Author Mozambican Students' Understanding of Algebraic Language and Logical Reasoning

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Abstract
The language of instruction in Mozambique is Portuguese and the curriculum still promotes a comparatively formal version of school algebra. As all programmers in upper secondary school include mathematics, the students who master it are privileged for careers in tertiary education. There is agreement about the fact that mathematical and scientific language organizes meaning in a different way than unspecialized everyday language, and that mathematical language is decontextualized as the things to what it refers can remain unspecified. In the light of these observations, the study set out to explore students’ inclination to engage with decontextualized language and logical reasoning.

Keywords: Logical reasoning, algebraic language, everyday language, decontextualized language

1. Introduction
During last three decades researchers have studied students’ problems with the learning of formal algebra, especially at the beginning of the learning process when learners are introduced into the subject (see e.g. [22]). It is not possible to synthesize results, as those studies were conducted from various theoretical perspectives, which are not based on common assumptions, such as the following groups of approaches:

- Cognitive psychological, which includes Piagetian approaches, embodied cognition, constructivism, and/or those who do not consider any theory.
- Sociocultural, which includes Vygotskyan approaches, situated cognition, activity theory, communities in practice, social interactions, socio-semiotic approaches, social psychology and discourse analysis.
- Sociological, which includes sociology of education, hermeneutics and critical theory.

Such research has been done within the following contexts:

- Mostly in developed countries, using typical schools for case studies, with the findings reflecting this specific context.
- In countries where the medium of instruction is English and policy makers and curriculum developers do not take into account the languages and cultures of minorities. Examples are from Australia, United States of America (USA), and the United Kingdom (UK).
- In countries where the medium of instruction is the language of the power and policy makers and curriculum developers do not consider the mother tongue of the majority of students. Examples are from Australia, Papua New Guinea, some regions of USA where the majority of inhabitants are Hispano-Americans.

A point commonly made by researchers is that the central feature of the algebra is the symbolic system considered to be the algebraic language, which can be described by the concept of a specific mathematics register1. Regarding the article purpose it seems fundamental to present literature based on different views of "language". In these aspects should be important to analyse language proficiency and success in school mathematics, also school policy and awareness of the relevance of language. As stated in [30], language proficiency, however it is defined or measured, is in many ways, important for mathematics achievement. From research carried out in the USA, he also reports that for bilingual Puerto Rican adults in a test including logical reasoning, conducted in English and Spanish, the reading performance in English was a factor for the logical reasoning [30]. The study by [10] for example, showed poor performance in mathematics of British ethnic minority students with low proficiency in their mother tongues. The international PISA study (Programme for International Student Assessment) from the OECD claims to measure “reading literacy”, which is meant to be not just surface language proficiency. The study shows relatively high correlations between the sub-scales of

1 Within social functional linguistics, a register is a set of meanings that is appropriate to a particular function of language, together with the words and structures that express these meanings. We can refer to a ‘mathematics register’ in the sense of the meanings that belong to the language of mathematics ([16], 195). A mathematics register uses specific grammatical constructions to emphasise particular relationships between ideas.
mathematical literacy and the ones for reading and science literacy. This means that the tasks do not differentiate between these “literacies”, but it also means that much of the test results can be explained by a common factor. Reading skills, in the widest sense, are certainly important for answering the mathematics questions, especially given the fact that in that test these are mostly contextualized tasks (word-problems) [21].

In [27] also is pointed out that by importing theories from linguistics, there is a danger of misreading and simplifying, and she states that there is a difficulty in agreeing what is meant by ‘language’. On another hand [9] suggests that a certain level of linguistic proficiency seems to be in general necessary for academic achievement, but not language as such, but skills in a certain type of language. According to [9] there are two different types of language, both are related to thinking, one involved in social everyday interactions, and another one involved in decontextualized academic contexts. This differentiation resembles many other ones, e.g. also by [18] or [3], who adopt a sociological perspective.

In [28] is also suggested that it is necessary to move away from simplistic views of language as vocabulary and also acknowledge that there is a variety of different mathematical discourses. In this study language is seen as tool for communication in social interaction and as a cultural tool. However, when in the following text the term language is used, it often only refers to the name of the medium of instruction (the Portuguese language) or other languages spoken in Mozambique. When the term language proficiency is used, it refers to the degree of fluency in a language, written or spoken, but not in any specialized register of this language.

From the above evidence a question to be asked whether those who set up educational policies are aware of the importance of linguistic fluency in the language of instruction for the learning of mathematics in school. As a research response there are findings and arguments showing that in some cases policy makers and curriculum developers do not consider learners’ main language(s) as a factor in the learning process that should be given priority. Examples supporting this statement are from the US, Spain, Ireland, Papua New Guinea and Australia:

- In [25:7] is claimed: “In the US many high schools ignore the language and literacy needs of recent immigrant students. Also teachers with little preparation and sometimes no mathematics background are regularly placed in classrooms with immigrant students and bilingual youth”[25].
- In [15:8] is stated that “The Catalan educational administration considers that there is no possible regular access to the curriculum before having acquired a high competency in the official language of learning”.
- In [29:395] is stated that Gaeilge is more accessible to the majority of people now (media, increase in language provision, advertising, etc.) and attitudes have changed towards the language and its use in daily life in Ireland. This reflects the significant increase in Gaeilge-medium education provision within the country, a provision that continues to increase annually. This a research done in Ireland where the researcher intends to extend this in examining the socio-political and cultural influences on the development of the mathematics registers through the medium of Gaeilge in Ireland (p. 395).
- In [6:428] stated: “The present government policy of limiting the use of non-English languages to just six months of schooling may be far too restrictive”.

