

# Interactions in a Group with One Blind and Three Sighted Students in a Chemistry Experimental Activity and the Possible Relationships with Students' Conceptions of Blindness

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## ABSTRACT

**Background:** the increase in blind students in regular schools challenges pedagogical practices and educational research. **Objectives:** to analyse how to characterise the interactions within a group of one blind and three sighted students during an experimental activity in chemistry developed in elementary school and their possible associations with students' conceptions of blindness. **Design:** qualitative research. **Setting and Participants:** four students (one blind student and three sighted students) from an 8<sup>th</sup> grade class of a Brazilian elementary school. **Data collection and Analysis:** social interactions were captured through audio and video recordings of a sequence of experimental activities to which students were submitted. Qualitative information about the understanding of blindness was obtained by semi-structured interviews conducted with the investigated group before and after the sequence of experimental activities. Discursive textual analysis was used as an analytical procedure. **Results:** the research revealed that the interactions can be characterised as tutorial and collaborative, and, to some extent, they can relate to students' conceptions of blindness, namely, mystical and sociopsychological. **Conclusions:** It is important to reflect on these understandings that can be linked to the interactions promoted in experimental activities with consequences for student learning.

**Keywords:** Experimental activity; Chemistry teaching; Blind; Social interactions.

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## As interações em um grupo com uma estudante cega e videntes em atividades experimentais de química e possíveis relações com as compreensões discentes sobre a cegueira

### RESUMO

**Contexto:** a crescente presença de estudantes cegos/as nas escolas regulares impõe desafios às práticas pedagógicas e à pesquisa educacional. **Objetivo:** analisar como se caracterizam interações em um grupo constituído por uma estudante cega e videntes no contexto de uma proposta de atividade experimental de Química desenvolvida no ensino fundamental e possíveis associações dessas interações com os entendimentos discentes sobre a cegueira. **Design:** pesquisa de natureza qualitativa. **Cenário e participantes:** quatro estudantes (uma aluna cega e três videntes) de uma turma do 8º ano do ensino fundamental brasileiro. **Coleta e análise dos dados:** as interações sociais foram captadas por meio de gravações de áudio e vídeo de uma sequência de atividades experimentais às quais os estudantes foram submetidos. Informações qualitativas concernentes às compreensões de cegueira foram obtidas por entrevistas semiestruturadas realizadas com o grupo investigado em momentos anteriores e posteriores à sequência de atividades experimentais. Utilizou-se a análise textual discursiva na qualidade de procedimento analítico. **Resultados:** pontua-se que as interações podem se caracterizar como tutoriais e colaborativas e, em alguma medida, podem se relacionar com compreensões a respeito da cegueira, a saber, mística e sociopsicológica, respectivamente. **Conclusões:** depreende-se dos resultados a importância de refletir sobre as compreensões concernentes à cegueira que podem se vincular às interações promovidas nas atividades experimentais com consequências às aprendizagens discentes.

**Palavras-chave:** Atividade experimental; Cego; Interações sociais.

### INTRODUCTION

In Brazil, the number of enrollments of “students with disabilities”, pervasive developmental disorders, and/or high abilities/giftedness in regular classes or exclusive special classes has been highlighted (Brasil, 2019). However, although essential, access to school is insufficient. Therefore, there must be actions to promote practices favoring the development of the special education target audience (Souza, Silva, França-Freitas, & Gatto, 2016). In the case of blind students, those actions that can be underestimated when education is based solely on the sense of sight (Nunes & Lomônaco, 2010) and carried out in physical spaces that segregate the visually impaired from the others (Voos & Gonçalves, 2020).

On the other hand, Fernandes and Costa (2015) and Alves and Duarte (2014) highlight the potential of social interactions in the school environment

to provide learning for blind students – and, as is well known, not only for them. Social interactions, however, have repercussions on the consolidation of values and behavioral tendencies (Palmieri & Branco, 2004), thus, despite the contributions described, depending on their nature, social interactions can limit the independence of blind people, often placing them in the role of being helped by others (Alves & Duarte, 2014).

We can add to this problem the difficulties in teaching blind people, especially in experimental activities (Camargo, Santos, Nardi, & Veraszto, 2007). In this way, Biagini and Gonçalves (2017) planned and developed experimental activities for that target audience, based on different references, among which those that value work in small groups. For the authors, this type of work constitutes a fruitful way of fomenting attitudinal learning (respect, cooperation, and solidarity), essential in the interaction between students, especially when considering blind students. However, on the other hand, they suggest the need for studies on the relationship between the nature of interactions established by blind and sighted students and the understanding of the blindness they carry with them.

Thus, this study aimed to investigate how to characterize the interactions in a group of one blind and three sighted students in the context of an experimental chemistry activity developed in elementary school and their possible associations with the students' conceptions of blindness.

