Analysing the Palestinian school mathematics textbooks: A multimodal (multisemiotic) perspective

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Analysing the Palestinian school mathematics textbooks: A multimodal (multisemiotic) perspective

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The project reported here aims to produce an analysis of Palestinian school mathematics textbooks, focusing on the nature of the mathematics portrayed in the texts and of the mathematical activity expected of students. The academic collaboration enabled by the project includes comparison with a sample of English textbooks. We share some results of an early analysis of two extracts of textbooks and discuss the nature of the mathematics that students are expected to experience.

Keywords: nature of mathematics, agency, discourse analysis, textbooks

Introduction

In the past decade or so the mathematical performance of Palestinian students has been a source of concern for Palestinian educators (see e.g. Mullis, Martin, Foy, & Arora, 2012). One of the reasons proposed for poor performance is the textbooks used as a main source for teaching and learning mathematics in schools. These have been the subject of research for some years now. In particular Masters dissertations have compared Palestinian textbooks with the NCTM standards (e.g. Rewadi, 2005). None of these studies, however, has considered how the linguistic and other semiotic features of the texts may influence mathematics teaching and learning. The project "Analysing the Palestinian school mathematics textbooks: A multimodal (multisemiotic) perspective" aims to produce an analysis of Palestinian school mathematics textbooks, focusing on the nature of mathematics portrayed in the texts and the nature of mathematical activity expected of students. Comparison will be made with a smaller sample of English textbooks. The results of the analysis and the analytic framework developed for the project will have particular relevance for textbook developers and teachers of mathematics in Palestine but, we believe, will also be of more general international relevance. In this short paper we focus on specialised mathematical discourse and learner agency in mathematical processes; we share some results of an early analysis of two extracts of textbooks and discuss the nature of the mathematics that learners are expected to experience.

Analytic framework

Drawing on Social Semiotics (Halliday, 1978; Kress & Van Leeuwen, 2006), especially on Morgan's (2006) linguistic approach and Alshwaikh's (2011) diagrammatic approach to analysing mathematical texts, as well as Sfard's (2008) characterisation of mathematical discourse and the framework developed by Tang, Morgan and Sfard (2012), we develop an analytic framework to analyse Palestinian and English mathematics textbooks. This framework has three components corresponding to the field, tenor and mode of discourse: (a) the nature of mathematics and mathematical activity, (b) the image of learners and their relationships to mathematics and (c) the nature of the mathematical text. In the limited space available here we focus on two aspects: specialised mathematical discourse (contributing to realise the field of discourse) and learner agency in mathematical processes (contributing to the tenor of the discourse). Table 1 shows the structure of our analytic framework: each component is elaborated by questions that guide our analysis and indicators that allow us to identify relevant characteristics of the verbal and visual text. The structure of this framework is based on that proposed by Tang et al. (2012).

An early analysis of two extracts

We present here our preliminary analysis of one topic. In Palestinian schools, there is only one textbook for each subject, supervised by the Ministry of Education. We selected the unit "The congruence of triangles" for grade 7 (age 12-13 years). We have chosen a section on a similar theme from a commonly used textbook for English pupils of a similar age: "Congruent shapes" from *New Maths Frameworking – Year 8 Pupil Book 2*. The main analysis of the Palestinian text was done in Arabic. This was translated to allow us to check the reliability of the analysis and to communicate our findings. Working with translations poses a number of problems and raises some interesting issues. For example, in Arabic there is a verb used to indicate that one thing is congruent to another, while a similar verb is used to indicate the material process of comparing two shapes physically (see Table 3). Coining an English equivalent verb *to congruent* allows our translation to reflect the way in which congruency is represented as a process. In this paper we will focus on the extent to which the texts use a specialised mathematical discourse, and how learner agency in mathematical processes is construed. We ask how these aspects shape the nature of the mathematics that learners are expected to experience.