The last point in the list above refers to research done in Papua New Guinea, where the missionary schools before the 1960s utilized local vernaculars for teaching. After the 1960s the national government adopted English as the official language and the medium of instruction. In 1989, however, it changed its official policy and decided that the first six months of schooling should be in the local vernacular [6:418]. Regarding the change of official policy it can be considered a positive aspect but six months is a very short period to acquire proficiency in English, the medium of instruction in that country. The experience presented by [7] refers to Australia:

- [7:1] States: “Curriculum developers rarely had language as a priority in the school mathematics materials that they published, and for that matter researchers did little to problematize this area of learning.”

In Australia there are more than ten different languages, but many teachers are monolingual English speakers and they consider that children would cope with mathematics as soon as they mastered the symbols and manipulation of those symbols. These five examples in five different countries show that policy makers and curriculum developers often do not consider learners’ main languages and cultural background as a priority in the teaching and learning process.

To explore this particular theme my interest stems from [11] work about validity and relevance: comparing and
combining two sociological perspectives on mathematics classroom practice. In some way is argued that social class is determinant and influential in students’ strategies in when solving school mathematics tasks. The idea resonates with [1] [2] [4] [5] in discussing symbolic control and identity, codes, modalities and the process of cultural reproduction. [20] Presents a theoretical model for the reproduction of social class differences through pedagogies, and argues that for middle class learners school is a hidden subsidy (cf. [1] p. 133) in that it facilitates school learning. When middle class and working class children go to school they experience the form of communication in the school differently [20:27]. On one hand, [19] points to substantial differences of pedagogic modalities’ those teachers use according to the social class of the learners. For working class students the teachers use a ‘horizontal modality’, where there is a weak potential for the specialization of learners’ voice with respect to the reproduction of school knowledge (p. 23), while for middle class students there is predominance of a ‘vertical modality’ where learners are treated differently, as having different learning competences and requirements (p. 24). This means that the pedagogic modalities lead to differences in mathematics achievement. In the particular case of South African primary schools in Hoadley’s study, the teachers, students and schools were purposively selected in order to include a variety with different conditions leading to differences in expected pedagogic practices [20]. In general these research and findings were in developed countries, so considering Mozambique in an opposite extreme I intended to find similarities or not.

2. Materials and Methods

2.1 Sample and Data Gathering

The study adopted a discursive approach for learning mathematics, and then based on this theoretical perspective, 8 students were selected (in a sample of 41 students involved in whole study). The participants’ students filled a background questionnaire where they have been asked to state their first language and also to say in which language(s) they mostly communicate outside school or with classmates outside the lessons. Data were gathered at a school in a semi-rural area, and the following criteria influenced the selection of the study site:

- A public secondary school (less expensive, no restrictive, acceptable infrastructure, willingness),
- a school situated in a semi-rural area and not too far from the town (condition to have mixed social status at school and /or classroom),
- a school easily accessible by road, even during rainy seasons, and
- Researcher familiarity with the local languages spoken in the site and habits.

A logic task was set up as a collaborative problem solving activity for the students to work in small groups and their talk was audio taped. To have it as group task is to bring out students’ argumentation and orientation towards the task. The task is not typically mathematical itself but given in the mathematics classroom, somehow, permits evaluating in which perspective students discuss and argue, i.e. if they discuss it in their everyday context or in an appropriate manner. Putting it in [4] terms, if they have access to the recognition rules (meaning individuals are able to recognise the speciality of the context they are in) and realization rules (meaning the production of the expected legitimate text). For this purpose eight students were selected to form three working groups. The main criteria to be selected for the logic task are students’ willingness, social status, and gender. The working group was given forty minutes for discussing and giving the response and/or conclusion. This time frame seemed to be sufficient.

2.2 Logic Task

Magaia, Manhique and Sumbane live in this district. They plan to travel: One will go to Maputo, another to Bilene and another to Kruger Park Reserve. You know:

1. Magaia borrows a car from the person who goes to Maputo.
2. The person going to Maputo and Manhique both go with their children.
3. Magaia will stay longer than the person who goes to Bilene Beach.

Who goes where?
(Magaia, Manhique and Sumbane are family names very common and known in the region. It is also common to refer to people by their family names).

2.3 Task Solution
This task has been constructed so that it can be approached in two ways. One can read it as a narrative about people who are planning to travel and conceptualize it as a task related to domestic and leisure time activities. On the other hand, it can be considered as a purely logical task that can be solved by completely ignoring all local information about the context. However the problem can be considered as a school mathematical task because of its closeness to formal logic and, from a sociological point of view, because the students have been asked to solve it within the mathematics classroom which is considered as an implicit mathematical framing. In order to answer the question, the students have to contextualize the task as a logic one, and with this lens they need to consider only three travelers, three destinations and the linguistic structure of the three sentences/conditions about relations between the three travelers. Reading the three sentences only with respect to this relevant content gives:

- The first sentence allows concluding that Magaia does not go to Maputo as he borrows something (a car) from the person who goes to Maputo. The third sentence allows concluding that Magaia does not travel to Bilene Beach as it states that he (Magaia) does something different (stay longer) from the one who goes to Bilene Beach. Magaia is excluded from two destinations in a range of three, which means he travels to the third one: Kruger Park Reserve.