## **THEORETICAL AND METHODOLOGICAL CONSIDERATIONS**

Next, we present perceptions about blindness based on Vygotski's (1983) contributions, which guided the development of semi-structured interview scripts and the construction of *a priori* categories to analyze how the students' realize blindness. Then, we present discussions on experimental activities for blind students that guided the development of activities promoted in this research, the context of promoting the activities experienced, and the procedures for obtaining and analyzing qualitative information.

### **Conceptions about blindness, according to Vygotski**

Over time, people's perceptions of blindness affected how they behaved towards the blind and the blind's status in society. From this perspective, Vygotski (1983) deals with three understandings concerning

blindness: the mystical, the naive biological, and the sociopsychological conceptions.

In the first, the blind are seen as the poor dears, the helpless. Simultaneously, they are attributed superior mystical forces of the soul, such as access to the spiritual vision (Camargo, 2005).

The naive biological understanding marks a second conception, in which the lack of one organ is believed to be compensated by the accentuated development of others (Vygotski, 1983). Taking the kidneys and lungs as an example, if one is absent or sick, the other develops to compensate for the deficiency (Vygotski, 1983). Hence, wrongly, the naive biological conception assumes that the blind person would have the other senses developed sharply and naturally to compensate for the absence of vision.

Subsequently, the sociopsychological conception relies on different studies and rejects the idea of improvement of the other senses -or the belief in a mystical vision- in the blind person. For Vygotski (1983, p. 112, our translation), “the education of the blind boy must be organized like the education of the one that is capable of a normal, socially valid development, and eliminate the word and concept of ‘disabled’ about what involves the blind”.

The blind person is a social and historical being (Silva, Tureck, & Zanetti, 2017). Barriers to their development are social in nature (Vygotski, 1983). Thus, social interactions play a fundamental role in its development.

## **EXPERIMENTAL ACTIVITIES WITH BLIND AND SIGHTED STUDENTS**

The literature denounces several problems related to the proposition of experimental activities for educational contexts with blind students. For example, Camargo et al. (2007) report that the lack of infrastructure, accessible material, and guidance to prepare teaching material influence the participation of blind people in experimental activities. Silveira and Gonçalves (2019) highlight that proposals for experimental activities aimed at the participation of blind people disseminated in the literature are pervaded by problematic understandings about blindness and experimentation.

Given the scarcity of works in the literature that confront problems such as those mentioned above, Biagini and Gonçalves (2017) developed experimental activities for the participation of blind and sighted people. The

authors analyzed the potential of the experimental activities carried out and highlighted the importance of certain characteristics: appreciation of the students' prior knowledge, students' specificities, work in small groups, and social interactions associated with this work.

Moreover, the authors considered Soler's (1999) multisensory teaching approach, which suggests that we must use multiple senses to obtain information, an aspect that is often overlooked in the natural sciences teaching, culturally centered on the sense of vision (Soler, 1999). Without neglecting the problems that may underlie the act of observing in the teaching and learning process, Soler's (1999) proposal collaborates to value the different ways of observing.

Finally, we identify in the literature characteristics that can be avoided and others that can be important for developing experimental activities with blind students, which we used to support this research.

### **The context for developing experimental activities**

According to previous discussions, we relied mainly on the methodological proposal of experimental activity by Biagini and Gonçalves (2017) and on the contributions of a "pilot study" (3 classes) to construct a proposal for an experimental activity that was carried out in a class with 35 students from the 8<sup>th</sup> grade of an elementary public Brazilian school. First, we searched for schools that had blind students enrolled, who, together with their guardians, accepted to participate in the activity.

Three experimental activities were carried out in 12 classes (45 minutes/class). The first author of this study worked in the teaching practice together with one teacher from the area of the natural sciences and the other from special education. The subjects/contents studied were food preservation, the contribution of enzymes to digestion, and fermentation. Those contents were selected together with the teacher's planning in natural sciences. The activities had three stages. The first stage aimed to perceive students' knowledge through individual registered answers about one or more questions related to the experimental activity to be developed. As part of this stage, already distributed in small groups formed spontaneously and consisting of four members, the students were encouraged to discuss and prepare one or more answers that represented the group without necessarily showing a consensus among the participants. We sought to problematize the presented knowledge so that students could recognize their limitations and study other knowledge

needed to understand the proposed situation (Biagini & Gonçalves, 2017). In the second stage, experimental procedures were carried out, encouraging group participation and discussion, with teacher mediation. Furthermore, reflections on what they were doing, predictions, and sharing of ideas characterized this moment. In the last stage, the groups analyzed the results and debated in small groups and the large group, mediated by the teaching actions.

The multisensory dimension permeated all stages of the experimental activities carried out. For example, the blind student used the Perkins machine to type and read in Braille the material made available to her. Furthermore, all experimental procedures were planned for their manipulation and interaction with colleagues. The disclosure of the didactic material produced will constitute another publication.