Table 3: An Arabic verb: "to congruent"

△ABC congruents △EFL	△أ ب جـ يطابق △هـ و ل
I cut the triangle and I congruent it with the triangle of my colleague	أقص المثلث الناتج وأطابقه مع مثلث زميلي

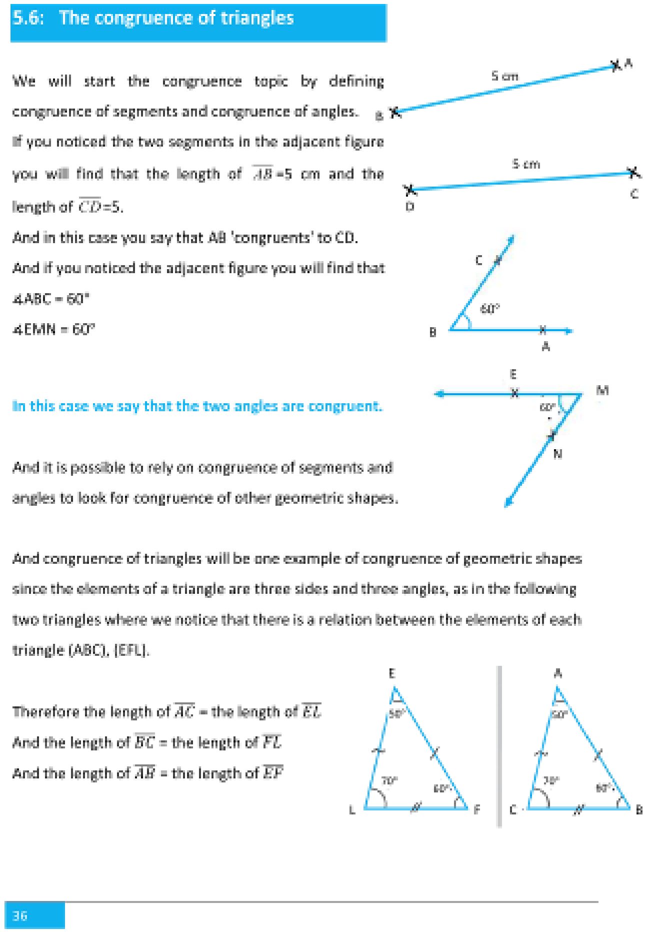
Specialisation

In this section we address the question: To what extent is specialised mathematical language used? Figure 1 shows one extract from the Palestinian textbook. In general we find the unit to be a highly specialized text. In the verbal text there is extensive use of specialised vocabulary. The term *congruence*, for example, is used repeatedly throughout the unit but we also find other mathematical objects referred to in specialised terms (*triangle*, *figure*, *angle*, *theorem*) and a general lack of non-specialised vocabulary. In addition, there is use of 'conventional' nominal groups naming further specialised objects such as *corresponding angles*, *adjacent figure*, *congruence theorem*. Mathematical symbols play an important role in the text, e.g. (S,S,S), ∠ABC, ≡, both incorporated into verbal sentences and paragraphs and standing alone in sequences of symbolic statements.

The visual components of the text are similarly specialised, comprising for the most part figures involving triangles, marked with conventional labels naming vertices and indicating equal lengths and angles. The one exception to this high degree of specialisation is in the final "Activity" section of the unit, which presents a

Table 4: An extract of the analytical framework, showing its structure

	property of the discourse	specific questions guiding analysis	indicators in verbal text	indicators in visual text
a) How is the nature of mathematics and mathematical activity construed?	**Specialisation**	To what extent is specialised mathematical language used?	- vocabulary used in accordance with mathematical definitions - ‘conventional’ expressions - mathematical symbols	- ‘conventional’ mathematical diagrams, charts, tables, graphs and labelling systems
	further properties include: *objectification, alienation, logical structure, status of mathematical knowledge*			
b) How are the learners and their relationship to mathematics construed?	**Agency**	What kind of activity is the learner expected to engage in?	- ‘thinker’ or ‘scribbler’ processes ascribed to the learner (e.g. imperatives, *you* …)	
	further properties include: *authority; formality*			
c) What role does the text play?	**construction of knowledge**	Does the text present facts or develop arguments? What is assumed?	- Thematic progression - Given-New	- information value - Given-New (horizontal) - Ideal-Real (vertical) - Centre-Margin
	further properties include: *topic; structure*			



5.6: The congruence of triangles

We will start the congruence topic by defining congruence of segments and congruence of angles.

