

STUDENTS' DISPOSITION FOR DE-CONTEXTUALISED AND ALGEBRAIC (SYMBOL-BASED) REASONING IN RELATION TO THEIR SOCIO-ECONOMIC AND CULTURAL BACKGROUND IN MOZAMBIQUE

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BACKGROUND

Algebra is an important topic because it is relevant to learn topics like functions, trigonometry, geometry, analysis and calculus. In Mozambique, mathematics is compulsory until 10th grade and optional from grade 11 to 12, from where the learners who intend to follow linguistics, literature, law, medicine, history and geography have to choose option A (which does not have mathematics) and others who intend to follow technical studies like architecture, engineering, geology, agriculture, farming, statistics or pure mathematics have to choose option B or C which include mathematics. Available data on students' enrolment show that the majority of learners prefer the option without mathematics. However, algebra is taught from 8th grade on that means for learners who are at least 12-13 years old. From 8th to 10th grade algebra consists of: the concept of equation, linear equations and inequalities with one unknown, word problems conducing to linear equations and systems of linear equations, inequalities with two unknowns, quadratic equations, exponential equations, logarithmic equations, and trigonometric equations. In upper secondary school algebra aims at preparing learners to achieve in set theory and formal logic, analytic geometry, statistics and probability, advanced trigonometry, calculus and combinatorial analysis.

As stated by Usiskin (1997), algebra as a language can be characterized by the following five major aspects: (i) unknowns, (ii) formulas, (iii) generalised patterns, (iv) placeholders, and (v) relationships. Wheeler (1996) describes algebra as a symbolic system (to describe patterns and relationships without the need for the use of ordinary language); a calculus (among its primary elementary uses is the computation of numerical solutions to problems) and a representational system (tables, graphs from where can be extracted and interpreted the needed or presented information what usually plays a large role in the mathematisation of situations and experiences).

MacGregor & Stacey (1993), analysing test items responses, present a brief overview of students' developing competence in four essential basic algebraic skills: (i) recognising what operation relates two quantities; (ii) using algebraic notation to write an expression; (iii) interpreting an equation and (iv) writing an equation. MacGregor & Stacey suggest several origins of difficulties in learning to use algebraic notation, including: (1) intuitive assumptions and sensible, pragmatic

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reasoning about an unfamiliar notation system; (2) analogies with symbol systems used in everyday life, in other parts of mathematics or in other schools subjects; (3) Interference from new learning in mathematics and (4) poorly-designed and misleading teaching materials.

In fact, in the literature (Küchemann, 1981 and MacGregor & Stacey, 1997) it can be found that when learning algebra:

- (i) Students frequently base interpretations of letters and algebraic expressions on intuition and guessing, on analogies with other symbol systems they know (for example associating m to metro, l to litre, k to kilo).
- (ii) Students' misinterpretations lead to difficulties in making sense of algebra and may persist for several years if not recognised and corrected;
- (iii) At all year-levels there were some students who seemed to be unable to deal with precise distinctions between letters and their referents as it is necessary for a proper understanding of algebra;
- (iv) When algebraic concepts and methods are not used in other parts of the mathematics curriculum students forget them and the notation for expressing them.

Meaney (2002) states:

Within every mathematics classroom there is an intersection between the culture which surrounds mathematics and the way that it is taught and the culture which forms students' backgrounds. When there are large differences between what is valued in these cultures, this intersection resembles a clash rather than a successful symbiosis. (p. 167)

The second part of Meaney's statement corroborates with learning theories such as that of 'cognitive apprenticeship' which emphasised the need for mathematical activity to begin by being 'embedded in a familiar activity' (Brown et al., 1989, p. 37 cited by Meaney, 2002, p. 177). This gains particular importance when taking into account that Mozambique is a multilingual and multicultural society where the language of instruction is Portuguese but the mother tongue for only about 6% of the population, which means that the majority of students in their everyday communication utilise Mozambican languages.

AIM OF THE STUDY

The purpose of the study is to explore students' disposition for de-contextualised and symbol-based reasoning in relation to their socio-economic and cultural background in the specific context of Mozambique. It aims to find ways to help secondary school pupils' to understand algebraic concepts and look for ways, relevant for students, to introduce these concepts. To this end, the following questions are proposed to guide the study:

- (i) What difficulties do students experience in translating problems from everyday language into algebraic language?

(ii) What are the constraints and affordances in interpreting algebraic problems or problems asking for logical reasoning in relation to students' social and cultural background? In particular, are the problems linked to their mother tongue, to their socio-economic background or to both?