The spontaneously formed groups remained throughout the sequence of experimental activities. Only one group was the center of the research, consisting of a congenitally blind student and three sighted students, following the students and their guardians' informed consent. The research was approved by the Ethics Committee on Research with Human Beings (CEPSH) of the Federal University of Santa Catarina, under Opinion n<sup>o</sup>: 2.985.982.

The work in small groups was characterized by role distribution. There was the communicator, coordinator, praiser, reader, and executor. In each experimental activity, the students shared the executor's role while the others swapped their roles, as shown in Table 1.

**Table 1**

*Research participants and assigned roles*

<b>Nicknames</b>	<b>Roles in experimental activity 1</b>	<b>Roles in experimental activity 2</b>	<b>Roles in experimental activity 3</b>
Ana (blind student)	Coordinator	Praiser	Reader
Bianca	Communicator	Coordinator	Praiser
Fernanda	Reader	Communicator	Coordinator
Lucas	Praiser	Reader	Communicator

## **Procedures to obtain and analyse qualitative information**

To apprehend the students' perception of blindness, we carried out semi-structured interviews before and after the sequence of experimental activities with the four students characterized above. The interviews were audio-recorded and transcribed. The information about the interactions of one blind and three sighted students was obtained through audio and video recordings. All audio recordings were transcribed according to the contributions of Carvalho (2006) to compose the document to be analyzed.

The qualitative information was examined based on the contributions of the discursive textual analysis (DTA), consisting of three stages: unitization, categorization, and communication (Moraes, 2003). Initially, the *corpus* (transcription text of the interviews and recordings of the group) was subjected to unitization, in which the texts were fragmented into units of meaning according to the research objective. In the second stage, these units of meaning were grouped, following semantic criteria. We used two types of categories, *a priori* and emergent. The first corresponds to predefined theoretical constructions before carrying out the analysis itself (Moraes, 2003). The second, in turn, constitutes theoretical constructions emerging from the analysis. Thus, to analyze the perceptions about blindness, we chose *a priori* categories: mystical vision, naive biological, and sociopsychological understanding. To analyze the social interactions, we defined as *a priori* category collaborative and tutorial (Teodoro, Cabral, & Queiroz, 2015) and emerging interactions: the role of interventions in the group, roles played in the group, students' understandings about group work, and the roles and their influence on interactions. In the third stage, we created descriptive and interpretive texts about each category, which we will present in the next section.

## **DATA ANALYSIS**

We first present the analysis of the social interactions and, finally, the analysis of the perceptions about blindness.

### **Collaborative and tutorial interactions**

According to Teodoro et al. (2015), interactions in educational processes can be characterized as collaborative and tutorial. In the first, the group members also participate in carrying out the activities, while in the second, a member's or the teacher's help to one of the members of the group

stands out. According to the authors, collaborative interaction more powerfully favors student learning. We have an example of this type of interaction in the following fragment:

Fernanda: — Ok... who's going to be the first to read?...

Lucas: — I made mine like this...

Ana: — Ok... Bianca or Lucas reads, then...

Lucas: — I put it like this... don't leave it out of the fridge... try that most domestic food... I put it in parentheses... domestic is to grow at home...

Bianca: — okay... I'll put this one here... I'll put it here...  
Lucas' answer...

Ana: — Ok... now Fernanda reads her answer...

Lucas: — don't leave it out of the fridge...

Ana: — after Lucas answers to Bianca, it's your turn...

(Transcript of the first experimental activity)

The group alternates the lines between members for the socialization of answers initially prepared individually. It is noteworthy that this alternation can be important to promote learning related to respect among colleagues, the ability to listen and reach agreements based on dialogue, favoring reflections on different points of view.

Tutorial interactions were also identified:

Fernanda: — then you have to get water and put it in her pot ((Ana))...

Bianca: — take the plastic out of the broth?...

[...]

Bianca: — You can cut it now, right?...

Ana: — yes...

Researcher: — yes... but each one is to do their own...

Bianca: — but I'm helping Ana...

Researcher: — but she can do hers...

Ana: — Ok... I can do mine...

(Transcript of the first experimental activity)

Fernanda: — Look... I'll open it here for you... 20 mL... I will tell you when it is full up... it's done... now you (Ana) put it in your pot...

Researcher: — how do we know that this syringe is really 20 ml?...

(Transcript of the second experimental activity)

Tutorial interactions increased during the experimental procedures, especially for sighted students (Bianca and Fernanda) as tutors and Ana, blind student, as tutored. Even though the tutors assume simple tasks, they played a part of the executor's role, an attribution of all students. For the use of the syringe, the researcher had already explained how the blind student would identify the amount of liquid contained in the container, which, however, we believe is a skill that required some time to be incorporated.

We interpret that in those cases, the tutorial interaction jeopardized the development of the blind student's potential and autonomy, as Ana was encouraged to depend on the group's intervention to carry out the experimental activities.