If you noticed the two segments in the adjacent figure you will find that the length of $\overline{AB}$=5 cm and the length of $\overline{CD}$=5.

And in this case you say that AB 'congruents' to CD.

And if you noticed the adjacent figure you will find that

∡ABC = 60°

∡EMN = 60°

In this case we say that the two angles are congruent.

And it is possible to rely on congruence of segments and angles to look for congruence of other geometric shapes.

And congruence of triangles will be one example of congruence of geometric shapes since the elements of a triangle are three sides and three angles, as in the following two triangles where we notice that there is a relation between the elements of each triangle (ABC), (EFL).

Therefore the length of $\overline{AC}$ = the length of $\overline{EL}$

And the length of $\overline{BC}$ = the length of $\overline{FL}$

And the length of $\overline{AB}$ = the length of $\overline{EF}$

36

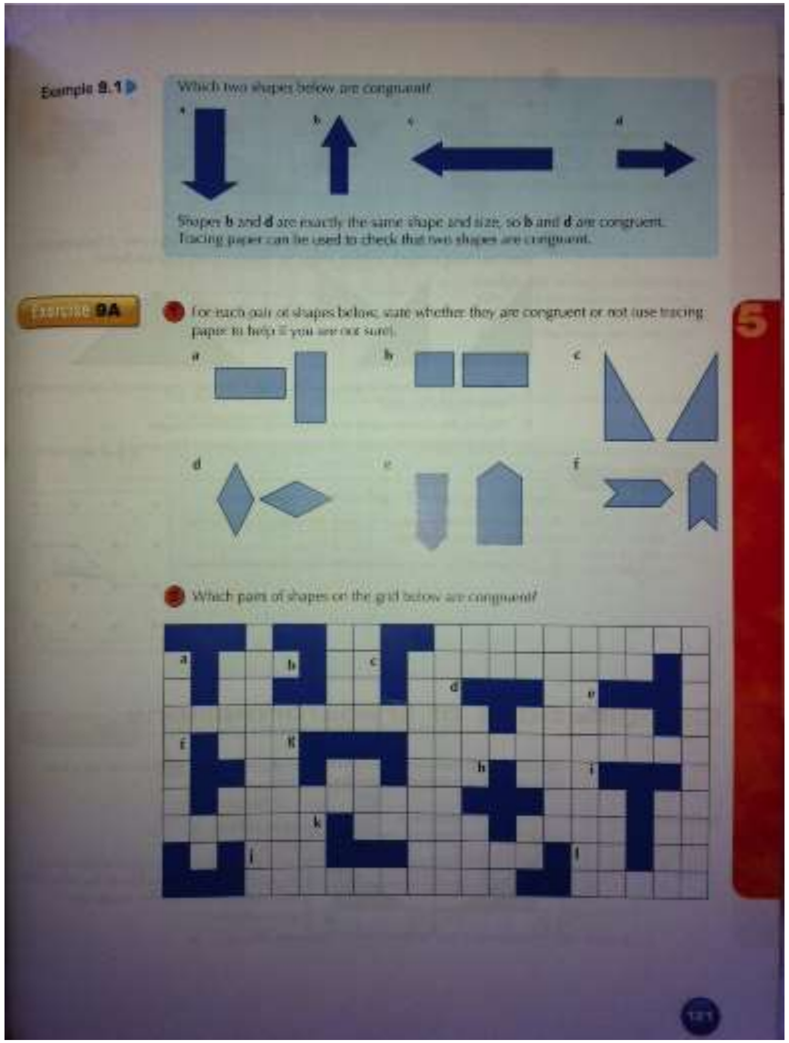


Figure 1: extract of translated Palestinian text

Figure 2: extract of English text

problem in a ‘real world’ context. Even here, however, the story of a boy trying to find the width of a river concludes with the following statement, imposing a highly specialised mathematical gaze onto the real world (cf. Dowling, 1998):

> Ahmad claimed that the orthogonal distance CE is the width of the river AD.

