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Native Languages and Performance in School Mathematics in the Mozambique's Social Context

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***Abstract:* -** Mozambique is a multilingual society, with about 40 native spoken languages that belong to the Bantu's origins, a part of Portuguese language, the main and official language for business and instruction. As pointed out in some studies the proficiency in the language of instruction is generally seen as linked to mathematics performance at school and that, in the situation which the language of instruction is different from that spoken in everyday life, there is a much bigger "gap", particularly when dealing with mathematics teaching and learning processes, than in other teaching-learning contexts. Regarding the situation of Mozambique the lack of development of specialized mathematics registers in native languages is visible since, even in simple trading relations, people mark and discuss prices and conduct counting and basic operations mostly in Portuguese. Thus, the present study intended to explore possible relationship between the students' way of reasoning to solve algebraic mathematics problems and their language proficiency.

***Keywords*:** *- native language, algebraic language, problem solving, mathematics register*

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I. INTRODUCTION

Mozambique is a multilingual society, with about 40 spoken languages with the exception of Portuguese and a few other immigrant languages, all of them belong to the Bantu's origin. More or less closely related, and according to [4], Bantu languages are often merged into regional zones and groups according to lexicographic similarity or the degree of mutual intelligibility.

As pointed out in the international literature studies, some researchers (e.g., [6]; [15]; [8]; [1]; [3]), have found that proficiency in the language of instruction is generally seen as linked to mathematics achievement at school. For instance, in the research work of, involving students from language minorities or of multilingual classrooms, it is pointed out a strong relationship between achievement in mathematics and students' language competency. As an example, [9], in the discussion document on "*Mathematics Education and Language Diversity*" presented in the conference organized under the auspices of the "*International Commission for Mathematical Instruction*", held in Brazil in September 2011, are described seven contexts where multilingualism is apparent, such as: i) societies where people are used to using several languages (e.g. South Africa); ii) societies with more than one official language, one having a higher status (e.g. Catalonia; Wales); iii) bilingual societies where two languages are sometimes used in support of minority language(s) (e.g. Peru) and multilingual societies in which the use of minority languages in the classroom is restricted by law (e.g. some states in the USA); iv) societies previously seen as monolingual where immigration has made language diversity more salient (e.g. Europe, Australia); v) societies in which a foreign language is taught through subjects like mathematics (e.g. Czech Republic); vi) societies in which mathematics education for indigenous language speakers is conducted in a majority colonizing language (e.g. Africa, South America); vii) societies with changing languages of instruction change across school sectors (e.g. Pakistan, Algeria). Therefore, Mozambique is an example of the second last context mentioned in the list, where a colonizing language is used for education for indigenous language speakers.

According to [13] the notion of "language" itself is diverse and contested, and there are often naïve interpretations of both, students' language competence and the language of mathematics. However, [2], investigating the language factor in Nigerian children's performance on arithmetic word problems found that their achievement was better both in skills and strategies when mathematics word problems were presented in the children's native language than when the problems were presented in English, finding which resonates with that from a study by [10] done in Manukau in New Zealand where was found "enough evidence to support the theory that students who use their mother tongue while learning in English perform better than those who do not".

On one hand, [11] draws attention to the importance of motivating student participation in a mathematical discussion, encouraging dialogue and giving priority to students' ways of expressing their thoughts. This proved to be relevant in this case where the language of instruction is not the first language of the student and they can express their thoughts in their first language. On the other hand, [12] also argued that using two languages helped to mediate between a more informal and a formal mathematical register.

Although, [14], in a research done in Catalonia and South Africa, argued that the uses of languages in multilingual classrooms should also be viewed in a political perspective as, according to them, the choice of language of instruction is mainly a political issue. The same authors illustrate their argument referring that, in South Africa, in the post-apartheid era, eleven official languages were institutionalized, and nine of which are native or local, and that, communities should choose the language, in which they want deliver the education, or which language is to be used as the medium of instruction in the school, or in a specific region. However, in many situations, students and teachers (with higher incidence for these) prefer to learn or to teach in English because proficiency in English is "a prerequisite for individuals aspiring to gain a share of the socio-economic, material resources enjoyed by an elite group".

To end the considerations about the language of teaching and learning mathematics, especially for second language learners, the following statement seems relevant, as it summarizes some of the main problems arising with teaching and assessment. And thus, "The learning of mathematics requires a variety of linguistic skills that second-language learners may not have mastered. Furthermore, special problems of reliability and validity arise in assessing the mathematics achievement of students from a language minority. A mathematics curriculum is needed that would develop second-language learning and mathematics learning" [5:134].