- The second proposition excludes Manhique from the destination Maputo and it is known that Kruger Park Reserve destination is taken by Magaia, so the one left for Manhique is Bilene Beach. Consequently Sumbane goes to the remaining destination Maputo.

Amongst several strategies in solving this task, one could utilize a table (see Tables 1, 2) presenting the three travelers and the three destinations and then interpreting and analyzing the proposed conditions, ticking for example N (meaning no) and Y (meaning yes): The first and third sentences permit ticking N in the first and second destination columns for Magaia, the second sentence permits ticking N in first destination column for Manhique.

<table>
<thead>
<tr>
<th>Traveler</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maputo</td>
</tr>
<tr>
<td>Magaia</td>
<td>N</td>
</tr>
<tr>
<td>Manhique</td>
<td>N</td>
</tr>
<tr>
<td>Sumbawa</td>
<td>N</td>
</tr>
</tbody>
</table>

From the table it is then possible to conclude who goes to Kruger Park Reserve by reading off the rows, and to Maputo by reading off the columns and so one could tick Y (YES) in to read off the conclusion (see Table 2):

Table 2: The solution to the logic task

<table>
<thead>
<tr>
<th>Traveler</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maputo</td>
</tr>
<tr>
<td>Magaia</td>
<td></td>
</tr>
<tr>
<td>Manhique</td>
<td></td>
</tr>
<tr>
<td>Sumbawa</td>
<td></td>
</tr>
</tbody>
</table>

For this or a similar strategy one needs to understand the exclusiveness of the destinations and the one-to-one mapping between people and destinations together with the representational format one has chosen.

The task is expected to show the students’ preferred approach to contextualize questions and to investigate relations between their tendency to ignore context information and pay attention to meta-linguistic features of the text (negation, exclusion). It will help to study the relationship between the students’ disposition to attend to logic in relation to their success in school algebra, as stated in the research questions.

2.4 Language Difficulties of the task

In the light of the study’s purpose the language of the test items is important, taking into account that on the one hand most of the students are not main Portuguese speakers, and on the other hand they are from a disadvantaged social status. Morgan, Tang and Shard’s analysis of mathematics language [23] fits for the language complexity analysis required for the written questions. The analysis below includes also the sentences’ lexical cohesion, i.e. how the phrases are connected, and focus on what [23]. Call recursive depth, i.e. the possible decomposition to make a language unit become easily perceptible. In the following, these issues will be discussed for each of the written test items. The goal was not to make the test “easier”, as it should reflect the language use in textbooks and tests. The analysis below is
to create awareness for some sources of difficulties the students might face. The text is written relatively low language complexity. The first sentence tells the reader where the subjects live. Magaia, Manhique, Sumbane are family names and in the local context family names use to be male:

[Magaia, Manhique e Sumbane vivem neste distrito]
[Magaia, Manhique and Sumbane live in this district]

The second sentence ‘Eles planificam viajar: Um vai a Maputo, outro vai á Praia de Bilene e outro vai à reserva de Kruger Park’ tells the reader about the intention of travelling and the possible destinations for travelers. The third sentence ‘Sabes que’ (you know that), must be understood meaning ‘you only know’.

The sentences presenting what one knows are of level 2 recursive depth. They all qualify either the subject or an object of the sentence by means of a relative clause. The structure of the item, and also the numbering of the sentences, prompts the student to realize that the matter should be dealt with in a school perspective and not as a type of puzzle one might do in leisure time.

2.5 Main features of the selected students

Below the tables, follows some information about the selected students: Ana, Maria, Jaime, Filipe Dinis, Irene, Luisa and Sara.

<table>
<thead>
<tr>
<th>Status</th>
<th>Birth area</th>
<th>Language first spoken</th>
<th>Guardian degree</th>
<th>activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irene</td>
<td>Low Urban</td>
<td>Loc</td>
<td>Port</td>
<td>Parents On Own account</td>
</tr>
<tr>
<td>Sara</td>
<td>Rural</td>
<td>Port</td>
<td>Loc</td>
<td>Employed</td>
</tr>
<tr>
<td>Maria</td>
<td>Middle Suburb</td>
<td>Loc</td>
<td>Port</td>
<td>Employed</td>
</tr>
<tr>
<td>Luisa</td>
<td>Suburb</td>
<td>Port</td>
<td>Loc</td>
<td>Parents On Own account</td>
</tr>
<tr>
<td>Jaime</td>
<td>High Urban</td>
<td>Loc</td>
<td>Port</td>
<td>Mother</td>
</tr>
<tr>
<td>Filipe</td>
<td>Rural</td>
<td>Port</td>
<td>Port</td>
<td>Employed</td>
</tr>
<tr>
<td>Dinis</td>
<td>Rural</td>
<td>Port</td>
<td>Port</td>
<td></td>
</tr>
</tbody>
</table>

Port – Portuguese, Loc – local, degree - kindred's degree

Ana:

Ana is a sixteen year old girl, born in a rural area in the district. She is Ronga (local language spoken in Maputo City) first language speaker and uses this language mainly at home while she communicates in Changana with neighbors and friends. She only speaks Portuguese at school with teachers and classmates. Her father works in a public service and the mother works on her own account as livestock breeder. She lives with her parents in a family composed of seven members in a house built using conventional material equipped with electricity, running water, TV radio. She lives five kilometers from school needing about one hour walking and she has two meals per day, a lunch and a dinner. She has been classified as of middle social status. Here marks are displayed below.

