the topic tend to employ more well-supported refutations and arguments (Demiral; Çepni, 2018), potentially leading to more complex and sophisticated arguments. Additionally, prior knowledge can influence the depth and quality of the argumentation, as students with a deeper understanding of the subject are better equipped to engage in counter-argumentation and integrate opposing perspectives (Peralta *et al.*, 2022). In the present study, as first-year Psychology and Psychopedagogy students, participants had basic knowledge of the therapeutic approaches and autism spectrum disorder, which was further supported by a text providing information on both topics. However, these aspects warrant further consideration in future research, as variations in prior knowledge may influence how students engage in argumentative tasks.

Another important consideration is the role of teacher or researcher mediation as a potential moderating variable between the independent variables and dialogical argumentation. Specifically, in technology-mediated contexts, the presence of pedagogical scaffolding can significantly influence the quality of argumentative

interactions. Technological tools that support collaborative diagramming have been shown to improve participation and reasoning quality when accompanied by pedagogically informed guidance (Asterhan *et al.*, 2012; Schwarz; Asterhan, 2011). Moreover, some studies have shown that researcher mediation can influence the effect of group size on dialogical argumentation (Peralta; Roselli, 2021), along with other moderating variables such as the type of task (Peralta; Roselli, 2017) and gender composition (Asterhan *et al.*, 2012).

Despite the findings of the study, several limitations should be acknowledged. Firstly, the sample was restricted to psychology and psychopedagogy students from Argentinian universities, which may limit the generalizability of the results to other disciplines or educational contexts. Additionally, the study was conducted in a quasi-experimental setting, limiting control over external variables that could have influenced argumentative interactions, such as prior dynamics among participants or their individual experiences with technological tools. Another limitation is that the analysis of argumentative interactions relied on audio recordings, which may have overlooked non-verbal elements that are significant for the negotiation of meanings.

Looking towards future research, it would be beneficial to explore the influence of technological mediation across various educational contexts and with more diverse samples. Furthermore, examining how different group configurations beyond dyads and triads affect the quality of argumentative interactions could offer valuable insights. For instance, studies have highlighted the importance of gender composition within groups (Asterhan *et al.*, 2012). Lastly, investigating individual differences within group configurations also presents a promising avenue for future inquiry.

In conclusion, this study highlights the potential of technological mediation to enhance dialogical argumentation in higher education. The results underscore the importance of creating environments that encourage sociocognitive conflict and provide tools that aid students in externalizing and structuring their arguments. Likewise, group size emerges as a relevant factor, as it shapes the dynamics of participation and the diversity of viewpoints brought into the discussion. Both technological tools and thoughtful group configurations can thus contribute to fostering deeper engagement and the collaborative construction of knowledge.

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