However, the tutorial interaction can also influence positive aspects of group work, such as concern for others – even though such an attitude may be permeated by certain prejudices. Here is an example:

Fernanda: — now, the lemon juice... the... who's got the lemon juice?...

Lucas: — here, take it... take it... Ana...

Ana: — thank you, Lucas...

Lucas: — you're welcome...

(Transcript of the second experimental activity)

The concern with others strengthens the students' interaction in groups (Bonals 2003). At different times, Ana also acted as a tutor:

Bianca: — Ok... help me to make a detailed answer...

Ana: — of course...

Bianca: — I put it like this... the beef broth...

Ana: — I had an idea... beef broth... it can decompose even when preserved with salt and vinegar... (just like in water it can be diluted)... ((inaudible))

(Transcript of the first experimental activity)

The interaction between Ana and Bianca is seen as a tutorial, especially when preparing an answer that represents the group. In that case, as in other moments, we identify limitations for the development of the tutored person, in this case, Bianca, since Ana does not value her contributions.

In general, Bianca and Fernanda took on roles of tutors to Ana, as well as Lucas – in a more specific way. The tutored consents at different times to this assignment but also takes up the role of a tutor. We interpret that the tutorial interaction may have restrictive aspects for student development; even so, its contributions can be highlighted. Alternating between tutor and tutored, providing different moments of mutual assistance, decreased, for example, the probability that some would develop more than others, besides contemplating the concern for others. However, the attitudinal dimension was even more considered in collaborative interactions. In general, reflecting on the nature of the interactions established in small groups in the context of experimental activities can help us develop actions to strengthen or prevent the undesired characteristics. In this study, we take into account the learning of conceptual contents and procedures associated with the curriculum component chemistry and the attitudinal contents linked to more general students' education, such as learning to respect, listen, and care for others.

### **The role of interventions in the group**

We interpret that the teachers' interventions carried out in the group had implications for the interactions:

Researcher: — Have you decided who will play each role?...

Bianca: — yes...

[...]

Ana: — Fernanda will be the reader... Lucas will be the praiser... and I'll be the coordinator...

Researcher: — So... has the coordinator already asked everyone to read their question?...

Ana: — not yet...

Researcher: — ah... so let's go...

(Transcript of the first experimental activity)

The researcher seeks to encourage the incorporation of planned roles in the group. We estimate that the intervention favored collaborative-type interactions, as it aims to include the participation of the entire group.

In other cases, the teaching activity was focused on overcoming tutorial interactions towards those of a collaborative nature:

Fernanda: — Look... I'll open it here for you... 20 ml... I will tell you when it is full up... it's done... now you put it in your pot...

Researcher: — how do we know that this syringe is really 20 ml?...

Fernanda: — because it's in Braille...

Lucas: — each one of us must get a little?...

Researcher: — here, right?... ((taking Ana's hand to the mark on the syringe))

(Transcript of the second experimental activity)

Even though tutoring can contribute to the students' formation, it can imply some undesirable behaviors, as already discussed. At that time, attributing the executor's role to all group members was intended to favor positive interdependence over unilateral dependence, which, however, needed to be reinforced with the teaching intervention.

In other words, the interventions sought to contemplate the participation of each member of the group while calling into question specific tutorial interactions. To some extent, this can collaborate to face possible prejudices amalgamated in the historically established interactions between the described target groups. Interventions in group work also contradict the idea that students do it in a totally independent way from the teaching actions in this type of work. Rather, those actions are necessary to teach students about the nature of the interactions that are important to be established during

experimental activities to collaborate with their learning. With this, we expect to contribute also to confront a perception of experimental activities as a simple execution of procedures with a minimum reflection. The reflection, however, was not restricted to the conceptual contents. It also reached the attitudinal ones.

### **The roles taken up in the group**

The roles were designed to be incorporated into the development of experimental activities. However, we know that other roles, beyond those planned, can be taken up during group work (Silva & Villani, 2012); and this is what happened in the group under analysis.

Ana took a very frequent stance in relation to proposing ideas to the group, which were in the direction of considering everyone's ideas:

Lucas: — I put it on one (which will grow and be fluffy)...

Fernanda: — you, Bianca...

Bianca: — no... to grow the bread...

Fernanda: — I also put the bread to rise...

Ana: — so we can assemble the following answer... the yeast can make the bread rise... it gives it consistency... it helps to bake... it gives it consistency... and so it makes it fluffy... so we gather all the answers into one and it's not as long an answer as the last few times...

(Transcript of the third experimental activity)

Ana's suggestions were often accepted as answers to represent the group. If, on the one hand, the role of proposing ideas assumed by her favors the development of tasks (Bonals 2003), on the other, in the long term, there is a noticeable decrease in collective reflections. Bonals (2003) points out that some students are especially adept at proposing ideas. Which, for the author, should not restrict other students from incorporating that skill with the development of group work. In other words, the ability of some cannot inhibit its development in others.