Therefore, with the view to study the relationship between the students' performance when solving mathematics problems and their first language (mother tongue) and the main national language and language of instruction, this study brought a more encouragement to the use of native languages in the context of learning mathematics or solving mathematics problems. To this end, one question was aroused for the study with the aim analysis how much code-switching or students talking in their first language would, perhaps, help when they are asked to explain the strategies they use in solving mathematics problems in the achievement tests.

II. Material and Methods

A. Sampling and Data Gathering

The study adopted a discursive approach to learning mathematics. Based on this theoretical orientation, a test related to school algebra was developed, which included tasks where the students needed to convert a text describing relations between numbers (a word-problem in a mathematical context) into symbolic language, to re-contextualize a description of an everyday context from the perspective of school algebra (word-problem in a non-mathematical context) and to interpret algebraic expressions from the viewpoint of an everyday context. The data for the study were gathered at one school in a semi-rural area and involved a sample of 41 students from grade 10, using firstly, a background questionnaire the participants they were asked to state their first language or mother tong and also to say in which language or languages they mostly communicate outside school or with classmates outside the classroom. In that, students were found to be mostly, from the same, native-first-language spoken group, which is predominantly *Xichangana's* that is originally based in the south region of Mozambique. Secondly, a written test was also set up by the researchers, to access their performance in solving mathematics problems. All the instruments were designed in Portuguese language as it is the official and the medium of instruction at all levels of the education system in Mozambique.

Still regarding the construction of the test items for this study, likely linked to school Algebra, the focus was on what has been called abstract reasoning or engagement with decontextualized language, which is most prominent in dealing with school algebra. According to the research questions the purpose of the tasks in the items' test was to investigate to which type of school mathematical knowledge from algebra the students have access in relation to their language background. The mathematical substrate of the tasks in the test was chosen to be on a low level in relation to the curriculum, except for one task. Thus, the test was designed with the view to understand students' strategies and analyze their preferences in relation to tasks that make use of symbolic language, use natural language, were both contextualized and not contextualized in the form of word problems that relate to domestic activities. If the mathematics level were too high, the students might not try the items at all exclusively because of their mathematical proficiency. All already mentioned the tasks were set up to students in the medium of instruction in Mozambique, Portuguese Language. Then, the questions were elaborated in different forms as a way to achieve the main aim of the study. Some of the items were designed using school mathematics language that appears in mathematics textbooks, and which [7] classifies as strongly institutionalized form and content of expression (esoteric domain text), while others are presented as descriptive and/or public domain text (weakly institutionalized content and/or form of expression). The items using everyday language (public domain text) have the aim to evaluate respondents' skills and abilities to re-contextualize it from the perspective of school algebra. Those were the typical word problems, to which the students were yet familiar since they are recommended in mathematics curriculum in Mozambique.

B. Data Analysis

As one main goal of the study was to investigate the students' algebraic and logical reasoning in relation to their language proficiency either in native or Portuguese languages, then, the sample was aggregated into three status groups (low, middle, high) based on what they have written in the background questionnaire, which, a part of the demographic data there were some question related to spoken languages, social structure and economic class. In this case, indicators were also added, regarding socio-economic information of family, and an ordinal scale with student gains in status according to achieved "points" was constructed. Such point codes have been assigned for all questions from the background questionnaire in order to ease some analysis. Eventually, some of these factors were selected for constructing an aggregated description of three status groups. As result, three socio-economic status clusters have been constructed from the background questionnaires. A detailed characterization of these clusters in is given in Table 1 and this information forms the basis for the groupings used in data analysis.

TABLE I. Nr and % of Students by socio-economic status and gender

	Low Status (1st Cluster)	*Middle Status (2nd Cluster)*	*High Status (3rd Cluster)*	*Total*
Girls	8	11	2	21
Boys	6	6	8	20
Total	14	17	10	41
%	34%	42%	24%	100%

III. Results

A. The Sample

The first results of the study refer to the sample grouped and t its aggregated cluster groups for the analysis of the written test-item results and the main findings with respect to the sample are provided in Tables 2 to 5 taking into account the whole sample used, and considering only whether the students produced a correct or reasonable solution or not.