<table>
<thead>
<tr>
<th>Port</th>
<th>Eng</th>
<th>His</th>
<th>Geo</th>
<th>Phys</th>
<th>Chem</th>
<th>Biol</th>
<th>Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>12</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>11</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Maria:

Maria is sixteen years old, born in a rural area in the district. She is Portuguese first language speaker and she uses this language in communicating everywhere: home, school and neighborhood. Her father works in the public sector and the mother in a private company. She lives with the parents, in a family composed of eleven members in a house built using conventional material with electricity, TV and radio, but no running water. She has four meals per day: breakfast, lunch, snack and dinner. Maria lives five kilometers from school needing about one hour walking. According to the construction of the status clusters she is integrated in the middle cluster. Below are her marks for grade 10. For grade 11 in upper secondary she chose the science section where Portuguese and English are compulsory for everyone.

<table>
<thead>
<tr>
<th>Port</th>
<th>Eng</th>
<th>His</th>
<th>Geo</th>
<th>Phys</th>
<th>Chem</th>
<th>Biol</th>
<th>Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>12</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>11</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>9.0</td>
<td>11</td>
<td>-</td>
<td>-</td>
<td>12</td>
<td>10</td>
<td>11</td>
<td>8.0</td>
</tr>
</tbody>
</table>

João:

João is a boy aged sixteen, born in a rural area in the district. His first language is Portuguese and he communicates also in Changana with friends and neighbors. João’s father is a farmer with a family composed by five members and a house built of conventional material (masonry) with electricity, running water, TV and radio. João has two main meals per day: lunch and dinner. He lives near to school needing fifteen minutes walking. He is classified as of high status. Below his school marks are displayed.

<table>
<thead>
<tr>
<th>Port</th>
<th>Eng</th>
<th>His</th>
<th>Geo</th>
<th>Phys</th>
<th>Chem</th>
<th>Biol</th>
<th>Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>13</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>11</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

Filipe:

Filipe is a sixteen year old boy born in a suburban area in the district. He is first language Portuguese speaker, and
he communicates also fluently in local languages. Filipe’s parents work on their own account as farmers and traders. He lives with the parents in a house built using conventional material, having electricity running water radio and TV in a family composed of seven members. Filipe has four meals per day. Filipe lives ten minutes walking distance from school. Filipe is classified as from high social status.

Table 7: Filipe’s School marks in grade 11 – 2010

<table>
<thead>
<tr>
<th>Eng</th>
<th>His</th>
<th>Geo</th>
<th>Phys</th>
<th>Chem.</th>
<th>Biol</th>
<th>Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>-</td>
<td>12</td>
<td>11</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

Jaime:

Jaime is a sixteen year old boy born in the centre of the country in an urban area. He is first language Portuguese speaker and he communicates only in this medium. He doesn’t speak the local language spoken in the district because he is born in Tete Province. Jaime’s father is a fisherman working on his own account with a family composed of five members. The parents’ house is built using conventional material. Jaime lives at a friends’ house with electricity, running water, radio, and TV. Jaime has four meals per day and lives near to school needing ten to fifteen minutes walking. Jaime belongs to the high social status group. His marks are shown below. Jaime was repeating the science section in grade 10 and he passed other disciplines one year before.

Table 8: Jaime’s school marks in grade 10 – 2010

<table>
<thead>
<tr>
<th>His</th>
<th>Geo</th>
<th>Phys</th>
<th>Chem.</th>
<th>Biol</th>
<th>Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>-</td>
<td>13</td>
<td>11</td>
<td>15</td>
<td>13</td>
</tr>
</tbody>
</table>

As can be seen from the table above, the selected students were not very successful in the written test, but some of their strategies, as well as their potential of solving the tasks interactively, were exhibited in the interviews.

Dinis:

Dinis is a fifteen year old boy, born in rural area in the district. He is first language Portuguese speaker, his main means of communication at home, but at school he uses the local language Changana to communicate with colleagues or classmates and also at home with neighbors. Dinis is son of a livestock farmer working in public service. Dinis lives with his parents in a house built using conventional material (masonry) with electricity, running water, radio, and TV. Dinis has three meals per day (breakfast, lunch and dinner) and he lives about one kilometer from school needing a few minutes walking to get there. His total “status points” allowed classifying him as of high social and economic status. In grade 11 in upper secondary Dinis chose the science section where Portuguese and English are compulsory subjects for everyone.

Table 9: Dinis’ school marks in grade 11 – 2010

<table>
<thead>
<tr>
<th>Port</th>
<th>Eng</th>
<th>Phi</th>
<th>Chem.</th>
<th>Bio</th>
<th>Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>10</td>
<td>12</td>
<td>11</td>
<td>14</td>
<td>15</td>
</tr>
</tbody>
</table>

Irene:

Irene is seventeen year old girl, born in suburban area in Maputo City. Changana is her first language, in which she communicates at home, with friends and neighbors. Irene communicates in Portuguese only at school and with classmates. Irene is a daughter of a fisherman working on his own account and she lives with her parents in a house built using precarious material (reed, grass, straw) with electricity, TV and radio but no running water. The family is composed of nine members and she has three main meals per day (breakfast, lunch and dinner). She lives five kilometers from the school needing about forty minutes walking. In the study she is classified as from low social and economic status. She has sufficient marks in all subjects except History.

