

**A STUDY ABOUT THE DEVELOPMENT OF KNOWLEDGE
in fifth to eighth graders, subject to the same didactical intervention involving
ordering relations**

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ABSTRACT

The authors present, in this article, the results of a research on the knowledge about relations of 5th to 8th graders (10 to 14 years old). The study was conducted in three phases: a pre-test, a class and a post-test among 4 groups of students from different grades totaling 64 subjects of a school in the state of São Paulo, Brazil. The results showed that students used the relation “come before than” *meaning* only “come immediately before than” (restricted conception) and the ordering relation “not come after than” meaning “come before than” instead of “come before than or at the same time as”. The authors analyzed the effect of a didactical intervention (the same for all grades under study) aimed at reaching the learning of effective ordering procedures as well as the overcoming of a restricted conception of the relation “come before than” besides the acquisition of the mathematical conception of the ordering relation “not come after than”. In this didactical intervention, the students’ production was under questioning based on the Didactical Situations Theory by Brousseau (1997).

The results show that the acquisition of a broader conception of these relations depended on the didactical intervention.

The fact that the problems diagnosed in the pre-test disregarded the grade fomented the development of a similar study among students of higher levels.

1. Introduction

Igliori and Maranhão (2000) checked, in a late study, that fifth graders restricted the meanings of the relations “come before than” and “not come after than” in solving problems. For these students, “come before than” meant “come immediately before than” and, in the ordering relation “not come after than” (equivalent to come before than or at the same time as), they did not admit “come at the same time as” as an ordering. The authors also checked if it was possible to see an improvement in the knowledge of students subject to a didactic intervention based on the Didactical Situations Theory by Guy Brousseau (1997). To this end, questions about enunciations of the following kind were proposed:

“A teacher wanted to know the order of arrival of her students. They informed her but **she could not figure out the exact order of their arrival**. Give the possible orders of arrival according to the statements students gave her.

Maria said that she came to school before Eni. Eni said that she came before Bia. Rita could not remember the arrival of her mates, but she was sure she came after Eni.”

In this study, the order of presentation of characters in the problems’ enunciation was not questioned as a possible didactic variable (which influences the students’ performance). Besides that, it was restricted to fifth graders. Bearing in mind that establishing relations is adamant for the learning of mathematics in the various teaching levels, the authors elaborated the present study, which widened the former, based on the following questions:

- a. Did fifth to eighth graders (10 to 14) have the same problems diagnosed in the late research? And if they had, was the evolution of a restricted conception to a broader one different for each grade for the same didactic intervention?
- b. Was the order of characters’ presentation in the problems’ enunciations a didactic variable?

2. Theoretical Framework

This research was developed according to the principles of Brousseau’s Didactical Situations Theory (1997). In this theory, a problem regarded as a source of learning must lead the student to a reflection, which involves him in an action phase. So, the action phases are understood as researching ones, aiming at the knowledge of a mathematical object. In a dialectical process, this phase is followed by a formulation phase, which is regarded as one of explanation of conceptions by the students, usually provoked by an action phase. In this process, the validation phase provides a confrontation of conceptions explained by the students, either through debates among themselves or through questioning by teachers/researchers. The teachers/researchers must propitiate an atmosphere in the classroom that activates the dialectical process, boosting the formulation and validation phases, aiming at knowledge evolution. The problems must be conceived so that the student has the knowledge to solve it, at least in part, and that some mathematical knowledge is crucial for the complete solution. So, the problems proposed to the students in this study were conceived in such a way as to benefit both goals, that is: the use of their cultural background and the acquisition of mathematical notions. Therefore, the problems were derived from their daily routine.

3. Methodology

The research was conducted among 4 groups of 5th to 8th graders (10 to 14 years old), totaling 64 students, from a school in the state of São Paulo, Brazil. We had 13 students in 5th grade, 23 in 6th, 17 in 7th and 15 in 8th grade. There were 3 application sessions dated a week apart always conducted by the same researcher and followed by the same observers, based in the theoretical framework.

