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STUDY OF THE SUPPORT PROVIDED TO A VISUALLY IMPAIRED STUDENT INCLUDED IN A MAINSTREAM CLASSROOM

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The present research aims to reveal the specific types of interactions which can foster and optimize the engagement of students with special needs in mathematical learning. In a semiotic approach, the present analyses focus on a study of the relationships between language productions and non-verbal signs (gestures, gaze, ...) which students feed back to us in interaction. This paper analyzes the support provided by a Special Education Assistant (SEA) to a visually impaired student included in a mainstream sixth grade class, in solving a mathematical problem requiring the use of manipulatives, during an introductory lesson on the notion of area. The present analyses highlight semiotic misunderstandings which can arise, providing insight into the obstacles to learning that can result from the support offered by the SEA to a visually impaired student in mainstream education.

The present research seeks to understand the dynamic interactions between actors (students, teacher, special education assistant) which could provide insight into some of the difficulties which arise in teaching mathematics to students with special needs. To do this, the semiotic dimension of mathematical activity is explored herein. In this paper, the support provided by a Special Education Assistant (SEA) to a visually impaired student within a mainstream sixth grade class is analyzed in the performance of solving a mathematical problem requiring the use of manipulatives. The present goal is to reveal the types of interactions which foster the engagement of students with special needs in learning. First the theoretical background and analytical tools used for this research are presented, followed by the background to the study, a presentation of analyses and finally, the conclusions drawn.

THEORETICAL BACKGROUND AND TOOLS

Semiotic approach

Drawing on Vygotsky's sociocultural theory of learning (Vygotsky, 1978) and following Radford (2009, p.113), we can consider that in mathematics, "thinking does not occur solely *in* the head but also *in* and *through* a sophisticated semiotic coordination of speech, body, gestures, symbols and tools." We thus rely on the concept of the semiotic bundle (Arzarello, 2006), in order to consider the dynamic development of interactions between semiotic sets, such as language, coordinated with embodied aspects (gestures, body postures, glances, actions with tools) and written aspects (words, drawings, mathematical symbols).

A *semiotic table* (Houdement & Petitfour, 2019) is used to reveal the multimodality of teaching and learning phenomena and to interpret the different signs implemented during interactions between the actors in the classroom (e.g. Figure 2). Finally, the term *semiotic misunderstanding* (*ibid.*) is used to define a discrepancy between two interpretations of the same signs, or an unusual personal interpretation of a mathematical sign.

Framework for analysing the support provided to a visually impaired student

The analysis framework of instrumented action (Petitfour, 2016) is used herein to identify two types of support that can be provided to a visually impaired student in a mathematical problem-solving activity requiring the use of manipulatives. *Practical support*, which aims to compensate for the visual handicap, relates to the concrete realization of the manipulation in its manipulative and organizational aspects and concerns everything that, in the action, does not involve mathematical knowledge. *Technical support* relates to aspects of manipulation related to the mathematical knowledge involved. The support can take different form (verbal and non-verbal). We identify these by analyzing the semiotic bundles.

DATA AND PRELIMINARY ANALYSIS

Background and data collection

Marco is a visually impaired student with tubular vision and is quickly tired when he has to read or write. To enable his inclusion in the mainstream sixth grade class, he is accompanied by an SEA and has a laptop computer.

The observed session is the first of a sequence on the theme of areas, designed and conducted by Emmy, an undergraduate math student wishing to become a teacher, in a guided practice internship one day a week in the college (the teacher is present in the classroom, observing). The activity she proposes aims to reintroduce the notion of area, encountered by students in the previous two years, by comparing surfaces according to their areas and differentiating the perimeter and area of a figure. The performance of the task of comparing "the amount of paper used" by rectangle 1 and rectangle 3 is analyzed (Figure 1).

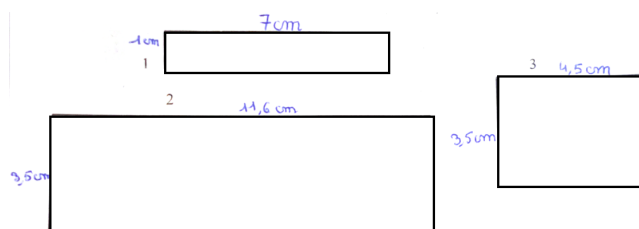


Figure 1: Extract from the student document (on the original, the figures are at a scale of 1)

A priori analysis

Two techniques are possible to compare two rectangular surfaces according to their area by manipulating material objects (paper shapes). A direct comparison (T1 technique) can be tested: one takes a form, places it on the top of the other, slides it and turns it to check, by sight or by touch, whether the two overlap or whether one fits inside the other. If neither superposition nor inclusion is obtained, an indirect comparison (T2 technique) is tested: one shape is transformed to make it comparable to the other by cutting and recompositing.