TABLE II. First cluster achievement by 1ST/ most spoken languages

Language		***Count***	***Low status group achievement***				
First	***Spoken***		***Item1***	***Item2***	***Item3***	***Item4***	***Item5***
Portuguese	Portuguese	1	1	1	1	1	0
Native	Portuguese	2	2	1	2	2	0
Portuguese	Native	1	1	0	0	0	0
Native	Native	10	9	5	4	4	1
Total		14	13	7	7	7	1
Achievement percentage			93%	50%	50%	50%	7%

TABLE III. Second cluster achievement by 1ST/ most spoken languages

Language		***Count***	***Middle status group achievement***				
First	***Spoken***		***Item1***	***Item2***	***Item3***	***Item4***	***Item5***
Portuguese	Portuguese	6	5	3	2	6	3
Native	Portuguese	2	2	1	0	2	0
Portuguese	Native	3	3	3	3	3	1
Native	Native	6	5	2	3	3	3
Total		17	15	9	8	14	7
Achievement percentage			88%	53%	47%	82%	41%

TABLE IV. Third cluster achievement by 1ST/ most spoken languages

Language		***Count***	***Middle status group achievement***				
First	***Spoken***		***Item1***	***Item2***	***Item3***	***Item4***	***Item5***
Portuguese	Portuguese	4	4	2	1	3	1
Native	Portuguese	3	3	2	2	2	2
Portuguese	Native	1	1	0	1	0	0
Native	Native	2	2	1	0	0	1
Total		10	10	5	4	5	4
Achievement percentage			100%	50%	40%	50%	40%

TABLE V. STUDENTS OVERALL ACHIEVEMENT IN THE WRITTEN TEST

	Count	*Item1*	*Item2*	*Item3*	*Item4*	*Item5*
1st Cluster	14	93%	50%	50%	50%	7%
2nd Cluster	17	88%	53%	47%	82%	41%
3rd Cluster	10	100%	50%	40%	50%	40%
Total	41	38	21	19	26	12
General Achievement		93%	51%	46%	63%	29%

So, the main results brought from the study in the written test can be seen in Table 6 where overall differences in relation to these groups, as displaced.

TABLE VI. LANGUAGE GROUPS

Name of Group	*N*	*Languages*	
		First Language	*Most Spoken Language*
Portuguese Speakers	11	Portuguese	Portuguese
Native Language and Portuguese speakers	7	Native	Portuguese
Native Language and Portuguese speakers	5	Portuguese	Native
Native Language Speakers	18	Native	Native

- 1st Language Group – "Portuguese speakers", students who mother tongue is the medium of instruction and who also use Portuguese in their everyday communication.
- 2nd Language Group – First Native language speakers, but who mostly communicate in the medium of instruction also outside school, referred to as "Native Language and Portuguese speakers".
- 3rd Language Group – Students whose first language is Portuguese, but they are mostly communicating in a native language because of the milieu or the social context, in which they are involved, referred to "Portuguese and native Language speakers".
- 4th Language Group – These are first native languages speakers who also mostly communicate in those languages, that is, Portuguese is used/spoken at school or in some situations where it is not possible to communicate via a native language, referred to as "native Language Speakers".

B. *The Overall Results in the Written Test*

Taking into account that, the study aimed to explore students' abstraction and symbol-based reasoning, especially in relation to school algebra, with regard to differences in their socio-economic and language background in the specific context of Mozambique, the research test-items focused on: *i) students' skills in solving items requiring to articulate and explain mathematical procedures; ii) converting text describing relations between numbers into symbolic language and solving the "translated" problem; iii) re-contextualizing a question described in everyday context from the school algebra perspective as well as interpreting algebraic expressions from the viewpoint of an everyday context; and, iv) understanding different aspects of the concept of variable or "unknown"*.

Tables 7, 8, 9 and 10 depict the results in the written test by language group. From these Tables, some general observations can be made. Firstly, there is no obvious advantage of being in the category "Portuguese Speaker".

TABLE VII. CORRECT SOLUTIONS BY CLUSTER FOR "PORTUGUESE SPEAKERS"

		Item1	*Item2*	*Item3*	*Item4*	*Item5*
1st Cluster	1	1	1	1	1	0
	%	100	100	100	100	0
2nd Cluster	6	5	3	2	6	3
	%	83	50	33	100	50
3rd Cluster	4	4	2	1	3	1
	%	100	50	25	75	25
Total	11	10	6	4	9	4
	%	91	55	36	82	36

TABLE VIII. CORRECT SOLUTIONS BY CLUSTER FOR "NATIVE LANGUAGE AND PORTUGUESE SPEAKERS"

		Item1	*Item2*	*Item3*	*Item4*	*Item5*
1st Cluster	2	2	1	2	2	0
	%	100	50	50	50	0
2nd Cluster	2	2	1	0	2	0
	%	100	50	0	100	0
3rd Cluster	3	3	2	2	2	2
	%	100	67	67	67	67
Total	7	7	4	4	6	2
	%	100	57	57	86	29

