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Psychosocial Obstacles in Young Children Argumentative Interactions

Josephine Convertini

Department of Education and Learning, University of Applied Sciences and Arts of Southern Switzerland, 6600 Locarno, Switzerland; josephine.convertini@supsi.ch

Abstract: Argumentation is an important aspect in the field of education because of its impact on learning processes. At the same time, argumentation is a complex activity in terms of cognitive, relational, emotional and social dynamics. In this paper, I investigate and I describe possible difficulties encountered by children during the argumentative process. The study involves 25 preschool children at a kindergarten engaged in three building tasks. The tasks were video-recorded and the argumentative discussions transcribed. For the aim of this paper, I analyze how argumentation are distributed among participants. I select interactions in which participants apparently do not argue or there are differences in the degree of argumentative participation between participants of the same group. I analyze these interactions and moments of impasse in the argumentative steps. The findings show how the simplicity of solving the task (e.g., when children do not encounter any problem in completing the activity) and the children's self-perception of their competences in solving the task may have an impact on argumentation activities. Moreover, this perception is co-constructed by children within the interaction. The study contributes to the line of research on designing argumentation and highlights the role of the adult in managing children's interactions.

Keywords: argumentation; preschool children; competence; self-efficacy; design; problem-solving; socio-cultural psychology; collaboration

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1. Introduction

Argumentation is a process that is investigated since the preschool age (e.g., [1]). For example, some researchers have been interested in tracing its qualities in child development (e.g., [2,3]), while others have investigated argumentation as a key to accessing the child's cultural world (e.g., [4]) or to their ways of reasoning (e.g., [5,6]). Argumentation is widely explored in the field of education, especially in science education, as it is a process of critical reasoning that affects a child's learning [7] and pushes the students' knowledge further [8]. Argumentation it is also relevant for the development of young citizens [8]. For these reasons, the participation of young children in argumentative discussions is widely encouraged in the field of education. Although there is no doubt today that arguing in and out of the classroom is important, also recognized is how difficult it can be for a child to engage in such an activity. In this respect, a rich literature focuses on the observation of children's difficulties in arguing with peers and the adult (teacher). The aspects that have been investigated are mainly related to relational, affective, cognitive and social dimensions [9].

The present study is part of this line of research. Within a socio-cultural perspective, the aims are to investigate argumentative discussions among preschool children and to highlight the possible difficulties they encounter in the argumentative process. The education context of the study is STEM education at the kindergarten level in which children are asked to solve a technical problem together.

The understanding of barriers to children's active participation in argumentative discussion can offer to the teachers some useful tools to provide children with a positive experience within classroom debates.

The paper is organized as follows: first, I briefly review the existing research regarding children's difficulties during argumentative activities with peers and the adult. Second, I present the literature on designing activities planned to overcome some of the obstacles in argumentative tasks at school. Then, I introduce the methodological aspects of the present study on young children's argumentative interactions. Finally, I discuss the findings and address some final reflections in the conclusion of the paper.

2. Children's Difficulties in Argumentation Process

Argumentation is a "context-dependent activity" [10] (p. 7), and "argumentative analysis and evaluation cannot do without a proper consideration of context" [10] (p. 8). As the present study intends to investigate argumentative discussions among children in kindergarten, it is important to draw attention to the specific characteristics of argumentation in institutional contexts [7].

Arguing is a rather complex practice from a cognitive, relational, emotional and social point of view [11]. This complexity can be easily explained if we consider that argumentation, like other practices, is a form of interaction, an "argumentative interaction" [12]. However, when the context in which the actors are placed is the school, the required commitment increases and pupils' argumentation rarely occurs spontaneously [13,14]. In fact, while in family contexts children open up about different issues and discuss a large set of topics [15,16], in other, more institutionalized contexts, it is often the adult proposing the topic of the lesson and of discussion. In this regard, ref. [17] present ten rules of conduct for reasonable discussion. According to ref. [17] (p. 190), the "freedom rule" specifies that "discussants may not prevent each other from advancing standpoints or from calling standpoints into question".