Table 10: Irene’s school marks in grade 10 - 2010

<table>
<thead>
<tr>
<th>Port</th>
<th>Eng</th>
<th>Geo</th>
<th>Phi</th>
<th>Chem</th>
<th>Bio</th>
<th>Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>11</td>
<td>11</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

Luisa:

Luisa is a girl aged seventeen, born in suburban area in a neighboring district in the same province. She is Changana first language speaker, communicating in this instrument at home and in the neighborhood. Luisa communicates in Portuguese at school in the classroom and with colleagues and classmates. Luisa is a daughter of a medic working in the public hospital and her mother runs a small farm. Luisa lives in a house built using conventional material (masonry) with electricity, running water, radio, and TV. The family is composed by six members and Luisa has four meals per day. Luisa’s home is situated about three kilometers from school needing half hour walking. The achieved “status points” classified her as being of middle social status. She has sufficient marks in all subjects except mathematics.

Table 11: Luisa’s school marks in grade 10 - 2010

<table>
<thead>
<tr>
<th>Port</th>
<th>Eng</th>
<th>His</th>
<th>Geo</th>
<th>Phi</th>
<th>Chem</th>
<th>Bio</th>
<th>Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>12</td>
<td>10</td>
<td>12</td>
<td>10</td>
<td>11</td>
<td>8.0</td>
<td></td>
</tr>
</tbody>
</table>
Sara:
Sara is a seventeen year old girl, born in suburban area in the district. She is Changana first language speaker in which she communicates everywhere, except with teachers and classmates. There is no specific data about the parents’ activities; she states only that they work on their own account and they are liberal. She lives with her parents in a family composed of seven members in a house built using conventional material with electricity and TV but without running water. She has two meals per day (breakfast and dinner). The house is about three kilometers from school needing half an hour walking. According to the “status points” she belongs to the low status group. Sara is repeating grade 10. She has insufficient marks in half of the subjects, including mathematics.

Table 12: Sara’s school marks in grade 10 – 2010

<table>
<thead>
<tr>
<th>Port</th>
<th>Eng</th>
<th>His</th>
<th>Geo</th>
<th>Phi</th>
<th>Chem</th>
<th>Bio</th>
<th>Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>7.0</td>
<td>7.0</td>
<td>11</td>
<td>9.0</td>
<td>9.0</td>
<td>10</td>
<td>9.0</td>
</tr>
</tbody>
</table>

2.6 The students’ strategies for solving the task
The logic task was set up as a collaborative problem solving activity. The eight selected students were asked to form three small groups constituted as follow:

Table 13: Working groups for the logic task

<table>
<thead>
<tr>
<th>Group</th>
<th>Students</th>
<th>Age</th>
<th>Status Group</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Filipe</td>
<td>16</td>
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3. Results and Discussion

Each group was given forty minutes for a discussion and they also wrote their conclusions on a sheet of paper and gave back. Groups I and II wrote down the destinations that logically follow for each traveller, that is Magaia goes to Kruger Park, Sumbane to Maputo, and Manhique to Bilene Beach. Group III arrived at a different solution, namely Magaia goes to Maputo, Manhique to Bilene Beach and Sumbane to Kruger Park Reserve.

In the following the groups’ strategies will be discussed with a focus on whether they attended to the content of the “story” or did not do so in their arguments. The excerpts of the tape-recorded discussion given below are not exhaustive transcriptions of all what was said, but only show the discussion of the task and some other sentences are not included. Further, the language has been smoothened, as the focus here is on the base of their arguments and not on the conversation.

3.1 Group I discussion and solution
Filipe starts with reading out the text addressed to everybody and at the end Dinis asks for reading it again and Maria proposes an individual reading to get to understand it and explain to others. The idea was accepted and after a while the following argumentation occurs:

1) Filipe: We can affirm that Magaia doesn’t go to Maputo as he borrows a car from the person going to Maputo…
2) Maria: Yah, I agree, he does not go to Maputo, but this is not enough to know where he is going…
3) Filipe: Well, first of all he doesn’t go to Maputo. Dinis has any idea about it?
4) Dinis: The second sentence or second condition can be helpful to know the person going to Maputo because it says: The man going to Maputo and Manhique both go with their sons. It seems sure that Magaia and Manhique do not go to Maputo, then…
5) Maria: Yes you are right, Manhique is going to Bilene Beach as it’s said that he will be out of the district shorter than Magaia, according to the third sentence…
6) Filipe: Ok let us find Magaia’s destination knowing that he does not go to Maputo and he does not go to Bilene Beach according to the last sentence…
7) Dinis: Hah, then…
8) Maria: Of course he goes to Kruger Park Reserve, clear and easy you see…
9) Dinis: Ok, now and from the second sentence we know that Manhique does not go to Maputo then who goes there it is Sumbane isn’t it?
10) Filipe: If this is true means Manhique goes to Bilene Beach.
11) Maria: Yah, I think Magaia goes to Kruger Park as he borrows a car from Sumbane who goes to Maputo with his sons and Manhique also with his sons goes to Bilene Beach.
12) Dinis: Yah, going to Maputo and Bilene Beach with kids is fine and so good…
13) Filipe: Now the final response to the given task is…
14) Maria: Magaia’s destination is Kruger Park. Sumbane destination is Maputo and…
15) Dinis: At last Manhique goes to Bilene Beach with the kids.