ANALYSIS

The teacher's instructions: a source of misunderstanding

In her oral instructions, Emmy closely guides the students on the actions to be performed in order to compare the area of rectangles 1 and 3. Her speech shows her willingness to control the progress of

the task both from a mathematical point of view, by guiding the students in the T2 technique, and from a practical point of view regarding material organization and copying the activity into their notebooks. The conveyance of instructions is a source of a semiotic misunderstanding that will guide the SEA's interventions with Marco in the support it will provide him. We explain this misunderstanding by using the semiotic table in Figure 2.

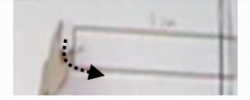



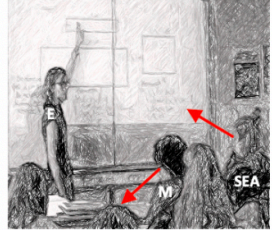



24'23 – Teacher (Emmy)				24'30 – Teacher (Emmy)
Mots	So	you are going to cut out	the first rectangle, okay? Only the first one	So you can cut out the rectangle
Gestes				
24'33 – Teacher (Emmy)				
and you're going to fit all of the paper	from rectangle 1	into rectangle 3		
				

Figure 2: Semiotic Table

The beginning of Emmy's instructions suggests the use of the T1 technique (24'09. "we're going to try to fit rectangle 1 into rectangle 3, we're going to try to overlay them"), even if that's not Emmy's intention. The end of the instructions is confusing. Indeed, we can think that "you can cut out the rectangle" (24'30) pertains to the organizational aspect stated above, "to cut out the first rectangle" (24'23), however, if we look at the gestures that accompany Emmy's speech, we see that she uses the term "cut out" in two different ways. At 24'23, it is a question of cutting the contour of rectangle 1 (designated by a deictic gesture) in order to be able to work with this paper form, detached from its support, this is a practical task; at 24'30, it is a question of cutting out the paper rectangle into several parts (her hand shows a cutting line which divides the rectangle into two parts), this pertains to the description at the beginning of the T2 technique. Her instruction "try to fit the quantity of paper from rectangle 1 into rectangle 3" (24'33) must be interpreted as preserving and recomposing the parts of rectangle 1, obtained by cutting and placing them inside rectangle 3. Emmy combines T1 and T2 techniques, not only in her oral speech, but also in the written form in the method she asks students to write before implementing the task.

Support provided to Marco by the SEA

First, the SEA directs Marco to the T1 technique by repeating the beginning of Emmy's instructions. She provides practical support by cutting out rectangle 1 from its holder and showing him rectangle 3 on the document (Figure 1) to avoid confusion with rectangle 2. Then she guides him with different technical support steps relating to T1: she says that rectangle 1 cannot be folded and encourages Marco to try to position rectangle 1 on rectangle 3 "in all directions", she then asks him to verbalize and justify his answer.

In a second step, Marco asks Emmy – who says from the beginning that it is necessary to "fit rectangle 1 into rectangle 3" – if rectangle 1 can be folded. Emmy tells him that folding is possible but that after

that, you have to cut "to be able to put it in rectangle 3". This information will not guide the SEA on a correct interpretation of Emmy's expectations. The support she gives Marco shows that she has not understood the meaning of the manipulation. She lets him take the initiative of folding rectangle 1, provides him with practical support by cutting the fold but she only gives him back a part of this rectangle, considering the other part as a surplus. This prevents Marco from implementing the T2 technique. She then provides him with further practical support by applying glue to the retained part of rectangle 1 and lets him take the initiative to glue it on rectangle 3 "as he wishes". She then asks him about the figure obtained, which seems to her to be the purpose of the manipulation. This interpretation is linked to another semiotic misunderstanding: at the beginning of the session, the SEA informed Marco that this was a geometric activity, probably due to having seen the rectangles, but the theme addressed, although not announced by Emmy to the class, is that of measurement.

CONCLUSION

The SEA provides essential practical support to make it possible to solve a task requiring visual control (cutting, pasting and visual identification of figures). However, some support provided exceeded the objective of compensating for Marco's visual impairment. As such, he is not incited to take the initiative for the technique he applies to solve the problem (whereas he should), nor does he oppose the erroneous interpretation of the resolution of the task by the SEA. Marco allows himself to be guided in micro-tasks, thus probably losing sight of the purpose. The semiotic misunderstandings of the SEA exacerbate the identification of this phenomenon.

In previous research (Petitfour, 2017), the value of using a technical language that allows dyspraxic students to access geometric concepts in a dyadic work was highlighted. Technical language describes the aspects of manipulation (which these students cannot perform successfully because of their disability) in relation to the mathematical knowledge involved. We hypothesize that, in activities where materials must be manipulated in order to generate mathematical knowledge, the use of technical language will be equally beneficial to visually impaired students and dyspraxic students alike to help them to take the initiative in describing their *intentions to act*, or for the SEA to encourage them in this endeavor. Provided that she is trained to do so...

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