Moreover, in educational institutional contexts, the teacher can be very demanding about student performance. The expectations that students have about the context can keep them from participating in a dialogue and, consequently, also in an argumentative discussion. Ref. [18] investigated some of the causes of students' low verbal participation in biology classrooms. Among the causes, some refer to causes of a personal nature (such as a deficit of attention or anxiety about being heard), others are related to the adult's intervention (such as the incentives he/she provides for participating), and others concern the proposed task (such as the lack of knowledge or understanding of the topic of discussion). Ref. [19] observed some preschool and school-aged children engaged in solving building tasks. The authors recognized the children's need to find an interactional space, including a physical one, as a prerequisite for participating in argumentative discussions.

In adult-child or child-to-child argumentative activities in the classroom, the mutual commitment is not only to produce arguments, but also to use the dialogue as a mean to maintain a constant propensity to understand the other's argument [20]. The dialogical process can be hindered when children and adults do not share the same implicit cultural premises [4,21]. Power relations between the adult and the child, as well as the institutional expectations that children have about how to answer and how to interact with the adult [22,23], can have a negative effect on the interaction by reducing learning opportunities. In the case of these dynamics with the adult, it is very important to maintain a collaborative relationship with the peer group.

The variety of studies briefly reported here indicates how argumentation is as important as it is complex for pupils in institutional context. For this reason, the next section of the paper focuses on the design of argumentative tasks intended to overcome some of these obstacles.

3. Argumentative Design in Activities with Children

Some research focusing on argumentation in pedagogy paid attention to the design of school tasks. The term "design" refers to the construction of situations that support participants to engage in argumentative tasks.

The line of research called *arguing to learn* [24] has extensively examined the design features that best promote the development of argumentative activities in school tasks. Indeed, this line of research considers argumentation as a tool for promoting knowledge and a mean through which it becomes possible to foster learning. In this sense, designing within the arguing to learn line aims to accompany students in expanding and pushing forward their knowledge within argumentative discussions. Thus, the role of the design is important because of its effects on knowledge acquisition through argumentative practices.

This view implies the need to think about the context and the conceptual framework in which an argumentative activity is constructed and promoted for various purposes.

Concerning the argumentative activity in school, designing is not an easy task because the activity itself is a complex practice [24,25]. The designing choices are linked to the researcher's goals. Within the arguing to learn approach, Ref. [8] (p. 183) indicate that a good argumentative discussion must meet two criteria: the engagement and the productivity. The authors refer to the engagement as the high participation of people involved in an interaction. The term also indicates a high responsiveness to others' interventions, to the coordination of all interventions rather than the presentation of parallel ideas (As it is the case in the cumulative talk [26], described as repetitions and accumulation of different ideas.), and to the discussion and the difference of opinions centered on an epistemic level, rather than personal [27]. Another element is the interlocutors' willingness to question and challenge the standpoints advanced by others. Ref. [8] refer to the productivity to indicate how, in a process in which different points of view are discussed, the interlocutors are willing to collaborate and bring mutual respect to each other, when learning is extended to other activities than the one in which the project is carried out.

Starting from these elements, it is possible to identify some principles that are likely to foster a discussion with the above-mentioned approach. One principle concerns the problematization that occurs when a question raised by the teacher is identified as interesting and problematic by the students [8]. For this purpose, the adult can propose semi-structured and unstructured problems for which everyone can contribute with his/her own knowledge because there is not a single possible solution. In this case, it is relevant to emphasize the active role of the adult in encouraging, through questions, critical student attitudes [8].