In the extract of the English text shown in Figure 2, however, we see a mostly non-specialised text with some use of specialised vocabulary. There is a mixture of specialised and non-specialised vocabularies and minimal use of symbols. Figures are coloured and labelled by single letters or not at all in early examples; *triangle ABC* only appears in later examples. There are also numerous unconventional shapes as well as triangles (e.g. arrows; irregular shapes; representation of a pin board).

Learner agency

In order to address the question of learner agency, we ask: What kind of activity is the learner expected to engage in and what choices are available to them? We distinguish in particular between engagement in material processes that construe a role as a ‘scribbler’ and mental processes, construing a ‘thinker’. According to Rotman (1988), the activity of mathematicians combines both these roles. In the Palestinian text, the majority of processes construe the learner as a ‘scribbler’ (e.g. *use*, *cut*, *draw*, *find*), but there is also an expectation that the learner will be a ‘thinker’ (e.g. *show*, *prove*, *notice*, *consider*), engaged in observation, reflection and reasoning. In the visual component of the text, figures are labelled with specific measurements or with marks indicating equality. The learner’s role is thus construed as observing and reasoning about the properties of the shapes. The learner’s activity is elicited not only through imperatives but also through the use of questions which allow choice in the mode of response, e.g. *If you try to measure AB and RP*, *what do you notice?*

The English text also construes the learner as active mainly in ‘scribbler’ activity, including manipulation of concrete objects. Moreover, where there are mental processes, such as *notice*, these tend to refer to observation of facts rather than to engagement in reasoning. In the visual component of the text, the lack of labelling of shapes with measures or marks indicating properties suggests that the task of determining congruency is one of visualisation rather than analysis. In some cases, shapes are positioned on grids, suggesting that learners might be expected to check equality of lengths by counting. The use of questions such as: *Which pairs of shapes are congruent?* allows a choice of method. However, the absence of provision of any formal definition, method or example of reasoning and the marking of use of concrete manipulation as less desirable (*use tracing paper to help if you are not sure*) mean that learners seem to be expected to rely on everyday notions of shape and size and informal methods of visualisation and measurement.

Comparison between the two texts

The two texts deal with the same topic of congruency in different ways: While the Palestinian text uses a specialized discourse, emphasising formally defined objects and reasoning about properties, the English text uses a mixed discourse, emphasising processes of practical manipulation and visualisation. Both sets of learners are expected to engage in material activity. The Palestinian text, however, also construes the learner as a ‘thinker’. The combination of scribbler and thinker activity suggests that the Palestinian text as a whole seeks to apprentice learners into specialised mathematical discourse (cf. Dowling, 1998), though it is unclear how successful this might be.

Some questions

We have looked in detail at only one topic – a topic that is treated very differently in the two textbooks and is positioned differently in relation to other parts of mathematics. In particular, the topic of congruence is treated in the English text in the context of a chapter whose main focus is on transformations – a topic that does not appear explicitly in the Palestinian chapter. We are thus hesitant to draw conclusions from the analysis presented here. Instead, we pose questions raised by this early analysis. To what extent do texts such as these:

- provide students with a valid/ valued/ valuable image of mathematics?
- apprentice students to the specialized discourse of mathematics?
- exclude or enable access to valid/ valued/ valuable mathematics?
- encourage/ discourage the learner to engage in mathematical activities?

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