STUDENT TEACHERS INTERPRETING MEDIA GRAPHS

Carlos Monteiro
Universidade Federal de Pernambuco, Brazil
Janet Ainley
The University of Warwick, United Kingdom
cefmonteiro@uol.com.br

The official inclusion of the teaching of graphing in school curricula has motivated increasing research and innovative pedagogical strategies such as the use of media graphs in school contexts. However, only a few studies have investigated knowledge about graphing among those who will teach this curricular content. We discuss aspects of the interpretation of media graphs among primary school student teachers from Brazil and England. We focus on data which came from questionnaires which gives evidence of elements of "Critical Sense," which involves the mobilisation of several kinds of knowledge and experiences, in the interpretation of statistical graphs.

INTRODUCTION

A statistical graph can be conceptualised as a construct which was developed in specific cultural contexts to mediate interpretation of data. Therefore, the interpretation of statistical graphs should be considered as an activity which is related to a complex range of elements and processes. In current society, print media commonly use graphs to illustrate journalistic arguments in publications (e.g., newspapers, magazines, periodicals and public reports) that provide news and information for the general public. Several studies in statistics education have emphasised the importance of the statistical teaching which considers the use of graphing knowledge in out-of-school daily situations (Ainley, 2000; Evans, 2000; Meira, 1997). However the activity of reading graphs might be different in specific contexts such as: academic (e.g., Wild and Pfannkuch, 1999), reading (e.g., Gal, 2002) and school contexts (Monteiro and Ainley, 2004). Within school contexts the kinds of interpretation which pupils are asked to make are relatively limited, focussing largely on knowledge of statistical processes, with little attention given to the social context from which the data has (supposedly) been taken. Indeed, responses which do draw on knowledge of the context are likely to be perceived as incorrect (Cooper and Dunne, 2000).

A strategy to bridge this gap between the school and out-of-school use of graphs involves the utilisation of media graphs as pedagogical resource. For example, Watson (1997) suggests that this innovation can motivate students in learning statistics. However, the importation of media graphs into classrooms from the cultural contexts in which people read print media requires careful consideration. School graphing activities are not simply a continuation of solving mathematical problems outside school, since their purposes are different (Ainley, 2000; Evans, 2000).

In this paper we discuss part of the data from a research project which set out to explore the activity of student teachers interpreting graphs taken from the media. The study was designed to encourage the use of a combination of statistical and contextual knowledge, and one focus of the research was to look at whether individual differences between participants (age, academic background) corresponded to differences in the emphasis placed on different kinds of knowledge in their interpretations.

Our focus on media graphs also raises the issue of how people may act differently when reading graphs in different contexts. The activity involved when looking at a graph presented in a newspaper alongside accompanying text, or as part of an advertisement, may be quite different from the activity involved in using a graph in a professional context, and different again from the activity required in response to graphing tasks in a school context. In the part of the study reported here, carefully chosen media graphs were presented in a written questionnaire which was given to groups of student teachers. However, the questions which were asked about the graphs were designed to be more open than those which would normally be found in school contexts, trying to stimulate the kinds of concerns which might occur in a *reader* context. Whilst acknowledging the limitations of this approach in terms of accessing detail of the participants

thinking, we chose to use this method in order to collect a sufficient body of data to test out some initial conjectures and to provide the basis for the design of a subsequent interview-based study.

METHOD

The questionnaire study was carried out with British and Brazilian student teachers who were taking curriculum methods courses in primary school mathematics during the 2002/2003 academic year. In total 218 took part, made up of Brazilian and British student teachers taking four year undergraduate education courses, and British PGCE (Postgraduate Certificate in Education) students taking a one year course which gives *Qualified Teacher Status* (QTS). Our initial conjecture was that we would see differences in the patterns of responses from student teachers who had different academic backgrounds (particularly in terms of their experience of mathematics and statistics). In addition, we conjectured that we might see differences between the responses of more mature students who had a range of professional experience in the workplace and younger students without such experience.