Another principle concerns the role of the adult during the activity, based on the idea that the task is not only designed before the interaction, but also during it (through the adult's interventions) [8]. This can have long-term effects on the students' interactional attitudes, even when the teacher is not present [20]. The interventions having positive effects are those related to a request for clarification and explication of a reasoning, or to check the soundness of the advanced arguments. In the context of this line of research, the impacts of technological devices on the development of arguments have been investigated in terms of digitized maps, in which the standpoint and the arguments expressed by participants can be presented to the entire group (e.g., [28]).

A further line of investigation refers to the use of texts and hypothesis testing devices. These are intended as supports offering alternative standpoints that, presumably, can produce cognitive (or socio-cognitive) conflicts and can be implemented by students through argumentation. In the context of the hypothesis testing devices, the introduction of a tool that possibly contradicts the knowledge of the user is not sufficient, as the result of the tool may be ignored; on the contrary, the use of the tool with a request to reach the consensus among participants seems to have better effects [29,30].

Based on these elements, in the next section of the paper, I present a study in which three tasks of technical problem solving have been designed by the adult to support preschool children's argumentative activities.

4. Goal

The study's aim is twofold: to investigate argumentative discussions among preschool children involved in problem solving tasks, and to highlight possible difficulties encountered by children in the argumentative process.

I adopted a socio-cultural psychology perspective to look at how argumentation is dynamically co-constructed during the interactions in the context of production [31–34].

5. Method

5.1. Participants and Data Collection

A group of 25 children (male = 13; female = 12) aged 3 to 5 years (mean age = 4 years 8 months) was involved in the study. The data were collected by the author within a project on children's implicit argumentation (Research project "Analyzing young children's implicit argumentation", funded by the Swiss National Science Foundation, grant n. 100019_156690, applicants: A.-N. Perret-Clermont, S. Greco, A. Iannaccone and A. Rocci). After having obtained all the necessary permissions, the procedures to ensure anonymity and to guarantee the ethic management of the data were established for the entire research process.

Data were collected in the autumn 2016 in a kindergarten in Italy. Previously, I spent one week in the kindergarten to participate with teachers and children in their everyday activities (e.g., welcoming children in the kindergarten, having free play time, attending lessons). This period allowed the researcher to become familiar with children and the environment, and vice versa. Data collection was carried out in the toy library of the kindergarten. This room had two glass walls overlooking the kindergarten's backyard and another indoor classroom.

The activities were recorded: an audio recorder was placed on the worktable of the toy library and a camera in front of the worktable. Children were asked to engage in three different activities: building a tunnel with Legos® in such a way that a car could pass through it; building a bridge with Legos® to connect two opposite points of a river; and building an hourglass with recycled materials. Children were divided in 7 triads and 2 couples. Each group participated to the three activities. A total of 27 recordings, lasting about 16 h, were collected.

5.2. Presentation of the Activities

The three activities proposed to the children have been designed according to previous studies on argumentative designs.

5.2.1. Building a Bridge

The activity is inspired by [35] and consists of building a bridge with Lego® bricks. The materials include a box of Legos® of small size, a box of Legos® of big size, a blue paper, two toy cars, and two mannequins. The blue paper is taped to the worktable. The toy cars and the two mannequins are placed at opposite sides of the paper. The adult asks children to build a bridge with Lego® bricks in such a manner that the mannequin (representing two friends) could pass over the lake (the blue paper) by car (the toy cars).

This task intends to promote the participation of all children in the activity by using the Legos® of the size and shape they prefer. The adult does not give any specific instructions on how the bridge should be. The request of building a bridge per group intends to put children in the situation of being obliged to face potential individual differences during the work.

5.2.2. Building a Tunnel

The activity is inspired by [36] and consists of building a tunnel with Lego® bricks. The material adopted for the activity includes four images of different kinds of tunnels, a box of Legos® of small size, a box of Legos® of big size, and a toy car. The adult invites children to build a tunnel in such a manner that the toy car could pass through it.