TABLE IX. CORRECT SOLUTIONS BY CLUSTER FOR "PORTUGUESE AND NATIVE LANGUAGE SPEAKERS"

		Item1	*Item2*	*Item3*	*Item4*	*Item5*
1st Cluster	1	1	0	0	0	0
	%	100	0	0	0	0
2nd Cluster	3	3	3	3	3	1
	%	100	100	100	100	33
3rd Cluster	1	1	0	1	0	0
	%	100	0	0	100	0
Total	5	5	3	4	3	1
	%	100	60	80	60	20

TABLE X. CORRECT SOLUTIONS BY CLUSTER FOR "LOCAL LANGUAGE SPEAKERS"

		Item1	*Item2*	*Item3*	*Item4*	*Item5*
1st Cluster	10	9	5	4	4	1
	%	90	50	40	40	10
2nd Cluster	6	5	2	3	3	3
	%	83	33	50	50	50
3rd Cluster	2	2	1	0	0	1
	%	100	50	0	0	50
Total	18	16	8	7	7	5
	%	89	44	39	39	28

Looking at the total number of solved items "on average solution rate by students", the groups all solve between 2 or 3 items per student. The same applies to status clusters. However, there are differences between the items itself. For instance, item 2, which is an algebra word problem with an unknown number, was least successfully solved by "Native Language Speakers", which is not unexpected. But the expectation that "Portuguese Speakers" should do better, is not justified, as it was the ones with first language Portuguese who at the same time more often communicate in native languages who were most successful. For the other word-problem about cinema tickets, the "Portuguese Speakers" were better, but generally not many students solved it, which was also unexpected. The middle status group achieved better on it, the low and high status groups being similar. On item 5, about the swimming pool resembled a type of task from their current curriculum, and similar tasks are found in the textbooks although it was generally not solved correctly by most of the students of the weak achiever group. In the low status cluster only two students solved it, even though they had a lower number of insufficient marks in mathematics than the middle status group. A complementary finding is also that the middle status cluster solved more items as could have been expected, given the fact that in the school, they got the weakest achievement marks compared to all groups. Thus, it should allow concluding that the written test designed and used in this study did not "measure" the same as the school marks do.

C. *Achievement Results by Item Level*

On Item 1:

Item 1: - The expression, $12+15\div3-2\times3$, was given to three students to solve and they presented the following solutions.

Student 1	Student 2	Student 3
$12+15\div3-2\times3=$	$12+15\div3-2\times3=$	$12+15\div3-2\times3=$
$=12+5-6=1$	$=27\div3-6=$	$=12+15\div1\times3=$
$=7-6=$	$=9-6=$	$=27\div3=$
$=11$	$=3$	$=9$

Question 1: Which is the correct solution? Justify, in details, your answer/option using properties of the elementary operations (addition, subtraction, multiplication and division).

This item presents a typical mathematics classroom language employing number symbols and students are required to possess basic arithmetic skills in operating with addition, subtraction, multiplication and division since he/she will need to remember the priority rules for these operations. The sentence for then question has low grammatical complexity when asking for the task "*Indicate the right solution and justify your choice using properties of the elementary operations of addition, subtraction, multiplication and division*". As the task was posed in an imperative form, one could make the following question, "*The right solution for which question*?"

However, the lexical cohesion is ensured as the word solution is mentioned in the presentation of the alternatives. The word is repeated. But students must be able to understand that the act of selecting one option is what is called a "choice". The question (imperative) is formulated through a sentence that does not require any decomposition.

As many result in item 1, students' achievement was satisfactory with about 80% of the students choosing the correct option and all with a reasonable justification, but two of them didn't do it correctly, being one a boy, that is a main native language speaker, and one, a girl that is main Portuguese speaker, who chose the "*Student 1 option*", and they also provided insufficient argument for their choices. However, from the first cluster showed some constraints in the written language to produce their justification, deriving, perhaps, from their low language proficiency of the medium of instruction.

On Item 2:

Item 2: - "I thought of a number, and calculated its quadruple. To this result I added the quintuple of the number considered, divided by itself. Then I subtracted twice the number I had thought of. As a final result I got the number 11.

Question 2: What is the number that I thought of? *(Write down your reasoning and procedures in solving the problem)*

Item 2 is explicitly referred to as a simple algebraic word problem in esoteric domain text, though it includes some complexity in the grammatical structure. The sentence (in Portuguese language, "*Pensei num número e achei o seu quádruplo*", might be considered containing a level 2 complexity in the following way:

[*Pensei num número [e achei o seu quádruplo*]]
[*número pensado [achar o quádruplo do número*]]

In Portuguese, when the sentence is written in first person - singular or plural - the pronoun, 'I' or 'we', is omitted, since the concordance is made by the termination of the verb. The coherence and lexical cohesion is assured by reference to the use of the term '***seu***' meaning '***its***' referring to the number previously thought of. Otherwise the text sentence would be longer and repetitive in writing:

"*Pensei num número e achei o quádruplo do número em que pensei*"
[I thought of a number and I calculated the quadruple of the number thought of].