CONCEPTUAL FRAMEWORK

Although Mozambique is a multilingual society the medium of instruction is Portuguese. It is important to identify an adequate conceptual framework, especially, because the purpose of the study is to explore students' disposition for de-contextualised and symbol-based reasoning in relation to their socio-economic and cultural background. A classroom can be viewed as a social context in which mathematical knowledge is negotiated and constructed (Bauersfeld, 1992; Cobb, 1986 quoted by Atweh et al., 1998, p. 63). It is in the classroom where the teachers and students interact and share perceptions in specific circumstances creating a socio-cultural context. Assuming the social nature of mathematical knowledge construction in classrooms, the language tool is required. Halliday (1985) states that:

[L]anguage also varies according to the function it is being made to serve; what people are actually doing, in the course of which there is talking or writing involved; who the people that are taking part in whatever is going on (in what statuses and roles they are appearing); and what exactly the language is achieving, or being used to achieve, in the process. These three variables (what is going on; who is taking part; and what role the language is playing) are referred to as FIELD, TENOR and MODE; and they collectively determine the functional variety, or register, of language that is being used. (p. 44)

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Holliday's model is appropriate for the purpose of this study because it allows identifying the type of discourse used. The study will try to interpret the data from the perspective of these levels.

MATERIALS AND METHODS

Research Design. The main instruments to be used in this study are written tests for the research question (i) and semi-structured interviews for question (ii). The written tests will comprise a set of questions (such as the example given below) covering problem solving skills using Usiskin's (1997) characterisation of algebra considered above. This includes the three levels (1) understanding of ordinary language, (2) understanding of the presence of algebra in a given word problem and (3) the ability to translate an everyday problem into algebraic language.

A Linguistic conducted a survey of 100 families to determine the popularity of three local languages: E-Makhuwa[1], Chi-Chone[2], and Chi-Changana[3]. The results were as follows: 42 families spoke E-Makhuwa, 48 families spoke Chi-Chone, 41 families spoke Chi-Changana, 15 families spoke both E-Makhuwa and Chi-Chone, 17 families spoke both Chi-Chone and Chi-Changana, 18 families spoke both E-Makhuwa and Chi-

Changana, and 10 families spoke the three languages. Determine the number of families who spoke none of the three. (Adapted from Hanna S., & Saber J. 1971)

This is a problem of set theory and formal logic but it requires also algebraic knowledge: unknown and relationships among variables. This question allows exploring the levels considered above via written text and semi-structured interviews to understand students' constraints or affordances in interpreting it.

Sampling. The target population for the study will consist of 8th to 10th grades lower secondary school pupils in Mozambique. The schools involved in the study will be randomly selected taking into account geographic and socio-economic criteria. Within the schools, the classes to be involved in the study will also be randomly selected and it will comprises about 36 classes of about 40 to 50 pupils each, from 3 provinces representing the main regions of the country (south, centre and north) and the different socio-economic origins. In these provinces/regions, the referred classes will be selected in schools from an urban area (2 public and 1 private schools) and a rural area (1 public school). In each school the sample for the written test will involve students from 2 classes of each grade, comprising a total of about 1800.

Instruments. The study will use a combination of qualitative and quantitative data-gathering instruments assuming that, as stated by authors such as Lawrenz & McCreath (1988) and Miles & Huberman (1994), (i) the combination can enable a confirmation or corroboration of each other via triangulation; (ii) it makes possible an elaboration or development of analysis, providing richer detail, that is, the results of the first method can inform the second's sampling; (iii) quantitative methods can 'persuade' the reader trough de-emphasizing individual judgment and stressing results that can be generalized while the qualitative research methods persuades trough rich strategic comparisons across subjects, thereby overcoming abstraction inherent in quantitative studies; (iv) during analysis, quantitative data can help, by showing the generality of specific observations, and verifying or casting new light on qualitative findings. And the qualitative, on the other side, data can help validating, interpreting, clarifying and illustrating quantitative findings. According to Schumacher & McMillan (1993), tests, when used alone, have certain disadvantages and since with such instruments there is no possibility of asking subject clarifying questions immediately after a particular opinion has been given and also are static and give no information about the stability and dynamics of the subjects. Thus, to compensate for these disadvantages, a semi-structured interview will be developed by the researcher in order to identify and further explore the roots of the specific errors and misunderstandings in the use of algebraic language or its absence. Thus, after collecting data from the written tests two pupils (the best and the worst) in each tested classroom will be interviewed. With the test, a short questionnaire will be given to the students which will help to identify the socio-economic background and the language used in the everyday context of the participants.

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Data Analysis. A descriptive statistics (frequency/percentage distribution of score data will be presented and discussed the percentage of correct responses that students have given to all questions in the problem areas; measures of central tendency (means) and measures of relationship (correlation) and inferential statistics (testing for mean differences in knowledge scores through correlated t-test) will be used. The students' explanations to the tests results will be explored in a qualitative perspective, using Halliday's framework as a language of description. The interviews will also provide additional information about the students' socio-economic background and language used in everyday context.

NOTES

1. [One of the African languages spoken in Mozambique.](#)
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