The task is designed by considering studies about the effects of texts proposing different points of view and the hypothesis testing devices on the argumentative activity (cf. Section 3). Both have the potential to provoke a socio-cognitive conflict that can be solved (under certain conditions) by means of argumentation. In order to implement in the activities "texts proposing different points of view" to preschool children, four images are adopted. Moreover, the task is designed in such a way that the "hypothesis testing device" is somehow included in the researcher's instructions. The adult's request is to build a tunnel to allow a toy car to pass through it. Whether the car fails to pass through it, the idea that the tunnel is adequate for the aim of the activity is contradicted. This event could ideally stimulate children's argumentative debates.

5.2.3. Building an Hourglass

The activity is inspired by the foundation *La main à la pâte* (See http://www.fondation-lamap.org/en/international (accessed on 7 March 2021)). and consists of building an hourglass with recycled materials including a small-scale model of the object, two little plastic bottles, a plastic box containing sand, three small spoons, a tape, a pair of scissors, and three funnels.

As cooperation is an important aspect of designing an argumentative task (e.g., [30]), the construction of an hourglass ideally encourages the joint participation of all children, because the available material is sufficient to build only one hourglass. Accordingly, the product can be realized through the joint children's contributions. To achieve the goal, one of the two bottles must be filled with sand, while the second one must be turned upside down on the first bottle. Then, the two bottles must be sealed together with the tape. If (at least) one child is committed to holding the bottles, the presence of someone else committed to apply the tape is necessary.

5.3. Data Analysis

The software Transana Basic 3.10b was used to select the episodes of argumentative discussion within the recorded data. These episodes (N = 65) were transcribed by using a simplified version of the system elaborated by [37]. The symbols of transcription are indicated in Appendix A. Based on the transcripts, the following elements were identified: the issues occurring in each argumentative episode; the standpoints and the arguments; and the argumentative structures (according to the pragma-dialectical approach, see [17,38]). For the detection of the implicit premises connecting each argument to its standpoint, the Argumentum Model of Topics [39] was applied.

As a second step, by going back and forth between video recordings and transcriptions, an analysis of how argumentation is distributed among the participants was performed. Firstly, I selected the cases in which argumentation is less frequent. Then, I turned back to the videos to observe the activity and to describe the interaction. In order to classify an argumentation, the following criteria must be present: a problem to be solved (the "issue", e.g., [40–42]); a difference of opinion regarding the problem; and the presentation of one or more arguments.

Instead of focusing on single pieces of conversation, I analyzed how the interaction changes over time with the idea of highlighting the argumentative passages in which an impasse may eventually occur. Ref. [12] describes two different modalities in contrast with argumentation of "solving" a problem: "Firstly, people could try to ignore the problem: perhaps one person does not want to offend the other by appearing "difficult;" perhaps there is a general feeling that the question is not sufficiently important to merit deeper discussion; perhaps they are short of time and want to move on, and so on. Secondly, people could restrict themselves to a simple exchange of divergent opinions: "yes that's right/no it isn't/yes it is...." But such an approach does not generally produce the required result" (p. 128).

6. Results

A total of 89 children's argumentations were identified in the corpus and classified in 6 cases of multiple argumentative structures, 12 cases of subordinative argumentative structures, 3 cases of coordinative argumentative structures, and 68 cases of simple argumentative structures. A total of 110 arguments were identified. The analysis of the implicit premises shows a variety of implicit premises of inferential and contextual nature. For example, children reason regarding complex aspects of an action, such as the relation between tools and goals, the relation between an action and its consequences, the relation between the final result and its intermediate steps or the legitimacy of an action [6,43].

Despite the high number of children's arguments, results revealed cases in which no argumentation was performed or there was a discrepancy between the children's participation and the lack of argumentative production.

To better investigate this specific result, I selected three illustrative cases in which the argumentative activity performed by the children is not the one expected by the adult.