Bianca also took up the proposition of ideas:

Bianca: — I was thinking of putting it like this... the yeast has a... it's solid...

Ana: — uhum...

Bianca: — to make the bread dough rise in hot and cold places... because as my mother bakes bread at home... she uses bread yeast... and she puts a cloth over the...

Fernanda: — yeah... and she leaves it in a place for the bread to grow...

Ana: — yeah... sometimes she puts it in the sun... sometimes in the oven... yeah... my mother does that, too... so, we can put it, right?...

(Transcript of the third experimental activity)

Higher alternation in incorporating the role of proposing ideas can favor the permanence of collaborative interactions and reflections in the group. Therefore, in addition to teaching interventions that seek to reinforce or eliminate some roles assumed (Bonals 2003), it is possible to intervene to contemplate this alternation.

Bonals (2003) says that when a group starts a task, their components assume a series of roles divided between those that result in favoring and those that have the effect of interfering in the work and in the good understanding of the group. For the case of the role of proposing ideas when incorporated by a single student, in the short term, it can have the effect of favoring the work and good understanding of the group, but in the long term, it can only contribute to the completion of the task.

On the other hand, the praiser's role was interpreted as favoring the work and good understanding of the group, even though it is an attribution of one and taken up by the other. As evidenced in the following excerpt:

Ana: — Ok... I agree with those answers, you know, Fernanda?...

Fernanda: — is it?...

Ana: — well... Bianca...

[...]

Ana: — I also agreed with Lucas's... I thought it was really cool... you say that... it's good to conserve food... grow them at home... but... ((inaudible)) anyway ... I really liked it... your turn, Bianca...

(Transcript of the first experimental activity)

Ana was the coordinator, and Lucas was the praiser. Although the latter does not play his role in the situation, we understand that this is not a consequence of Ana's initiatives. The assessments by group members are interpreted as something positive both for its functioning and for the relationships established in this context (Bonals, 2003).

It seems that Ana's more continuous participation as a coordinator contributed mainly to the collaborative interactions. Here is an example:

Fernanda: — Ok... who's going to read first?...

Lucas: — I made mine like this...

Ana: — Ok... Bianca or Lucas reads, then...

Lucas: — I put it like this... don't leave it out of the fridge... try that most domestic food... I put it in parentheses... domestic is to grow at home...

Bianca: — okay... I'll put this one here... I'll put it here...  
Lucas' answer...

Ana: — Ok... now Fernanda reads her answer...

Lucas: — don't leave it out of the fridge...

Ana: — after Lucas answers to Bianca, it's your turn...

(Transcript of the first experimental activity)

The planned role favored the work and the good understanding of the group, given the participatory balance between students. It had the same repercussion when assumed by other group members, although they incorporated it in more specific moments.

In contrast to praiser's role, the coordinator's role, while contributing to group work, can be a catalyst for participatory imbalance and possible interference in the good understanding of the group, when assigned to one student and taken up by another, for example, something that it was not possible to analyze in this context.

In short, we interpret that the roles assumed can have favoring and interfering effects in the work and good perception of the group. The discussions suggest that it is easier for students to exercise specific roles at the expense of others. Adherence to planned roles, as we discussed, favored

interactions and the very development of experimental activities. The characteristics of the blind student during group work are inconsistent with discussions that show the tendency of blind people to present patterns of social isolation, as described by Silva and Batista (2011). This suggests that working in small groups to carry out experimental activities can be a way of confronting the stereotype of the blind person as someone who resists social interactions.

### **Students' perceptions about group work and roles and their influences on interactions**

We understand that the established interactions can reflect, tacitly and to some extent, on the students' understanding about group work and the roles assigned to the members. The interactions established at the beginning of the group work are taken as an example:

Fernanda: — Bianca... what did you put there?...

Lucas: — ah, one...

Bianca: — I put...

Lucas: — read...

Bianca: — read yours...

Lucas: — Why do I have to read?...

((inaudible))

Ana: — it's like this... what happens... each will tell their answers... then I think she'll get a sheet, if I'm not mistaken... and they'll actually write the answer/...

(Transcript of the first experimental activity)

Part of the group resists the proposed task. Bonals (2003) emphasizes that it is relatively common that difficulties in starting working in groups appear. The author describes that members of the group often focus on the activity initially and, consequently, the others also start to work. In this case, under analysis, the students take the initiative to develop the work but refuse to explain their ideas. Therefore, certain inertia for group work, in some way, can be supported by a perception of how to do it based on the development of previous group work. It is not uncommon for group work to be characterized

by a participatory imbalance in which part of the group develops the activities and another part is more passive.

At another point, an implicit understanding of the role in group work stands out:

Lucas: — I already said mine ((answer))... can I go to the toilet now?...

(Transcript of the first experimental activity)

Although the student tries to discuss the answers elaborated at other times, he seems to believe that he has already contributed to the group, but he does not explicitly recognize that the group can contribute to his learning. Therefore, his knowledge about the role of other group members can influence social interactions when, many times, he sought to develop the work alone.