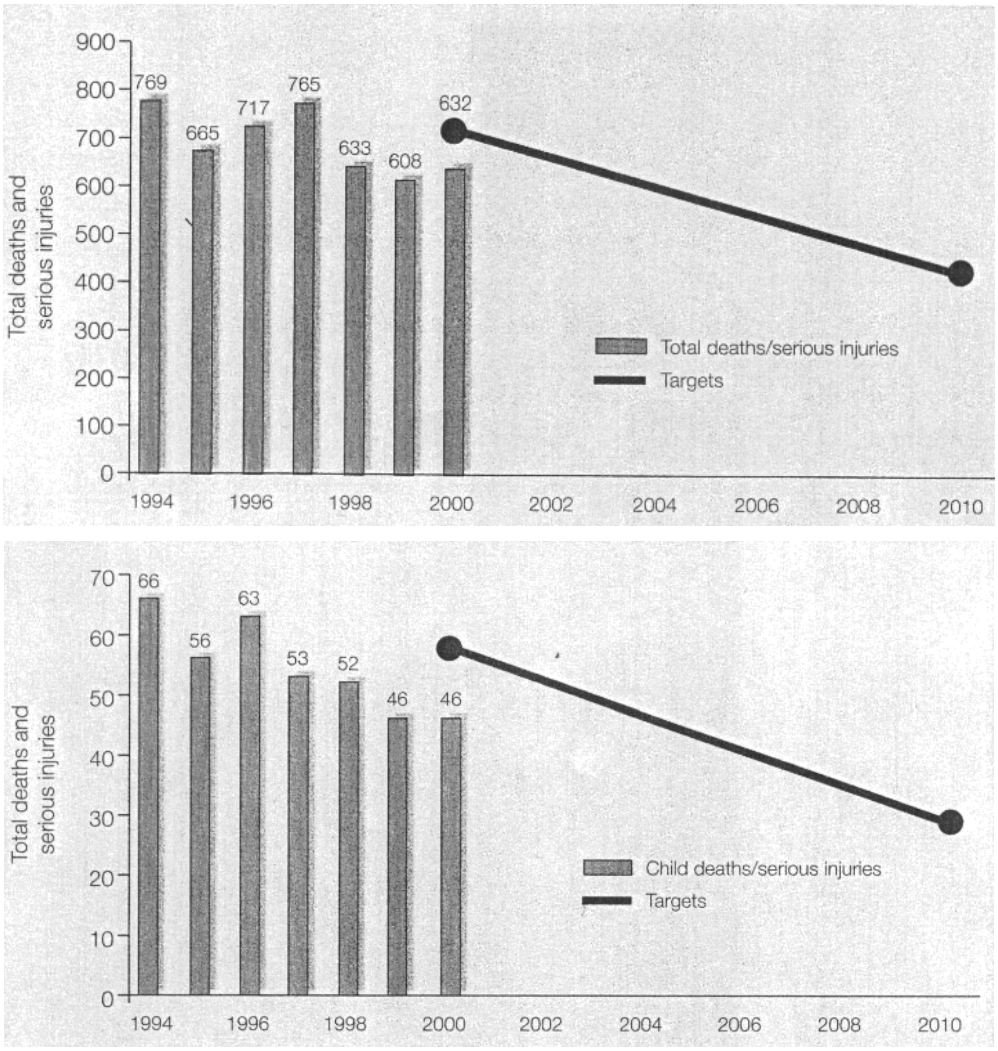
The use of the same questionnaire tasks (translated into Portuguese for the Brazilian students) also allowed a comparative analysis between the responses from the British and Brazilian participants. We anticipated that two factors in the two cultural settings could be a differential element in the performance of students. The first is that data handling is a more well established part of the school curriculum in Britain, and so we expected the British student teachers to have more experience in this area. The second is that Brazil is currently less stable both politically and economically than Britain, so that there is a relatively higher level of attention given to the presentation of issues in the media which may be supported by the use of graphs.