6.1. Illustrative Cases

6.1.1. Case 1: "I don't Know How to Make a Bridge"

Case 1 concerns a sequence involving three children, Mia (4 years 7 months), Giacomo (5 years 2 months) and Fulvio (4 years 6 months), who are building a bridge with Lego® blocks.

Firstly, I describe the activity performed by participants for 16 min (since the beginning of the task). After the adult's presentation of the task, children begin to build the bridge. Mia and Giacomo work separately. Fulvio checks pieces in the box. The researcher reminds children that they have to work together to build only one bridge. However, Mia and Giacomo continue to work separately. Fulvio is engaged in the exploration of the material. He raises one of the mannequins, attaches it to a piece of Lego® shaped like a wheel and makes it from one side of the paper to the center. Again, the adult invites children to work together, so the work would get done faster.

After 10 min, Mia looks at Fulvio and asks: "Fulvio, can you help us instead of playing?" She identifies his activity as "playing" and she takes the objects out of his hand, placing them into the box. Fulvio raises the wheel and says: "I want to have a swim." Thinking that children are struggling with the activity, the adult decides to give them the Legos® of big size. Fulvio raises the wheel again and adds: "I want to have a swim." Mia answers: "You can't go there anymore", taking the wheel out of his hand and placing it into the box. Then, Mia starts working with Legos® of big size and Giacomo continues to work with Legos® of small size. Fulvio picks up a piece of Lego® and tries to attach it to Giacomo's construction. He does not succeed. Giacomo says: "Look, how to do it", attaching the two pieces. Fulvio tries to add a piece to Giacomo's construction, but he fails. Giacomo says: "No, don't destroy it." The construction breaks into two. After a few seconds, Fulvio raises again the wheel and says: "I go to the lake." Mia says: "Fulvio, can you stop playing?" Then, Fulvio takes a piece of Lego® and asks Mia: "Can I put this?" (on Mia's construction). Mia answers: "No, can you go to build your bridge?" Then, she raises her construction and looks at the researcher.

After about 16 min since the beginning of the task, the adult, trying to convince the participants to work together, suggests they put together their constructions. In this moment, Fulvio makes explicit that he does not know how to make a bridge:

((Hour: Minute: Second): 0:16:12.5)

Adult: = maybe you can put together the pieces you have made

Fulvio: [I don't know how to make a bridge]

Mia: [Giacomo uses the small ones] Giacomo uses the small ones ((she points with her finger at the Giacomo's construction. She is referring to the size of the Lego®))

((Hour: Minute: Second): 0:16:27.6)

In the excerpt, when the adult invites children to put together their constructions, Fulvio answers: "I don't know how to make a bridge." In Fulvio's eyes, his difficulty in participating in the activity (as the adult is expecting) is related to a lack of competence in the building work. However, these children are used to playing with Legos® at the kindergarten, almost every day. The present activity was designed in such a way in agreement with the teacher and according to previous similar pedagogical activities. Following a socio-cultural perspective [44], Fulvio's self-perception of his competence (The definition of self-perception of competence adopted here follows [45]): "The self-perception of competence is a psychological variable that reflects the judgment of people about their own abilities to mobilize resources in order to achieve a particular goal.") has potentially been co-constructed and consolidated within the interaction. The problem in the interaction between Fulvio, Mia and Giacomo (and the adult) is that Fulvio is unable to build a bridge autonomously during the first phase of the activity. At the same time, the adult and the other children are not recognizing Fulvio's request of help. In this way, Fulvio never got a chance to fully experience and show his building competences. He tried channeling his participation into other activities (for example, choosing pieces of Lego® in the box or playing with the wheel).

Although the adult was soliciting children several time during the activity (as the role of the adult is continuously developed during the activity, based on the idea that the task is not only designed before the interaction, but also during it, through the adult's interventions [20]), her interventions had no positive effects on supporting the children's argumentative interaction.

The entire activity lasted about 30 min. At the end, Fulvio was not able to manage the construction of the bridge: he was just following the classmate's actions, although Giacomo never shared in an explicit way his plan and project with Fulvio. Since argumentation requires a problem to be solved [12], argumentation fails at a basic level.