In the 1st session, the students solved the problems individually with paper and pencil. In the 2nd session, a debate was promoted in each group about the students' outcome based on their answers in the previous session (made available to students). The discussions were held in two steps. In the first one, the teacher/researcher discussed effective strategies for ordering, such as the use of an arrow corresponding to the ordering relation "come before somebody" (for instance, if the group decided that "before somebody" should correspond to the positioning "on the left", an arrow was drawn pointing to the left and above it was written "before somebody"). Besides that, any positioning was checked, for each ordered character, against the problem's enunciation. In the second step, the teacher/researcher conducted discussions with the students, aiming at the acquisition of the mathematical conception of relations. In the 3rd session, the students solved the problems, whose descriptions had been altered only by changing the name of the characters.

Data was obtained from the answer sheets filled out by students and from observers' notes who were present in all sessions.

We used 4 problems divided in two categories.

The 1st, made up of problems 1 and 2, allowed the analysis of the order of characters' presentation in the text as an influence over the students' performance. They were also used in class aiming at the development of effective strategies for ordering.

The 2nd, composed of problems 3 and 4, allowed the analysis of the meaning attributed to the relations. These were also used in the classroom to lead students to an analysis of a possible multitude of correct answers.

3.1. The problems

A teacher wanted to know the order of arrival of her students. They informed her and **she could determine their exact order of their arrival**. Give the possible orders of arrival according to the statements students gave her.

1. Antonio said he came to school before Marcos. Marcos said he came before Sueli. Sueli said she came before Débora. With this description, can we determine the order in which they might have arrived? If this is possible, write it down.

2. Tadeu said he came to school before Elaine. Elaine said she came before Vera. Otávio said he came before Tadeu. Based on this description, can we determine the order in which they might have arrived? If this is possible, write it down.

A teacher wanted to know the order of arrival of her students. They informed her but **she could not figure out the exact order of their arrival**. Give the possible orders of arrival according to the statements students gave her.

3. Sérgio said he came to school before Carla. Carla said she came before Júlia. Ronaldo said he did not remember about the other colleagues, but he was sure he did not come after Carla.

a. Based on this description, can we determine the order in which they might have arrived? If this is possible, write it down.

b. According to this description, can you conclude that there is only one possibility for

their order of arrival? If not, indicate one or more possible orders.

4. Sandra said she came to school before Vicente. Fátima said she came before Sandra. Roseli said she did not remember about the other colleagues, but he was sure he did not come after Sandra.

a. Based on this description, can we determine the order in which they might have arrived? If this is possible, write it down.

b. According to this description, can you conclude that there is only one possibility for their order of arrival? If not, indicate one or more possible orders.

4. Results and Analysis

The first two problems allowed the students to present just one correct answer. The same situation applied to questions 3a and 4a. Questions 3b and 4b allowed them to present up to three correct answers different from those presented in 3a and 4a.

The data obtained from the written answers for the tests (or problems) of sessions 1 and 3, were coded and organized in tables (Figures 1, 3, 5, 7).

The codes used were the following:

0 – supplied incorrect ordering or left questions blank;

1 – scored in problems 1e 2 and in questions 3a and 4a, or presented a correct answer for questions 3b e 4b different from the one for 3a and 4a;

2 - presented two correct answers for questions 3b and 4b different from the ones for 3a and 4a;

3 - presented three correct answers for questions 3b and 4b different from the ones for 3a and 4a.

That what was regarded as relevant from the statistical analysis to evaluate the effect of the didactic intervention was also organized in tables (Figures 2, 4, 6, 8).