The questionnaire was given collectively to class groups with one researcher present at all data collection sessions. The first part of the questionnaire contained questions which asked about participants' personal details and their reading background experiences. The rationale of these initial items was to have a general characterization of the participants (e.g., gender, age, subject specialism or degree), and to have information about reading situations in which the participants might have access to media graphs. The second section contained questions relating to the interpretation of media graphs. Three main reasons influenced the choice of the media graphs used in the research tasks. Firstly, the graphs seemed to present accessible levels of complex statistical relationships. Basically, the graphs chosen were pictograms, bar charts and line graphs which present absolute, rational numbers, or percentages. Secondly, an attempt was made to choose media graphs which were related to familiar topics. Thirdly, we tried to select graphs which were free from technical errors or misleading elements. Therefore, unlike other authors (e.g., Watson, 1997) we did not want to emphasise the problematic aspects of the media graphs as a crucial element of the tasks. Figure 1 presents an example of these items related to graphs about road accidents. The questions posed about the graph were designed to give opportunities for participants to respond to the graphs in ways which might be similar to their responses when reading a newspaper or magazine.

ANALYSIS AND RESULTS

The analysis of data from the questionnaires was assisted by the use of NVivo software package. The analysis was based on counting of responses which depended of qualitative observation. The vast majority of the student teachers in the study were female (87% among the British participants and 91% among the Brazilians). Also, 78% of the British undergraduate students were aged 19 or 20 years old whereas 61% of PGCE students and 53% of the Brazilian undergraduates were aged between 21 and 25 years old. Their academic backgrounds covered a wide range of subjects, though relatively few were specialising in mathematics.

There were some differences in the patterns of reading activity reported by different groups. Among the Brazilians participants the most frequent type of reading was *newspapers* (43%), while among the British participants it was a variety of books which include fiction and non-fiction (46%), which is less likely to be associated with the inclusion of graphs. The majority of participants from all groups declared this variety of books as their favourite type of reading.



1. If you could talk to the person that produced these graphs, are there any questions you would like to ask?
2. If the information from these two graphs were combined what would the graph look like?
3. Do you think that these targets are realistic?

Figure 1: Road accident graphs task (Warwickshire County Council, 2001)

Participants' responses related to the first item of the road accidents graphs task, which requested the formulation of questions about the graphs, were grouped into five categories: concerning the targets, complementary information, graphical representation, data collection and the purpose of the graph. Table 1 shows the numbers of responses in each category, and Figure 2 gives examples of the responses.

Table 1: Main aspects of the questions raised about the road accident graphs

Groups	British Und.	PGCE	Brazilian	TOTAL
Concerning the targets	49 (33%)	40 (33%)	54 (35%)	143 (34%)
Requesting complementary data	43 (29%)	37 (31%)	54 (35%)	134 (32%)
Questioning graphical representation	27 (18%)	22 (18%)	17 (11%)	66 (16%)
Questioning data collection	09 (6%)	15 (12%)	15 (9%)	39 (9%)
Questioning purpose of the graph	19 (13%)	07 (6%)	10 (6%)	36 (8%)
"I have no questions"	---	---	06 (4%)	06 (1%)
TOTALS	147	121	156	424

The majority of participants' questions requested additional information, including information about how the targets had been set, which could clarify their interpretation of the data (66%). A large number of those questions seemed to be related to the participants' concerns about the targets displayed on the graphs (34%).

Questioning the targets
- How/why did you set the targets observed? (*British PGCE)*

Requesting complementary data
- How many were deaths and how many were serious injuries? (*British undergraduate*)
- Were there any particular contributing factors to the increase in road deaths in 1997 such as particularly bad weather? (*British PGCE)*
- What are the geographical characteristics of Warwick region? (*Brazilian)*

Questioning graphical representation
- Why is the target line drawn higher than actual death/injury number for 2000? (*PGCE)*

Questioning purpose of a category of the graph
- What do you classify as a serious injury? (*British PGCE)*

Questioning the data collection
- How did you produce those numbers? (*Brazilian)*

Figure 2: Examples of main aspect of the questions raised about the road accident graphs

Generally speaking, the most frequent categories of questions related to participants' concerns about technical aspects of the data collection, as well as possible variables which might affect the data displayed. On the other hand, there was a lower frequency of questions which only focused on graphical representation itself. This was an indication that most of the participants' interpretations were not restricted to the data displayed on the graph, but that they might be mobilising other previous knowledge and experiences about the topic of road safety.