6.1.2. Case 2: "The Work Is Too Easy"

Case 2 involves other three children (Elsa, 4:4 years, Sally, 5:3 years, and Camille, 4:6 years) who are building the bridge. At the beginning of the activity, the researcher introduces the "phase of exploration" and invites children to look at what they have around (she runs her hands over the table). She tells them that she will be back soon to present the activity. Elsa says: "I have a red chair", Camille says: "Me too", and Sally adds: "And I have the yellow one." They remain silent for some seconds and start looking at the researcher. Then, the adult asks: "Do you want I come explaining the activity?" The children agree and the researcher introduces the "phase of presentation of the task". She presents only a part of the instructions for the activity because the children want to describe how they spend time with friends. This phase lasts about 3 min. After, the researcher summarizes the instructions:

((Hour: Minute: Second): 0:03:34.5)

Adult: these two people are two friends, they want to be together, but here there is a river that divides them and they cannot meet, but they want to be together. So, I have found a solution, if you like. You can build a bridge with Lego®, to bring them together, would you like that? you have to make one bridge all together and when you're done, you call me, okay?

Camille: yes

Sally: yes

Elsa: ↑ I don't know how to make it ::

Adult: help you each other (.) try it

((Hour: Minute: Second): 0:03:53.2)

As in Case 1, a child makes explicit the fact that she does not know how to realize the work (Elsa: "↑ I don't know how to make it ::"). The adult invites the children to collaborate.

Contrary to the group of the first example, here Camille and Sally complete the activity in one minute and this prevents any changes in the interaction (in Elsa's possibility to exercise her skill and to change her self-perception on her competence). In fact, for the next 4 min, Elsa and Sally explore the content of the box (Elsa finds another mannequin and plays with it), while Camille tries to start building the bridge, although not all the pieces of Lego® she is using fit with the others (she asks for the adult's help). After exploring the box, Sally starts the building activity but, after few seconds, she leaves the construction and plays with a mannequin. Then, Camille says: "Let's make a bridge" and "The bridge is here" while putting the first piece of Lego® on one side of the paper. The bridge she is making is very simple, like a line of pieces of big size. Sally sees it and puts some additional Legos® on it. After one minute, Camille says: "We have already finished the bridge." All the children move the mannequins over the bridge and let them meet each other. The adult observes it and congratulates the group.

In Case 2, neither Elsa nor Camille and Sally worked in the appropriate context to develop an argumentative discussion. Elsa does not have space and time to prove her competence (and then to access the problem). Camille and Sally did not meet any real "problem": on one hand, Camille and Sally did not perceive the question raised by the adult as problematic; on the other hand, they decided to engage in a simple task (For the investigation of the reasons behind the choice of tasks with different degrees of difficulties by preschool children, see ref. [46]). Accordingly, there was no process of problematization [8].

6.1.3. Case 3: I Know How to Make Bridges

Case 3 concerns a group of three children who are building a bridge: Giacomo (4:8 years), Carlo (5:3 years) and Maria (4:9 years).

At the beginning of the sequence, the adult gives the children some time to assess the available material placed on the table. Then, she presents the activity by inviting the children to build a bridge in such a way so that two friends who live on the opposite sides of a lake can meet. She specifies that the children have to work together to build one bridge. Each child grabs two pieces of Lego®. Maria says: "I know how to make bridges" and starts building a bridge shaped like an arc. Carlo tries to take a piece of Lego® from the hands of Maria, but he fails. Maria continues to attach pieces of Lego®. The children are making three different bridges but, at some point they compare their works:

((Hour: Minute: Second): 0:07:11.0)

Maria: in the bridge I will put these ((she finds two Lego® shaped as rectangular central opening))