Analysis of discussion and solution Group I:

In Group I the discussion is generally oriented towards a logical perspective, although Maria and Denis also keep attending to the details of the story. Filipe, who positions himself as a kind of group leader, right from the start argues by exclusion of alternatives revealing a point of view of logic, stating a conclusion about Magaia’s destination excluding Maputo as this traveller will borrow the car from someone in the group who in fact goes to Maputo. But he still mentions what is borrowed (the car), even if this is also irrelevant for drawing the conclusion. Maria agrees with Filipe but she also acknowledges that this is not yet sufficient information for making a decision about the other travellers. She does not however state what could be done to find that out. After that in turn 3, Filipe, repeating what has been found out, shows confidence in his reasoning procedure, is stating it as irrefutable and relevant truth. Again, establishing himself as a discussion leader, he invites Dinis to contribute to the debate. Dinis, in turn 4, also works from a logic perspective and he calls the second sentence a condition, which is a term not used in an everyday conversation about people travelling. He also introduces his contribution with a meta-statement, saying that the sentence is of use for determining the person going to Maputo. His analysis makes him exclude Magaia and Manhique for the Maputo destination. This interpretation is very much depending on understanding that the phrase ‘the man going to Maputo’ qualifies this unknown man as being the only one going to Maputo and that it does not qualify the other person connected with an ‘and’ in the sentence The man going to Maputo and Manhique both go with their sons.

Dinis also sees his conclusion as ‘sure’, but he hedges it by ‘it seems’. From Maria’s comment in turn 5 it is not entirely clear whether she draws on a principle of exclusion. She rather draws on her knowledge about the time it takes to travel to the places. Filipe’s logical orientation comes up again in turn 6. He also operates on a meta-discursive level in saying what they could do (using the last sentence). His turn can be taken as an invitation to the other group members to contribute. In turn 7 Dinis utters a kind of agreement or insight about the strategy proposed by Filipe. In turn 8 Maria (turn 9) draws on Filipe’s statement and concludes, assuming it is true, that Magaia goes to Kruger Park. Her meta-comment about it being easy and clear and her introduction with ‘of course’ positions her being in a position of agreement. In turn 9 Denis draws a tentative conclusion, inviting the colleagues to collaborate in the group debate. In turn 10 Filipe talks in conditional form about Denis’ conclusion presented in turn 9, presenting it as a hypothetical statement. In turn 11 Maria combines the conclusions so far made with the contextual information about the situations of the people involved. And in turn 12 Dinis picks this up, in agreement with Maria’s concern about these facts. In turn 13 Filipe requests a final solution, and first Maria (turn 14) repeats her insight about Magaia going to Kruger Park, adding what Denis has tentatively said before about Sumbane. In turn 15 Dinis adds the destination of the third person Manhique. He also includes in his statement that he is going with the kids.

In terms of the theoretical background of the study, one could say that the students exhibit different orientations towards the meaning, and differences in recognising the task as a mere logic exercise. Dinis, in his first contribution in turn 3 shows the recognition rules for the context in which the task was presented, arguing in terms of the function of the sentences’ meanings. In turn 9 his more logical perspective is confirmed, although in turn 12 he legitimates the truth of Manhique’s destination by associating it with the kids’ enjoyment. Maria does not seem to immediately recognise the criteria of the context in which the task was presented. Her first contribution in turn 2 was to complement Filipe’s statement. Maria’s statement in turn 5 supports the assumption that she argues from her context related knowledge in stating: “Yes you are right, Manhique is going to Bilene Beach as it’s said that he will be out of the district shorter than Magaia, according to the third sentence…” In the local context it is most common to go and stay at the beach for a short time for one day or a weekend, unless when someone has a family beach house for holidays, a reality for only very few Mozambican citizens. In fact Manhique (in the task solution) goes to Bilene Beach, but this is not related to a short or long time taken for the trip. Maria’s contribution in turn 8 confirms her tendency to complete or complement her colleagues’ reasoning. In turn 11 Maria concludes that Magaia’s destination is Kruger Park by mentioning the borrowed car and the kids. Filipe, as said above, mostly argues from a logic perspective, He only mentioned context-related information once, in turn 1, but does not use this as an argument. In the conversation he assumes a position of a moderator. Maria’s practical orientation would perhaps be something expected from the point of view of the theoretical background. She also has insufficient marks in the subjects Portuguese and mathematics, but she is a main Portuguese speaker. Filipe and Dinis were classified as “high status”. Dinis and Filipe
have better marks than many of the students from the study and were included in the high status group. Dinis is also a main Portuguese speaker.