Results of 1 st in 5 th grade							Results of 3 rd session inn 5 th grade					
Question							Question					
Code	1	2	3a	3b	4a	4b	1	2	3a	3b	4a	4b
0	0%	0%	30.77%	53.85%	23.08%	46.15%	0%	8%	31%	31%	23%	15%
1	100%	100%	69.23%	30.77%	76.92%	30.77%	100%	92%	69%	15%	77%	15%
2				15.38%		23.08%				23%		23%
3				0.00%		0.00%				31%		46%

Figure 1

Statistical analysis of experiment in 5 th grade	t _{crit}	-3.18988	highly significant result
	d.f.	12	
	p-value	<0.005	

Figure 2

Results of 1 st session in 6 th grade							Results of 3 rd session in 6 th grade					
Question							Question					
Code	1	2	3a	3b	4a	4b	1	2	3a	3b	4a	4b
0	4.35%	13.04%	60.87%	60.87%	43.48%	47.83%	0.00%	8.70%	30.43%	21.74%	30.43%	26.09%
1	95.65%	86.96%	39.13%	34.78%	56.52%	39.13%	100.0%	91.30%	69.57%	30.43%	69.57%	17.39%
2				4.35%		13.04%				26.09%		21.74%
3				0.00%		0.00%				21.74%		34.78%

Figure 3

Statistical analysis of experiment in 6 th grade	t _{crit}	-6.95646	highly significant result
	d.f.	22	
	p-value	<0.001	

Figure 4

Results of 1 st session in 7 th grade							Results of 3 rd session in 7 th grade					
Question							Question					
Code	1	2	3a	3b	4a	4b	1	2	3a	3b	4a	4b
0	5.56%	0.00%	16.67%	27.78%	22.22%	22.22%	0.00%	5.88%	0.00%	0.00%	0.00%	5.88%
1	94.44%	100.00 %	83.33%	66.66%	77.78%	66.67%	100.0%	94.12%	100.00 %	17.65%	100.0%	11.77%
2				5.56%		11.11%				64.70%		58.82%
3				0.00%		0.00%				17.65%		23.53%

Figure 5

Statistical analysis of experiment in 7 th grade	t _{crit}	-6.97555	highly significant result
	d.f.	16	
	p-value	<0.001	

Figure 6

Results of 1 st session in 8 th grade							Results of 3 rd session in 8 th grade					
Question							Question					
Code	1a	2	3a	3b	4a	4b	1	2	3a	3b	4a	4b
0	6.25%	12.50%	31.25%	50.00%	37.50%	43.75%	0.00%	0.00%	6.67%	20.00%	0.00%	6.67%
1	93.75%	87.50%	68.75%	43.75%	62.50%	50.00%	100.0%	100.00 %	93.33%	13.33%	100.0%	33.33%
2				6.25%		6.25%				40.00%		33.33%
3				0.00%		0.00%				26.67%		26.67%

Figure 7

Statistical analysis of experiment in 8 th grade	t _{crit}	-7.09407	highly significant result
	d.f.	14	
	p-value	<0.001	

Figure 8

5. Conclusions

There was no significant students' performance gap for problems 1 and 2 when the order of presentation of characters in the text was changed both for the pre-test and for the post-test. This leads to the conclusion that it is not a didactic variable.

The relevant values to interpret the effects of a didactical intervention are: t_{crit} , d.f., and p-value.

The value of t_{crit} stands for the standardized scoring for the statistics under study. For all the instances, the values for t_{crit} were regarded highly significant. This means that there actually was a statistical shift in the students standard answer in favor of a better comprehension of the broader meaning of the relation "come before than" and of the ordering relation "not come before than". This alteration is attributed to the didactic intervention.

The statistical analysis shows that the result for 6th, 7th and 8th grades (p-value < 0.001) was better than for 5th grade (p-value < 0.005), in the present sample.

In 7th grade there was the least deviation, that is, the improvement for each student was very much alike in spite of the likeliness of experimental conditions to the other grades. This can be attributed to various factors such as students' and teachers' practices in grades before 7th. This will be investigated through an analysis of teachers' resumes and interviews with the teachers and coordinators of the researched school.

It should be highlighted that the pre-test results (1st session) show no difference in the standard for answers among the grades as regards the non-mathematical conception of the investigated relations. This is based on figures 1, 3, 5 and 7 that show 0% of students bearing code 3 for all grades for the answers to questions 3b e 4b in the 1st session. This code, for these questions, is what strikes the difference between those students who have a mathematical conception to those who do not. This proves that the existent difficulties disregard the grade and this fact foments the authors to carry the same study among higher-level students.

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