Carlo: xxx are like this

Giacomo: no (.) the bridges are like this look Carlo

Carlo: no (.) the bridges are like this

Maria: the bridges are also like this look (.) as I do ((she attaches the Lego® to her construction)) teacher :: teacher :: the bridges are like this look (.) I'll show you children

Carlo: it doesn't look like a bridge to me ((he looks at Maria's work and he shakes his head))

Maria: bridges are like this

Carlo: no ((he shakes his head))

Maria: looks like a bridge to me

Carlo: not to me

Giacomo: no (.) bridges are like that too

Carlo: no (.) maybe some (.) xxx

Maria: here (.) I made the bridge ((she built a part of the bridge)) give it to me and attach it ((try to grab the piece built by Carlo))

Carlo: no (.) that is not a bridge

Maria: come on :: ((Maria tries to attach the Giacomo's construction to her work, but Giacomo takes the pieces)) Come on :: I don't know how to build bridges

((Hour: Minute: Second): 0:08:16.0)

In Case 3, Maria's participation in the activities changes over time and in the degree through which she perceives herself as competent in the building task. Differently from Cases 1 and 2, at the very beginning of the activity the child immediately engages herself in the work. Moreover, she makes a positive comment on her competence: "I know how to make bridges." Her construction shaped like an arc is very similar to bridges built by other children in different recordings. Here we found a first moment of impasse in the collaboration when Carlo tries to take a piece of Lego® from the hands of Maria. A second moment of impasse is when Maria decides to add to the construction two Legos® of rectangular shape with a central opening. Carlo and Giacomo look at her work and the three children start making comments on the others' realizations. Carlo makes explicit that Maria's construction is not a bridge ("it doesn't look like a bridge to me"), but Maria disagrees ("bridges are like this"). For several moments, they present opposite standpoints about Maria's work, although without supportive arguments. The self-perception of Maria about her competence in solving the task changes. She says: "I do not know how to build bridges" and stops working. The adult reminds children to work together and the group start again to build the bridge (Giacomo on one side of the table and Carlo and Maria on the opposite side). As in Case 2, the children's work is very basic and they complete it in a short time. In this phase, Maria manages to add only one piece to the construction that Carlo relocates. After few seconds, Giacomo says: "Here is the bridge", announcing that they managed to complete the work and to connect the opposite sides of the lake.

In Cases 1 and 2, the moment of impasse in the argumentative interaction was due to the fact that the participants were not dealing with the problem. In Case 3, the situation is different. The issue is to qualify (as a bridge or not) the construction made by Maria. Despite the problem to solve, in Case 3, the children limit themselves to exchanging divergent opinions [12]. Their conflict seems to be more based on the affective level, rather than the epistemic one [47]. In fact, the children's interventions end with the following statement of Maria: "I don't know how to build bridges". This position related to Maria was co-constructed within the interaction with a negative effect on the argumentation process.

7. Discussion and Conclusions

Although there is no doubt that arguing in and out of the classroom is important because of its impact on learning processes [8,48], it is also recognized how difficult it could be for a child to engage in such an activity. A variety of studies investigated difficulties pupils encounter during argumentation in institutional contexts. As a result of these researches, arguing and learning are described as processes involving complex cognitive, relational, emotional and social dynamics [11,49,50].

In this paper, I investigated argumentative discussions among preschool children by taking a socio-cultural perspective, and I described possible obstacles children encounter during the argumentative process.

To move a step forward within this frame, in this paper I carefully designed three tasks of technical problem solving before proposing them to children. I adopted the frame of studies dealing with the "design" of tasks intended to support participants in engaging in argumentative discussions (e.g., [25]). These studies, as the one included in the line of research called *arguing to learn* [24], have extensively examined the design features that best promote the development of argumentative activities in children at school age. For the sake of the present paper, I adapted the *arguing to learn* line of research to situations involving preschool children (at a kindergarten) engaged in building tasks related to

technical problem solving. In order to do so, the first activity concerned the task of building a tunnel, the second was related to build a bridge—both with the use of Legos®—and the third asked participants to build an hourglass with recycled materials.