The second sentence, "*A este resultado adicionei o quíntuplo do número pensado dividido por ele mesmo*", might be decomposed in the following way:

[*adicionar [número pensado [seu quíntuplo [dividir este produto pelo número pensado] (dito dividido por ele mesmo*)]]].

[Adding [the number thought of [quintuple (i.e. multiplying by five) [dividing the result quintuple of the number thought of by the number thought of] (as is said divided by itself)]]].

The expression "*dividido por ele mesmo*", meaning 'divided by itself', refers to the number thought of not including the quintuple of the number. Yet the possibility of an incorrect interpretation is not ruled out and respondents might divide the result of the multiplication by five. The recursive depth is high.

The next sentence: "*Ao resultado obtido subtrai o dobro do número inicialmente pensado*" explicitly takes into account the previous one and continues with a sequential explanation which might be decomposed in this way:

[*Ao resultado obtido [subtrair [dobro [número inicialmente pensado*]]]]
[To the obtained result [subtract [twice [the number initially thought of]]]]

The high recursive depth of this sentence comes from the fact that it considers the result of the sequential events up to now and the subtraction of double the number thought of at the beginning. The "number thought of" is repeated to provide coherence.

The next sentence: "*Como resultado final obtive o número 11*", i.e., "as final result I got the number 11", is clearly of level 1 in terms of grammar complexity but the "final result" has to be understood to relate to the whole previous process, only said by referring to it as "final".

Finally the sentence, "*Encontre o número em que pensei*", i.e., "Find out the number I thought of", specifies the task to be done by the respondent. The grammar complexity might be considered to be of level 1 as the sentence does not require any decomposition.

In terms of the specificity of terminology the term "*encontre*" (= find out) may not be precise enough to denote a mathematical activity. It could also mean one can guess the number. In fact, there are such games, for example, "I'm seeing something beautiful that some of you would like to play with. What is it?"

On this item 2 it was found that the students' achievement centered around 50% in all status groups, which is low considering the similarity to the previous item. There were some common aspects between the first and third cluster. In both groups the students did not use a mixed formal-informal strategy, the formal strategy being more common (64% and 70% chose a formal approach, and 36% and 30% recurred to an informal strategy). Less students from the middle status cluster recurred to a formal strategy, and the others used a mixed (24%) and informal (29%) approach. The low achievement of students in this item can be assumed to be partly due to the students' low proficiency in the medium of instruction. Tables 7 to 10, yet presented, grouped students' achievement by first and most spoken languages show that the lowest proportion of correct solutions (44%) is from native language speakers group and the highest from students who use both Portuguese and native languages simultaneously (60%).

On Item 3:

Item 3: - In the School Library, every day, books are ordered and/or returned by students or teachers. The table below shows the available books by topic, books ordered and returned daily:

Topics	Number of books		
	in the library	ordered	returned
Portuguese	60	p	p'
Geography	45	g	g'
History	80	h	h'
Biology	40	b	b'
Physics	75	f	f'
Mathematics	90	m	m'
Chemistry	50	c	c'
Total	440		

Question 3: What does each of these expressions tell you?

<u>On Friday</u>:

a) $60-p=40$;

b) $45-g+g'=45$;

c) $(h'+c'+f')>(h+c+f)$;

<u>On Tuesday</u>:

d) $90-p+p'=50$;

e) $c'=15$;

f) $c=12$

<u>On Monday</u>:

g) $440-(p+g+m+b+h+c+f)=0$.

Certainly, the students usually attend the school library, but they do not think in terms of possible applications of school mathematics in the organization of a library. Neither do librarians need awareness or explicit use of mathematics in their work routine. Thus, this item is typical of school mathematics. Except for the short introductory text, the item is represented through strongly institutionalized expressions using symbols and variables. It can be considered to be descriptive domain text [about loaning (if the book is not in the Library) and returning (if the book is physically in the shelf) books]. The respondents must interpret the algebraic expressions in everyday terms (weakly institutionalized signifiers). So it can be seen as a prompt to produce public domain text. The relevance of the item in terms of access to forms of algebraic knowledge lies in capturing the students' interpretations of relationships between the variables. The variables, in the questions for different days, can be interpreted as "unknowns". Being able to produce an answer relies on language proficiency. As to the plausibility of the relevance of the information represented by the expressions for transactions in the library the expressions are different, even though they are all 'translatable':

<u>On Friday</u>:

- Expression a) assumes that someone (the librarian) knows the stock of Portuguese books and knows that there are now 40, perhaps the ones still in the library on Friday evening, and would want to know the number of ordered (on loan) books.
- Expression b) assumes that the librarian knows the stock of Geography books and she/he knows that are now 45, meaning that on Friday any book loaned or all loaned books were returned.
- Expression c) assumes that the librarian knows the stock of History, Chemistry and Physics and knows that on Friday the returned books quantity of these disciplines is greater than the loaned one.