The second item of the road accident graph task asked about the shape of a hypothetical graph which would combine the data from both road accidents graphs (see Figure 1). The participants were asked to make a sketch of the graph rather than producing an accurate drawing. The rationale for this item was to provide another type of opportunity for the participants to approach the data from both graphs in more detail rather than to evaluate their skills in constructing a graph. The responses to this item indicated that most participants understood the specific statistical relationships in the graphs. A small percentage of participants (8%) indicated some misconceptions about the graphical representation. This suggests that technical reading of the graphs was not problematic for the majority of the participants.

The third item relating to these graphs asked about whether the targets which had been set for the reduction in accidents were realistic. The frequencies of responses to this item suggested that a substantial number of participants saw the targets displayed as problematic. For example, a substantial number of participants (41%) responded that the targets displayed on the graphs were not realistic, and another large group (34%) answered that they were uncertain. A small percentage of participants answered that the targets were realistic (13%). This suggests that the majority of the participants were taking a sceptical approach to the graph and not simply accepting the data for the targets at face value. Participants' responses for item 3 were also analysed in terms of justifications given for their answers. See examples in Table 2 and Figure 3.

Table 2: Main aspect on which the answer about targets was based

	British Undergr.	PGCE Studs.	Brazilian Undergr.	TOTAL
Based on opinion	20 (31%)	21 (39%)	59 (59%)	100 (46%)
Based on the graphs	23 (36%)	19 (35%)	26 (26%)	68 (31%)
Both graph – opinion	17 (27%)	08 (15%)	06 (6%)	31 (14%)
Did not answer	04 (6%)	06 (11%)	09 (9%)	19 (9%)
TOTAL	64	54	100	218

Based on opinion

- Yes, because drivers will be more informed from campaigns to decrease road accidents. (*Brazilian)*

Based on the graphs

- They would appear so, as there is a general downward trend in both graphs and they are already below the present target. (*British PGCE)*

Both graph – opinion

- Yes, they are the same as the gradient between 1994 figures and 2000. No, it is unlikely that road accidents could ever be as low as in 2010 unless people change the way they drive and don't walk onto roads. (*British undergraduate*)

Figure 3: Examples of main aspect on which the answer about targets was based

For this item there was a noticeable difference between the responses given by Brazilian and British participants. A high proportion of British participants' responses included consideration of some aspect of the graphs (63% of PGCE and 50% of undergraduates). On the other hand, the majority of the Brazilians based their answer more on personal opinion about the data (59%). We conjecture that this difference in the pattern of responses might be related to the participants' background. For example, among the Brazilians participants there was higher percentage of frequent readers of print media which publish graphs. In such media publications, graphs are typically set alongside text which relates to the same context, but they are rarely referred to directly within this text. Indeed, their function often seems to be primarily to enhance the visual appeal of the presentation, rather than to add significantly to the discussion and analysis of issues. Thus, the fact that a larger proportion of Brazilians responded to this item only on the basis of their opinion could be associated with their familiarity with *reading* contexts, where readers do not generally make technical analysis of graphs.

Similarly, we see that the British participants tended to make more use of justifications relating to the graphs only, or to the graphs in combination with opinion. The use of media graphs (or at least of graphs similar to those in the media) is not unusual in *school* contexts in Britain, although the tasks within which they are used tend to focus on practicing statistical skills in reading information from the graph, rather than on interpretation. We might therefore conjecture that British participants were more likely to construe the questionnaire task as a *school* context.

However, for us a more interesting result is that references to personal perspectives and opinions based on knowledge of the context were involved in the majority of the participants' justifications (60% of responses in total based on opinion, or on both opinion and graph). This provides strong evidence that participants were drawing on their experience and knowledge of the context of the data, rather than relying entirely on a technical reading of the graphs. Whilst this might be the response that would be expected from adults encountering such a graph in an everyday context, this is not the way in which graphs are generally to be interpreted within school contexts. This reinforces our sense of the gap between school and out-of-school contexts for interpreting graphs.

DISCUSSION

Despite their different backgrounds, we did not find great differences between the performances of the groups of participants. The responses to items 1 and 3 of the road accidents graphs tasks, (see Figure 1), suggested that in making their interpretations participants amalgamated their statistical knowledge with other elements related to their knowledge and personal experience about the context which in which the data was set. Furthermore, the majority of participants displayed an ability to think critically about aspects of the data presented in the graphs, and to justify their ideas by drawing on statistical and/or other sources of knowledge.