The understanding of assigned roles also seems to have influenced the identified interactions:

Lucas: — I'll read it, right?!...

Bianca: — no... you're going to read it to us... she's going to read them... because she's going to be the communicator...

Lucas: — a... but I said I wanted to read...

Fernanda: — you... you said you wanted to be the reader... such an... airhead...

Bianca: — bye... get out... off with you...

(Transcript of the second experimental activity)

In the second experimental activity, Lucas chooses to be the reader. Despite this, he seems to understand his attributions are a reader and as a communicator. Even if the student does not know about the subject, possible interactions could have favored his understanding. On the other hand, disrespect in the group stood out and consequently interfered in the well-being among members and in the interactions between students. Given the above, we understand that attitudinal knowledge must also be valued throughout the formative process and is related to conceptions concerning what it means to work in a group.

This link between attitudinal knowledge and group work can also be identified in the following excerpt:

Ana: — activity... experimental...

Lucas: — (I'm number one)...

Bianca: — what are the numbers?...

Ana: — guideline... guidelines... identify... the materials... in the kit... we've already done that... right?!

Bianca: — uhum...

Ana: — each... student... must... pre-pa-re... one of the... sys-sys-tems below... one of the systems below... using tubes...

Lucas: — I want both...

Fernanda: — I want three...

Bianca: — I want one...

Ana: — take it easy... [...]

(Transcript of the third experimental activity)

In the third experimental activity, Ana was a reader. Even though a script in ink or Braille was made available to each group member, we wanted them to respect the reader and follow her performance. Nevertheless, when Ana starts reading the experimental procedures, Lucas indicates to be ahead of Ana's role and thus exposes the part he wanted to perform in that experimental activity. At that moment, the concern with oneself is highlighted. This initiative then suggests a discussion about who would do each part of the procedures, which interferes with the members' understanding of the experimental activity and has implications even for Ana exercising her role as a reader.

Like Lucas, Fernanda, in another procedure in the same experimental activity, also seeks to take on Ana's attribution:

Ana: — uhum... questions... for... discussion... in/

Fernanda: — group...

Ana: — wait, Braille is kind of complicated... end of a line... ((inaudible)) number one... make... predictions... that... that it should... that it should... happen... in each... in each system... (prepared by the group)... justify... the predictions...

Fernanda: — Can I go to the toilet?...

Researcher: — ah... now you have to finish...

Ana: — justify the predictions...

Researcher: — look... you have to pay attention to Ana...

(Transcript of the third experimental activity)

In light of Ana's comments, Fernanda tries to leave the group. This is perhaps linked to the disrespect for Ana's contributions because of her slower reading. We understand that such actions can have repercussions on unpleasant feelings in the context of group work.

It seems that when the reader's role is shared, they incorporate an attitudinal knowledge of knowing to wait for their turn:

Ana: — guys, what do you think of each one reading a little bit... until the end...

Lucas: — do you want me to read to the point?... I can read to the point...

Ana: — I start... could it be?... knowing a little more about bread production... did I read it right?... because that's what's written here for me...

Fernanda: — yes... that's the title...

Ana: — the proteins... the proteins?...

Fernanda: — aham...

Ana: — sorry... my throat's a little bad... present... in... wheat... flour... are res-pon-si-ble... for che-ck-ing checking... a net of com?...

Fernanda: — an elastic net...

Lucas: — an elastic net...

(Transcript of the third experimental activity)

We interpret that changing the reader's role was essential in characterizing collaborative interactions and respecting individual contributions.

We emphasize that, through his interactions, Lucas indicated that he understood group work and the roles, something that was more problematic for the other students. However, Bianca and Fernanda indicated they needed to incorporate respectful attitudes more consistently. On the other hand, Ana

showed to have more plausible conceptions about group work and the roles to be developed. In short, the students' understanding of group work and their roles can influence the interactions they establish and, consequently, the development of experimental activities.

### **Conceptions about blindness**

We present below the students' understandings/conceptions on blindness according to the categories defined *a priori* by Vygotski (1983).

#### **Mystical conception**

Before carrying out experimental activities in small groups, Bianca and Fernanda showed an almost mystical vision concept (Vygotski, 1983).

Bianca: — [...] she ((Ana)) can feel people's feelings... if you feel sad today... she can feel that you're sad...

(First interview)

Fernanda: — [...] I think it's kind of difficult... I am sighted, but can't ride a bicycle... imagine a person who is not sighted...

(First interview)

Bianca describes Ana as endowed with "supernatural" knowledge, in agreement with the mystical vision (Vygotski, 1983). The blindness conception is also permeated by the understanding that a blind person is inferior (Camargo, 2005), something highlighted in Fernanda's speech.