<u>Tuesday</u>:

- Expression d) assumes that someone knows the stock of Portuguese books and she/he knows that there are now 50, meaning that at end of the journey the amount of loaned books is greater than of the returned ones. The expression d) $90-p+p'=50$ refers to Portuguese books. In the given table the stock of Portuguese books is 60. Besides translation of the expression it is expected from the participant to realise the difference between the available stock and this expression d).
- Expression e) assumes that the librarian knows the stock of Chemistry books and knows that on Tuesday 15 books were returned.
- Expression f) assumes that the librarian knows the stock of Chemistry books and knows that on Tuesday 12 books were loaned.

<u>Monday</u>:

- Expression g) assumes that the librarian knows the stock of all books in the library, and knows that now any book is available, i.e. on Monday all books are loaned.

It is of interest whether such subtle differences in "realism" make a difference for the students' interpretations. Thus, item 3 is not in essence a typical mathematics classroom task, but the question amounts to a school mathematical perspective of the stocks of books in the school library, and librarians and library users do perhaps not interpret it from that perspective. That is why here the students' achievement has been looked first of all in relation to their understanding of the purpose of the question. Generally, this understanding turned out to be very low. The students from the first cluster, with all but one being main native language speakers, achieved 50%. The second cluster, with 47% of students' main native language speakers, achieved 47%. The third cluster, with only 30% mostly communicating in native languages achieved 40%. These results do not indicate an advantage of being from the Portuguese main speaker group, which is of course the medium of instruction in Mozambique, neither is there an obvious link to the social status assigned to the students in the three clusters.

On Item 4:

Item 4: - A moving cinema sells children's tickets for half the adult price. Knowing that 5 adult tickets and 8 child tickets cost a total of 180.00 MT (Mozambican currency) how much does the adult ticket cost? (*Write down your reasoning and the procedures in solving the problem*).
Question 4: - (*this is a word problem*)

The item 4 looks like a typical school algebra task and that it can be solved in an elementary standard way. The first sentence in the item: *"Um cinema móvel vende bilhete para criança a metade do preço do bilhete para adulto"*, i.e., *"A moving cinema sells children's tickets for half the adult price"*, can be decomposed into two levels of complexity:

[*Preço do bilhete de adulto (incógnita) [Preço do bilhete de criança) (metade da incógnita de adulto*)]]

[Adult ticket price (an unknown) [child ticket price (half of the adult unknown)]].

The second and last sentence, "*Sabendo que cinco (5) bilhetes para adulto e oito (8) bilhetes para criança custam 180.00 MT, quanto custa o bilhete para adulto*?", i.e. "Knowing that five (5) adult tickets and eight (8) child tickets cost a total of 180.00 MT, how much does the adult ticket cost?", it is connected by the words 'adult ticket' and 'child ticket'. This sentence may be decomposed recursively in two levels: [*Preço do bilhete de adulto [5 bilhetes de adulto por preço, 8 bilhetes de criança por metade do preço, montante gasto*]]. [Adult ticket price [5 adult tickets times' unknown price, 8 child tickets times' unknown half price, spent amount]].

In item 4 the students' general achievement was a little better and looking at the clusters, the first and third achieved a solution rate of 50% and the second cluster the highest with 82%. The most important feature in this item was considered to be linked to students' disposition in re-contextualizing an everyday (public domain) task into a school mathematical description. Altogether, the students had a preference for not doing so, but chose to approach the tasks with an informal strategy (ca. 63%). However, there were in fact differences in the choices between the statuses groups, independently of their mathematics achievement expressed in their school marks. The students from the low status cluster more often choose an informal approach (72%), but there were also quite many in the high status group (60%), but only around half of the students from the middle status group did so. It was only in this middle group, where students also used mixed strategies. In general, the girls tended to prefer to approach the task from an informal perspective and not to use school mathematics. For the first cluster the high percentage of students using an informal strategy can reflect the tendency of low social status groups found in other investigations, as does the girls' preference.