The part of our study reported here supported the idea of *critical sense* which has been elaborated by Monteiro (2005) to encapsulate the way in which a sophisticated reading of graphs involves drawing on a range of different kinds of knowledge and experience. For example, our analyses suggest that readers may make references which connect the quantitative relationships displayed on the graph with their previous knowledge about the processes of data collection and

analysis, and with knowledge of social context from which the data has been drawn, or may respond on the basis of personal experience or opinion with little reference to the data. We argue that a complete reading of a graph involves *balancing* these different elements appropriately.

The nature of the tasks used in the questionnaire constitutes an important aspect of our analysis. Because of their origins, the graphs were associated with *reading* contexts. In these contexts people can develop interpretations of graphs which do not necessarily focus on statistical and technical analysis of the graphical representation, but may be of a more impressionistic nature, based on the immediate visual impact and on expectations about the source of the data. However, to compose the questionnaire tasks, the graphs were extracted from the original sources as generally happens when media graphs are transferred into *school* contexts, with the result that more emphasis may be placed on the graph itself. As in other *school* contexts of interpretation, the questionnaire emphasised written responses, limited the time available and restricted the way in which the participants could express their interpretation of the graphs. On the other hand, the questionnaires tasks also differed from conventional *school* contexts because the items tried explicitly to develop a questioning attitude from the readers. For example, the items asked the participants to produce questions and express their views, rather than just answering questions.

Consideration of the features of *reading* contexts, *school* contexts and the hybrid nature of the questionnaires tasks has helped to highlight evidence of the complex relationship between elements of interpretation of graphs which are related to both school and out-of-school kinds of knowledge, which in turn raises pedagogical implications for the teaching of graphing. We suggest that the teaching of graphing should be based on opportunities to learn how to be aware of, and to balance, the diversity of elements involved in the interpretation of graphs. In order to achieve this it is necessary that that teacher education programmes encourage student teachers to reflect on their own interpretations of graphs in order to learn how to deal with the complex range of elements and processes involved in the interpretation of graphs, and to be aware that the isolation of statistical knowledge from other types of knowledge and experiences can be difficult and ineffective.

ACKNOWLEDGEMENT

We thank Conselho Nacional do Desenvolvimento Científico e Tecnológico for support.

REFERENCES

Ainley, J. (2000). Constructing purposeful mathematical activity in primary classrooms, in C. Tikly and A. Wolf (Eds.), *The maths we need now: Demands, deficits and remedies.* London: Institute of Education, University of London, 138-153.

Cooper, C. and Dunne, M. (2000). *Assessing Children's Mathematical Knowledge.* Buckingham: Open University Press.

Evans, J. (2000). *Adult's Mathematical Thinking and Emotions: A Study of Numerate Practices*. New York: Routledge Falmer.

Gal, I. (2002). Adult statistical literacy: Meanings, components, responsibilities. *International Statistical Review*, 70(1), 1-25.

Meira, L. (1997). Gráficos e quantidades na vida diária e na mídia impressa, *Proceedings of II Semana de Estudos em Psicologia da Educação Matemática*, (pp. 11-18). Brazil: UFPE.

Monteiro, C. (2005). *Investigating Critical Sense in the Interpretation of Media Graphs.* Unpublished PhD dissertation, Institute of Education, The University of Warwick, Coventry.

Monteiro, C. and Ainley, J. (2004). Exploring the complexity of the interpretation of media graphs. In O. McNamara and R. Barwell (Eds.), *Research in Mathematics Education: Papers of the British Society for Research into Learning Mathematics*, Vol. 6, (pp. 115-128). London: BSRLM.

Watson, J. (1997). Assessing statistical literacy through the use of media surveys. In I. Gal and J. Garfield (Eds.), *The Assessment Challenge in Statistics Education*, (pp. 107-121). Amsterdam: IOS and Press International Statistical Institute.

Warwickshire County Council. (2001). *Quality of Life in Warwickshire*. Warwick: WCCouncil.

Wild, C. and Pfannkuch, M. (1999). Statistical thinking in empirical enquiry. *International Statistical Review*, 67(3), 223-265.