3.2 Group II discussion and solution
Irene reads out the task and Sara listens. The Sara asks to read it herself saying she needs time to interpret it alone. Irene agrees and after a while the following conversation starts,

1) **Irene**: I think if I understand, Manhique goes to Bilene Beach because he isn’t going to Kruger Park and neither to Maputo.
2) **Sara**: How do you assume that Manhique goes to Bilene? From where do you bring this conclusion? Please explain.
3) **Irene**: In the second sentence it is said Manhique goes with his kids, and then it is very nice going to the beach with…
4) **Sara**: The person going to Maputo also goes together with his sons. He could be Manhique.
5) **Irene**: It shouldn’t be Manhique, attend to the sentence “the man going to Maputo and Manhique both go with their sons”. So it’s excluded the hypothesis for him to go to Maputo.
6) **Sara**: Yah, you are right, we know that Manhique does not go to Maputo.
7) **Irene**: How and from where can you affirm it?
8) **Sara**: From the first sentence in saying Magaia borrowing the car from the one who goes to Maputo. But Sara’s answer was not strong enough to be the main argument to draw conclusions about Manhique’s destination. In logical terms it was easier to support her statement from Irene’s previous conclusion in excluding Maputo as a destination for Manhique. In turn 9 Irene again repeats her argument with the kids, which she sees now even more confirmed. She also argues with context-related facts for the other two destinations. In turn 10 Sara agrees and suggests writing down the conclusion. In this she includes only context-related information as arguments. The final solution presentation shows clearly Sara’s or either local or practical perspective about the given task, associating and highlighting the travellers’ destination and with whom they are travelling and the purpose of the trip. Before, during the conversation, Sara insisted a little less on context-related arguments. It is not clear whether her statement in turn 8 was based on a logical analysis or not, but it is unlikely.

Manhique not going to Maputo and from the first about Magaia also is not going there and neither to Bilene Beach). In turn 2 Sara asks very explicitly for a warrant for this destination of Manhique. Irene’s answer in turn 3 reveals that she has drawn the conclusion from context-related knowledge about it being nice at the beach for the kids, and not from a logical analysis of the three statements. In turn 4 Sara counters the argument by pointing out that there is also another person travelling with kids (“The person going to Maputo”). Then, in turn 5, Irene seemingly switches to a logical argument by exclusion in pointing to the sentence *the man going to Maputo and Manhique both go with their sons*. From this, one could indeed conclude that Manhique cannot be the person going to Maputo. In turn 6 Sara seems to take this as the argument and states that then Manhique cannot be the one going to Maputo. But in turn 7 Irene in fact asks Sara for a warrant for this, revealing that she perhaps did not adopt a logical perspective in her previous statement. And then in turn 8 Sara says she has concluded this from the first statement about Magaia borrowing the car from the one who goes to Maputo. But Sara’s answer was not strong enough to be the main argument to draw conclusions about Manhique’s destination. In logical terms it was easier to support her statement from Irene’s previous conclusion in excluding Maputo as a destination for Manhique. In turn 9 Irene again repeats her argument with the kids, which she sees now even more confirmed. She also argues with context-related facts for the other two destinations. In turn 10 Sara agrees and suggests writing down the conclusion. In this she includes only context-related information as arguments. The final solution presentation shows clearly Sara’s or either local or practical perspective about the given task, associating and highlighting the travellers’ destination and with whom they are travelling and the purpose of the trip. Before, during the conversation, Sara insisted a little less on context-related arguments. It is not clear whether her statement in turn 8 was based on a logical analysis or not, but it is unlikely.

From the point of view of the theory background an orientation towards local meanings should be expected from the two students as Irene and Sara are from the low socio-economic status group. It seems that in the discussion they prioritise the arguments based on their knowledge about what one reasonably does in the context. Irene has better marks at school than Sara, as she has an insufficient mark only in History, while Sara has these in five subjects, including mathematics. Both are main local language speakers. Yet, they discussed the task in Portuguese.

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**Analysis of discussion and solution Group II**
In turn 1 Irene starts with the statement that Manhique goes to Bilene Beach, which could have been made from a logical perspective (i.e. from the second condition about
3.3 Group III discussion and solution

Jaime starts reading the text and then he grants a few minutes to the others to read and interpret it individually. Then they start discussing.

1) Ana: Yah I’m ready, it’s so easy to interpret it...
2) Jaime: Yah, go ahead then...
3) Ana: Yah, Magaia will stay out of the district for long time in comparison with the person going to Bilene Beach...
4) Luisa: Your statement helps us for what and in which way to answer the question?
5) Ana: Immediately we can assume that he does not go to Bilene Beach...
6) Jaime: And so…? Attention please, in the first sentence it’s said that Magaia borrows a car from the one going to Maputo, meaning that he isn’t going there.
7) Luisa: In my understanding that who is going to Bilene is Manhique because he takes his kids to enjoy...
8) Jaime: It seems right; we can assume that Sumbane will stay in the District I mean he is going to Kruger Park near to the border with South Africa.
9) Ana: Yah, Kruger Park is in this District. Sumbane goes there.
10) Luisa: Perfect, you are right it means who goes to Maputo is Magaia.
11) Jaime: Notice that Magaia borrowed the car from the person going to Maputo so it doesn’t make sense assuming that Magaia travels to Maputo.
12) Luisa: This was the plan, no body travelled yet. We assume what we concluded then....
13) Ana: Yah I agree, answering the question we say:
14) Magaia goes to Maputo because he will stay out of the District so longer than the person going to Bilene Beach
15) Manhique is going to Bilene Beach because he travel with his kids
16) Sumbane goes to Kruger Park because will stay in the District.
17) Jaime: That’s all we finished.