<u>On Item 5:</u>

Item 5: - The perimeter of a rectangular plot does not exceed 330 meters. The length is *2x+5* and the width is *2x*.
Question 5: a) Find the possible range of 'x'. b) The owner of the plot intends to construct a swimming pool with maximum area. Find the dimensions (length and width) satisfying this purpose. (Write down your reasoning and the procedures in solving the problem).

This item 5 represents a task that can be solved by a simultaneous linear inequality in two unknowns, presented in the form of a standard word problem, with a short narrative expressed through strongly institutionalized mathematical signifiers (such as, *"x"*, *"2x + 5"*). A look at textbook tasks used in the school, particularly word problems related to inequalities and simultaneous, revealed eight types of word problems based on questions like:

- Find the integer verifying the inequality.
- What is the integer of which the sum is greater than two times…?
- Determine a set of real numbers verifying the following conditions…
- Knowing that the perimeter of a rectangle isn't greater than 100, and knowing the length is $2x+\frac{1}{2}$ and the width is $x-\frac{1}{3}$, determine x.

As can be seen, item 5 is presented as a standard word problem through strongly institutionalized mathematical signifiers. The introductory sentence "*O perímetro de um talhão rectangular não excede 330 metros*", in English 'The perimeter of a rectangular plot does not exceed 330 meters', has to be performed recursively in three levels of depth:

[Perímetro de um talhão rectangular (significado e formula) [não excede (significado e símbolo em linguagem matemática) [330 metros (estabelecer ligação)]]].
i.e.,
[Perimeter of rectangular plot (meaning and formula) [does not exceed (meaning of this in mathematics language/symbol) [330 meters (establishing the link/connection)]]].

The second sentence

"*o comprimento mede 2x+5 metros e a largura mede 2x metros*",
i.e.
'The length is *2x+5* and the width is *2x*', is only connected by 'length' and 'width' that have to be seen as belonging to 'perimeter' and 'rectangular plot'.

So, the necessary decomposition to understand the sentence should be:

[O comprimento mede 2x+5 [(significado da medida e associar a expressão em x)] [largura mede 2x [(significado da medida e associar a expressão em x)]]
i.e.,
[The length is 2x+5 [(meaning of the measure and associating to the expression in x)] [the width is 2x [(meaning of the measure and associating to the expression given in x)]]

The third sentence is the first sub-question asked,

"*Calcule o intervalo possível de x",*
meaning that,
"Find the possible range of *x*".

It does not require any decomposition as it is performed in only one level although it embodies in itself a complex concept, the 'possible range of x'.

The fourth and fifth sentence is the sub-question asked,
"O proprietário do talhão decidiu construir uma piscina com área máxima do espaço disponível. Calcule as dimensões (comprimento e largura) que satisfaçam o propósito",
i.e.
'The owner of the plot intends to construct a swimming pool with maximum area. Find the dimensions (length and width) satisfying this purpose'.

So, item 5 was fully solved only by two students, when measured by mathematical exactness as well as the interpretation of the results in the context, but there were quite many (68%) who produced partially reasonable solutions. As to differences between strategies of students from different status groups, there were none. All the twenty eight students who tried to solve the item recurred to a purely formal strategy. All the students seemed to recognize the task as a typical school mathematics question. That they ignored the context when interpreting their results might be due to a lack of experience with swimming pools. For the same reason nobody got "distracted" by making too much context-related assumptions and considerations, which would have resulted in seeing it as a task with incomplete information (e.g. that there is no border around the pool). As to the more highly specialize esoteric school mathematics, there were only two students from the high status group, who answered the theoretical question about the "range of x", while many more came up with measures for the pool.

IV. Discussion and Conclusions

In the present study, language proficiency was not been measured by any test; instead achievement and solution strategies were explored in relation to the students' language use. In the background questionnaire the students were asked, in which language they learned to speak, i.e. their first language, and also about the language they frequently use: *at home, with friends, neighbors and classmates or school colleagues*.