After carrying out the experimental activities, Bianca and Fernanda seem to move away from this comprehension:

Bianca: — help... her with us... ours with her... sometimes we helped her... sometimes she ended up helping us... no ((not what she expected)) ... because, I mean... I thought she wasn't going to help us because of the lack of vision... then it would get more difficult... then I was very surprised when she helped us... she gave some good answers... always helping us...

(Second interview)

Fernanda: — [...] the interaction was good... everyone interacted together...

(Second interview)

Bianca and Fernanda present knowledge that gets away from the conditions of inferiority attributed to the blind in relation to the sighted person that was expressed previously. In the second interview, Bianca does not show a supernatural understanding of blindness explicitly. From this analysis, it appears that the development of experimental activities may have provided reflections on the conceptions about blindness and learning about the blind student's potential. Ana and Lucas, in turn, did not present indications of this conception in their speeches at any point in the interviews.

### **Naive biological conception**

We could highlight understandings close to the naive biological conceptions. We bring the following examples:

Bianca: — I agree... [...] Ana... has the senses... like... the touch... which is the hand... the smell... and the... the hearing... which is very fine...

(First interview)

Bianca: — yes... I agree... [...] I think touch is more developed...

(Second interview)

Fernanda: — yes... people say that the... that blind people tend to hear better than the sighted people... because a lot of people say...

(First interview)

Fernanda: — because on TV... a lot of people say that... so I think so... at least the hearing I think is sharper...

(Second interview)

Lucas: — I saw on television... that when a person loses a sense... the others get more acute...

(First interview)

Lucas: — yes... I think so... because she lost her sight... the others became sharper...

(Second interview)

When asked about the accentuated development of other senses due to blindness, Bianca, Fernanda, and Lucas express understandings in the two interviews that dialogue with the naive biological understanding. They suggest that there is a simple and automatic compensation for different senses of sight due to the absence of the latter.

Ana also agrees with this understanding:

Ana: — [...] the visually impaired... to get one's bearings, one must have [...] all those senses, sharper than normal to perceive the world and also to get one's bearings...

(First interview)

Ana: — I agree... because after we lose our sight... [...] our hearing improves...

(Second interview)

Although the strong development of senses other than sight can contribute to the blind's development, we understand that this is not due to blindness itself, as highlighted by Vygotski (1983). Therefore, this understanding of the student approaches the naive biological conception. This is in agreement with the research results by Voos and Gonçalves (2015) in emphasizing that blind students also reveal a naive biological understanding.

In short, Ana, Bianca, Fernanda, and Lucas showed knowledge before and after the experimental activities that approached a naive biological understanding.

### **Sociopsychological conception**

When asked about the possibility of interaction between blind and sighted people, Ana, Fernanda, and Lucas are unanimous:

Ana: — yes... I agree... because... [...] they can help each other at playtime... the sighted can help the disabled person to get their bearings... and the disabled person... if they are

((inaudible)) they can help by giving some tips or something... and being partners... having fun together...

(First interview)

Ana: — I agree with this one... because we all support each other a lot... it doesn't matter if we see or not... like our experimental activity group... we always got along well... [...] and worked together... like all my colleagues do... even I can't see... and they can see... we always worked together...

(Second interview)

Fernanda: — yes... I agree... because... as the toys make noise... the person listens and... manages to organize these activities...

(First interview)

Fernanda: — I think that yes... interaction was good... everyone interacted together...

(Second interview)

Lucas: — I think so... because it's not just because a person is blind or sighted... that they can't play... they can't have a happy life...

(First interview)

Lucas: — I think so... of course... I don't know... there's no reason for them not to interact...

(Second interview)

Whether due to life experience, school context or even the promotion of social interactions during experimental activities, students understand that the blind and the sighted can be together, regardless of their specificities. Those indications are in the direction of the sociopsychological understanding, given the possibility of blind and sighted people interacting (Vygotski, 1983).

Fernanda emphasizes the condition for blind and sighted people to be able to relate, which, in this case, refers to obtaining information through senses other than sight. Something that we believe is in the direction of the sociopsychological conception, given the value they give to different sensory senses in communication, without, however, presenting limitations on the development of blind people, as described by Camargo et al. (2007).

Ana also highlights the contribution of social interaction, which is not restricted only to her but also to those who share those moments with the student, in accordance with the discussion by Biagini and Gonçalves (2017).

Finally, Bianca's understanding:

Bianca: — yes... because even if the person is blind... someone else can help... this person who is blind... to participate in the activities... she (blind person) must take care of herself... so... not so alone... someone supervising... but not helping much... helping once in a while... but always supervising the person who is blind...

(First interview)

Bianca: — help... her with us... ours with her... sometimes we helped her... sometimes she ended up helping us... no ((not what she expected)) ... because, I mean... I thought she wasn't going to help us because of the lack of vision... then it would get more difficult... then I was very surprised when she helped us... she gave some good answers... always helping us...