Analysis of discussion and solution Group III

Ana states in turn 1 that it is “easy” and after Jaime, who takes the role of the moderator, encourages her in turn 2, she points to the information from the third sentence, but she adds something that is not said there, namely that Magaia will “stay out of the district”. In turn 4 Luisa talks about the value of this for the solution, but does not suggest anything. In response, Ana in turn 5 makes the conclusion that Magaia can then not be the one who goes to Bilene Beach. This conclusion is not in accordance with him “staying out of the district”, as both Bilene Beach and Kruger Park are in fact out of the district. It is of course possible that she made her conclusion by exclusion from a logical point of view as the sentence says Magaia stays longer than the person going to Bilene Beach. In turn 6, Jaime requests attention and set out to analyse the first statement from which he rightly concludes that Magaia cannot be the one going to Maputo. In turn 7 Luisa contributes from a purely practical point of view arguing that Manhique goes to the beach because he takes the kids to enjoy it. By this she ignores the meaning of the whole sentence that mentions two people taking their kids (The person going to Maputo and Manhique both go with their children). Perhaps she attends only to that part where the name is mentioned. In turn 8 Jaime also adopts a practical perspective and talks about the proximity of Kruger Park that he assumes to be in the district. Ana (turn 9) agrees to the argument and she points out that Kruger Park is in the district and Sumbane goes there, as suggested by Jaime. In turn 10, Luisa, thinking the missing one is now Magaia’s destination, concludes that this person goes to Maputo. But in turn 11 Jaime again says what he said in turn 6, namely that the first sentence in the task excludes this possibility. He again mentions the car in his argument, even this is irrelevant. But then, in turn 12, Luisa reinterprets the meaning of the whole text in saying that the story only talks about a “plan” for travelling, and not what these people eventually did. So there is no contradiction from this point of view. Ana agrees (turn 13) and suggests producing a final answer. In this answer she takes up all the practical arguments made, including the one about being “out of the district” which is nowhere mentioned in the text. In turn 17 Jaime announces that they are finished with the task.

The group III achieved the right answer only for Manhique’s destination, but based this on an argument from a practical point of view, that is, that he takes the kids to enjoy the beach. The group’s justification also shows some limited knowledge about the geographic administrative division of the country. In addition to their attention to geographical conditions (albeit wrong ones), they attend to the purpose of the trip. The discussion was essentially in terms of local practices, except for some of Jaime’s intervention when pointing to the conclusion one can make from the first statement. Jaime, in some utterances, seemed to understand the perspective in which the task was given, but did not succeed in insisting on it. In addition he himself introduced a practical argument about Sumbane in turn 9. Ana and Luisa do not recognise the task as a theoretical question at all. Luisa’s reinterpretation of the story as only talking about a plan and not about the final destination shows that she did not
want to attend to the logic perspective mentioned by Jaime. In this group, Ana has sufficient marks in all subjects, Luisa has an insufficient mark in mathematics (an eight out of 20), Jaime has better marks, but he is repeating grade 10. Ana and Luisa are both main Local Language speakers and were classified as belonging to the middle status group, while Jaime is a main Portuguese speaker from the high status group.

4. Conclusions

The discussion in Group I, formed by two boys of high status and one girl from middle status, all main Portuguese speakers, with one boy having a local language as first language, was oriented towards a logical analysis although the girl intervened with some arguments from a practical perspective. The discussion in Group II, formed by two low status girls, who both are main local language speakers, was a more inclined to local and practical arguments, although some arguments reflected a logical analysis. They try to coordinate the two perspectives, with a preference for the context-related arguments. Group III was formed by two middle status girls, both main local language speakers, and one high status boy and main Portuguese speaker. This group was very much inclined to arguments referring to the practical context and they came up with a solution that did not adhere to the logic established in the text. The boy on occasion introduced a logical perspective, but also agreed to practical arguments.

Generally, the girls in the groups showed more inclination to attending to context-related features, including the ones who have been classified as being from middle social and economic status. The success in terms of school marks was to some extent reflected in the orientations of the participants. However, all of them did not solve many of the tasks in the written test. But from those students interviewed, it is not clear whether their orientation would be consistent across contexts. Ana (Group III), recognised the requirement in the “library task”, but Jaime (Group III) did not. Misrecognition of what was required in the test also came from Maria and Filipe (Group I). In the interviews about the word problem, the students were constrained to interpret the text as one whole, where the sentences are interrelated. This strategy of course also makes it hard to take into account the conditions of all three sentences in the logic task.

During the group work with the logic task, in all groups there was a tendency to discuss the trip of the three people from a practical perspective. There was one group formed by three students who mainly use Portuguese as a means for out-of classroom communication (one having a Local Language as first language), two boys from the high status group with comparatively good marks, and one girl from the middle status with insufficient marks in Portuguese and mathematics. As was anticipated by the theoretical and empirical background, this group was more oriented towards adopting a logic perspective although the girl did not share this perspective and brought in arguments about the purpose of the trip and the time it would take.

Another group formed by two low status girls, first and main Local Language speakers discussed entirely in a local perspective although some statements also denoted some logical argument by exclusion. One of the girls has insufficient marks in five subjects, including mathematics, the other one only in History. In their final solution, they exclusively included context-related information as arguments. The third group formed by three students, two girls of middle status, both first and main Local Language speakers and a boy from the high status group and main Portuguese speaker. In these group practical considerations also dominated, except for some of the boy’s contributions trying to remind the group to adopt a logic perspective. But eventually he also argues from a local perspective. The school marks of these students were sufficient, with one of the girls having an insufficient mark in mathematics. Altogether, there was a gendered tendency to adopt one of these perspectives, which did not depend on.

References