Students' marks at school in all eight main disciplines of the lower secondary school (Portuguese, English, History, Geography, Physics, Biology, Chemistry and Mathematics) have been retrieved in the study. These subjects are divided into two blocks, the natural sciences (Biology, Chemistry, Physics and Mathematics) and the humanities (Portuguese, English History and Geography). There was not found any relationship between the students' marks in Portuguese and in Mathematics when comparing their school marks. Altogether only four students (from 41) had "unsatisfactory" as their marks in Portuguese, whereas in mathematics these were 16 students. Three of these four who are below pass in Portuguese, also have unsatisfactory marks in mathematics, but in none other subject. Six who have the minimum points to pass in Portuguese, which is a big group between a third and a half of all students, do not pass in mathematics. The other seven, who do not pass in mathematics, have marks in the category "satisfactory" in Portuguese that are higher than the minimum. The next level, "good", is only reached by two students in Portuguese and they reach this also in mathematics. From the 16 who did not get satisfactory marks in mathematics, there are only four who not at the same time have a mark below the threshold in at least one other subject. Two of the four who have insufficient marks only in mathematics are in the fourth language group (both, their first language and the most spoken language being the native one), one has Portuguese as the first language but mostly communicates in a native language, and for another one this is the other way round. Despite their weak marks in mathematics, three of these students performed well in the written test, solving at least four of the five tasks. There is no obvious pattern in the students' marks in relation to their first and most spoken languages. In particular, it is not possible to say that the students who have Portuguese as their first and/or most spoken language have better marks than others. However, the students who have a native language as their first language and also predominantly use this as a means of communication outside school (n=18), are most diverse in their mathematics marks, as there are quite many (6 students) with insufficient marks but also the same number of students with mathematics marks higher than 10.

If the item test of this study "measures" competence in relation to what the school marks reflect, then in the case of mathematics it did not "measure" the same, as there is no obvious relation between students' succeeding in solving some of the tasks from the test and their marks in mathematics. This is not surprising, as there was only one task that reflected the students' present curriculum content (item 5, the swimming pool task), and another one that tested their basic arithmetic knowledge (item 1). The other tasks were developed to investigate the students' skills in looking at descriptions of everyday activities from a mathematical point of view, that is school algebra, translating a verbal statement about a transformation of an "unknown" into an equation, or to contextualize algebraic expressions in a context described in the task. Given that the curriculum can be characterized by establishing strong boundaries towards out-of-school knowledge, that is, by strong external classification, these activities do not reflect what the students' normally are asked to do.

Looking at the "average solution rate by student" for the items in the written test in the four language groups (all four combinations of first language and most spoken language), this is in all groups between 2 or 3 test items (out of 5) per student. The same applies to the three status groups. But there are patterned differences visible for the different tasks and also in the solution strategies chosen by the students, also for those who did not reach a final solution.

Although, looking at the students' success in the different types of item tasks which they were asked to answer, comparing with their main and/or most spoken languages and their first language (their mother tongue), there is indeed some evidence of a systematic relationship, but also there are some other patterns to be observed. As to the group in this study called "main Portuguese speakers" (n=11), whose the first language is Portuguese and who also mostly communicate in this language, only on item 5 they outnumbered those who had the native language as first language but communicating mostly in Portuguese (n=7). Also those having Portuguese as first language, but communicating mostly in native languages (n=5), performed at the same level or better than the "main Portuguese speakers", except in items 4 and 5.

So, one can find several possible explanations for this fact about which to speculate. The observation that the students using their second language more often than their first language in everyday conversations (independently of the fact whether their first language is Portuguese or native) performed better than main Portuguese speakers in items 1, 2, and 3, and with a smaller difference also in item 4, calls attention to the findings from studies on mathematics learning which show advantages for bilingual students when compared with their monolingual peers. But whatever the notion of bilingualism considered in some studies, they are from contexts where both languages are also used as a written language, which, up to this stage is still not the case in Mozambique. Here only Portuguese is used as the medium of instruction and also the language in which they learned how to write and read. Obviously, for this little group of students with mixed language use (n=12) it does not make a difference for solving the tasks from the study, whether their first language is the medium of instruction or not, as long as they use the other language for communication, a practice, which perhaps amounts to a special form of bilingualism. This outcome is less interesting for the arithmetic task (item 1, choice of right calculation with justification), but more interesting in terms of their success in the tasks that asked for a translation of an algebra-word problem (set up in a purely mathematical context) into an equation (item 2), or translating equations and inequalities into context-related information for a context described in the task (item 3, the library task). The algebraic word-problem included some sentences with a complex grammatical structure, whereas the latter task asked for constructing some consistent phrases and also for recognizing what it is all about, which turned out to be the biggest difficulty with this task. Both tasks are about switching register. The same group of students also managed quite well the item 4, which could be approached without switching from everyday vernacular to school algebra, but through applying basic numeracy skills. All three tasks on the item 2, 3 and 4 seem to rely on some flexibility in changing perspective and register.

Given the students' background, one can assume that their everyday communication centers mostly on domestic organizational and practical issues, no matter in which language. Numeracy practices (shopping, trading) are usually done in Portuguese, as is all official communication with public service and administration. Written communication is also mostly in Portuguese.

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