(Second interview)

Bianca initially emphasizes the possibility of interaction that can be interpreted as tutorial. In the final interview, she describes the possibility of blind people helping the sighted, which we believe is in the direction of overcoming the knowledge they initially presented, as she herself points out. Something that was present in social interactions during the experimental activities.

Finally, Ana, Bianca, Fernanda, and Lucas expressed knowledge that is close to the sociopsychological conceptions, thus suggesting that students live with more than one understanding of blindness.

## **FINAL CONSIDERATIONS**

We identified that social interactions in the context of a proposed experimental activity in small groups with the participation of a blind student and sighted students may present different characteristics. For example, those interactions can be tutorial or collaborative, according to Teodoro et al. (2015). Furthermore, the students take on roles that emerge in contributions not initially foreseen, regardless of whether they are planned during the group work.

Ana, a blind student, asked for and provided help, consistent with her sociopsychological understanding. However, there is some inconsistency between the naive biological conception made explicit by her and her requests for assistance with manipulative procedures.

Bianca valued her action of tutoring Ana, which dialogues with the mystical vision she showed before the development of the sequence of experimental activities, as a person who conceives the blind as inferior is expected to try to assist them constantly. After those activities, the student also expressed knowledge consonant with the sociopsychological understanding.

Fernanda gave indications that she enriched her knowledge about blindness and her attitudinal knowledge during the training process. Initially, she shows knowledge that fits into the mystical conception. However, at the end of the sequence of experimental activities, she shows knowledge related to the naive biological and sociopsychological understanding, and fails to express those linked to the mystical vision.

Lucas presented knowledge that comes closer to naive biological and sociopsychological understanding. Something that can be coherent with more specific tutorial interactions with Ana, especially since the establishment of such interactions seems to be influenced by a vision of inferiority of the blind person, a characteristic of the mystical understanding Lucas did not demonstrate. On the other hand, the conceptions about group work and the roles expressed by the student and characterized, to some extent, as more problematic, are configured as contradicting the sociopsychological understandings of blindness.

In short, different conceptions about blindness were identified. There is some relationship between conceptions about blindness and social interactions, especially the mystical understanding of blindness with tutorial interactions, which retains a certain coherence, as shown above. However, it is not possible to highlight a direct/causal relationship between mystical understanding and tutorial interactions, since Ana, for example, consents to the tutorial interaction and does not present indications of the understanding mentioned. At the same time, other factors that interfere in social interactions in the context of group work were described.

We could also identify the collaborative interactions that are coherent with the sociopsychological conception about blindness showed by Ana, Bianca, Fernanda, and Lucas. At the same time, understandings about group work and roles, in general, were considered more problematic for Bianca,

Fernanda, and Lucas. This knowledge contradicts in some way the sociopsychological conception of blindness, as they limited social interactions.

According to what was discussed, the understandings about group work and roles can influence the learned interactions (tutorials and collaboratives), teaching interventions, and the way students assume roles in group work.

The results suggest that problems associated with group work could favor reflection and deepen some students' knowledge presented throughout the research. In addition, the contribution of research to overcome issues linked to the presence of blind people in experimental activities is highlighted. In particular, there are indications of how to favor their constitution as social subjects.

It should be noted that in a more extended sequence of experimental activities, other results could be obtained in relation to the social interactions established by the groups. For example, students can develop one more type of social interaction at the expense of another, as they appropriate the methodological proposal of experimental activity, reflect on their attitudes and the blind person's potential. Based on this, it is also possible to investigate how students' understanding of blindness is transformed. This was not possible in this work, in which we identified possible relationships between the interactions characterized by the views of blindness presented by the group.

In light of the above, we note that the results presented in this research can help face the problem identified in the literature, as shown by Camargo et al. (2007), i.e., the difficulty of teaching to promote experimental activities in contexts with blind people. Furthermore, we understand that it was possible to characterize, to some extent, relationships between the nature of social interactions present in small group work in carrying out experimental activities in contexts with the presence of blind and sighted students and the understandings about the blindness they bring with them. This advances the understanding of a problem highlighted by Biagini and Gonçalves (2017), who signaled the possibility of social interactions established by students during group work to be associated with the conception about blindness they have, albeit tacitly. As highlighted above, it is still necessary to advance with research that deals with the investigation concerning the mentioned relationship. Finally, we emphasize that working in small groups in experimental activities can promote desirable social interactions and learning that is not reduced to the conceptual dimension in a school that bets on the diversity of knowledge, contexts, cultures and people.

## AUTHORS' CONTRIBUTIONS STATEMENTS

R.A.S and F.P.G conceived the idea presented. R.A.S. developed the experimental activities in the school context and performed the transcriptions. The authors discussed the theoretical framework that constitutes the production of this article and participated collectively in its construction.

## DATA AVAILABILITY STATEMENT

Data supporting the results of this study will be made available by the authors for correspondence, upon reasonable request.

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