The multi-step analysis focused on the following aspects: (1) the identification of the children's argumentation, (2) the reconstruction of the structure of each argumentation, and (3) the identification of their implicit premises. The findings show that children construct complex argumentative structures, and their arguments are based on a variety of implicit premises of inferential and contextual nature, advancing reasoning regarding complex aspects of an action [6,43].

As second step, I examined how argumentations are distributed among participants and I selected cases in which argumentation appears less frequently. By turning back to the videos, I identified the moments in which an argumentative impasse occurs [12]. Instead of focusing on single pieces of conversation, I analyzed how the interaction changes over time with the idea of highlighting the argumentative passages in which an impasse may eventually occur.

The present study highlights two phenomena that can potentially have an impact on the investigation of argumentative interactions.

The first one refers to the case in which the activity appears to be too easy for the children: in this case, they do not perceive the "problem" to be solved. This occurs when the children easily find a way to solve the task. For example, while building the bridge, some children decided to use Legos® of small size and built very complex structures (e.g., a concave structure), while other groups (see Cases 2 and 3) built very basic bridges and completed the activity in a short time. In these situations, the process of problematization [8] that is necessary to introduce an issue did not occur. This was the effect of a co-construct between participants: on one hand, the question raised by the adult was not problematic for the children; on the other hand, children engaged in a simple and quick task.

Secondly, I refer to the cases in which the children's negative/limited self-perception of competence [45] in solving a task potentially contributes to elicit the "exit" of the children from the activity. Since argumentation requires a problem to be solved [12], when the children did not deal with the problem, argumentative interaction fails. The concept of self-efficacy and how it is influenced by the context (peer interactions, family and school settings) is largely present in the theory of Bandura. However, as the present paper aims to rely on argumentation, a specific focus on the concept of self-efficacy is not offered. For further details, cf. [51], 1994.

Moreover, children's negative/limited self-perception of their competence is co-constructed within the interaction. Not surprisingly, adults (teachers, parents) can have diverse perceptions of the same child referring to his/her competence and this can impact the child's future performance (e.g., [52]).

The findings of the present study suggest useful insights for teachers of early childhood science education. In school interactions, a child "brings with them a history of positive and negative social encounters, a preferred pattern for interactions, and temperament characteristics" [53] (p. 102). However, adults also enter into these interactions and can have an impact on encouraging children in managing the activity. For example, the adult has the role to select the appropriate degree of difficulty of a task according to the children's ability and familiarity with the task (e.g., [54]), within their zone of proximal development [55]. However, the adult also needs to adapt the difficulty of a task after the beginning of the activity, according to a context's change. The adult also has the role of promoting the children's positive exploration experiences of their competences [45,56].

Despite the adult's efforts in designing the tasks, the argumentative process has not always been successful, as expected. Nevertheless, the careful attention needed to design tasks highlights some preschool children's difficulties in the argumentation process that are different from those already described by the literature in the field of children's argumentation at school age (cf. Section 2). For this reason, the present study contributes

to the line of research of design in argumentation, by exploring more in detail children's difficulties and by presenting adult's responsibilities during activities at preschool age.

I intend to conclude this work with some methodological remarks. I am conscious that some challenges stem from the research design adopted for the present study. I recognize that the limited number of recordings favored a careful analysis of how the building activity was interpreted and realized by participants, but did not allow elements for quantification and generalization. A larger database would probably expand the possibilities to identify relationships with different factors, such as gender, group composition, etc. Further studies and more in-depth analyses will contribute to address these concerns.

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Appendix A Transcription Symbols

Sign	Description
(( ))	nonverbal information
=	latching
[	overlapping
::	extensions of sound
(.)	short pause
↑↓	increasing or decreasing intonation
Xxx	non-understandable utterance

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