INTERPRETATION OF GRAPHS: READING THROUGH THE DATA

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Several studies investigated the interpretation of graphs as pedagogical issue. The studies of Curcio (e.g. Curcio, 1987) presented three levels of students' responses: reading the data, reading between the data and reading beyond the data. Watson's (e.g. 1997) studies suggest a hierarchical schema of classification of interpretation based on three tiers. We presented the idea of Critical Sense in graphing as a skill to analyse data and its interrelations rather than simply accepting the initial impression given by the graph. This paper discusses about convergent and divergent aspects among the authors referred above.[1]

INTRODUCTION

This paper presents three different perspectives which approach the interpretation of graphs. We will describe some elements of each perspective and build conclusions that support better understanding of *critical sense* as a fundamental idea of the graph interpretation process.

CURCIO'S PERSPECTIVE

Curcio (1987) applied to graphing the "Schema theory of understanding general discourse". According to this perspective the graph might be viewed as a type of text in which the effect of prior knowledge about topic, mathematical content, and graphical form, might influence the ability to comprehend the mathematical relationships expressed in graphs.

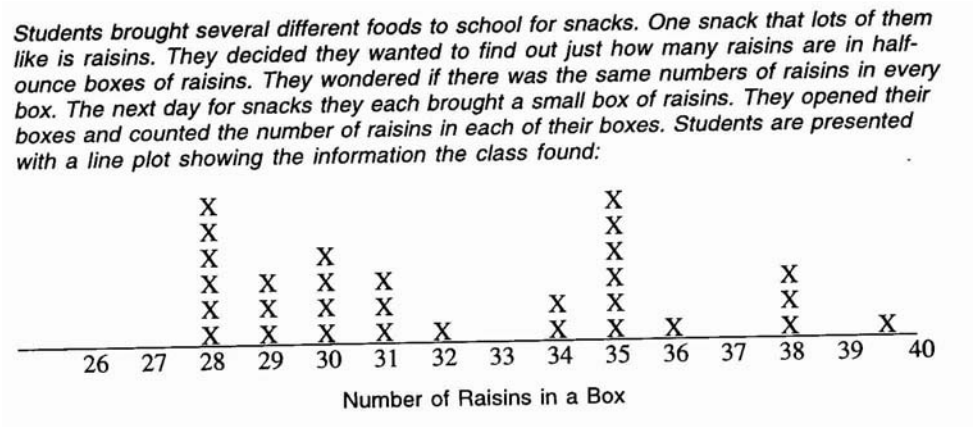

Figure 1: graph reprinted from Friel, Bright and Curcio (1997)

Although every graph has four structural components (i.e. framework, specifiers, labels and background), each kind of graph also has its own "language" associated

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with these structural components; readers use this "language" to discuss the data displayed. Therefore, the reader's interpretations of a graph might provide evidence of their knowledge of the graph's structure (Friel, Curcio, and Bright, 2001). An example of assessment task from their research is given above (Figure 1).

According to the authors, teachers need to think about the questions that they ask and how these questions may focus students' attention on the information pictured by a graph (Friel, Bright and Curcio, 1997). Three types of questions related to components of graph comprehension comprise the classical Curcio schema:

Reading the data: "Lifting" information to answer explicit questions for which the obvious answer is right there in the graph (e.g. What is the fewest number of raisins found in any box?)

Reading between the data: Interpolating and finding relationships in the data presented in a graph (e.g. Are there the same number of raisins in each box? How can you tell?).

Reading beyond the data: Extrapolating, predicting, or inferring from the representation to answer implicit questions (e.g. If the students opened one more box of raisins, how many raisins might they expect to find? Why do you think this?).

WATSON'S PERSPECTIVE

According to Watson (1997), statistical thinking needs to be assessed as it occurs in social settings outside the classroom. She suggests that unusual and misleading graphs, which occur in print media, might be excellent examples to motivate and challenge students (Watson and Moritz, in press).

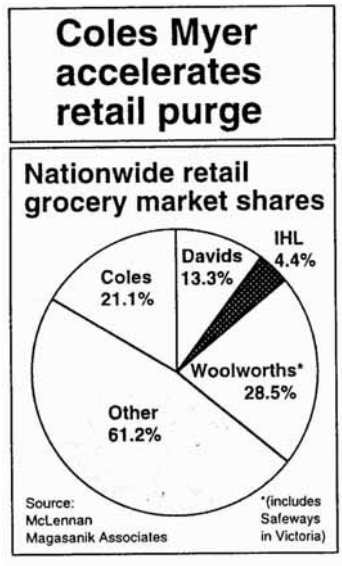

Figure 2: graph reprinted from Watson (1997)

In particular, Watson (1997) suggested a three-tiered hierarchy for assessing statistical literacy based on authentic extracts from the media:

Tier 1: A basic understanding of statistical terminology.

Tier 2: An understanding of statistical language and concepts when they are embedded in the context of wider social discussion, recognising, interpreting, and using these in applied contexts.

Tier 3: Being able to question unrealistic claims made by the media or others. A questioning attitude that can apply more sophisticated concepts to contradict claims made without proper statistical foundation.

According to Watson (2000), teachers might use these tiers to appreciate the increasingly complex nature of progression in the students' statistical thinking.

Figure 2 (above) is an example of item used in a large survey among students in grade 6 and 9 in Tasmania (Watson, 1997). Watson (1997) presented examples of the classification for the students' answers.

Item a: ***Explain the meaning of this pie chart***:

Tier 2 – "It tells us what % they have sold." "It shows who out of the 5 markets who [sic] has the most share of the grocery market shares."

Item b: ***Is there anything unusual about this?***

Tier 3 – "The percentages add up to 128.5; they should equal 100!!!" "Where it has Other, it says 61.2% and the percentage of that section on the pie is less than 50%."

Watson (1997) recognises that "a large-scale impersonal survey" is not the optimum method to investigate the statistical understanding involved in the interpretation of graphs. Watson & Callingham (2003) observed the "context" seems to be an important element which the students' answers. They detected that higher levels of sophistication in thinking are not always related to higher ability. "Rather, students appear to be drawing on different ways of conceptualising the question, and thus, in some situations, students at the same ability level have two ways of responding to a particular question" (p.23).

CRITICAL SENSE IN INTERPRETATION OF GRAPHS

We propose the idea of Critical Sense in graphing as a skill to analyse data and its interrelations rather than simply accepting the initial impression given by the graph. Critical Sense in graphing is not a behaviour, or an element, which can be acquired and applied for all situations. Critical Sense seems to be a context-dependent skill. Gal (2002) suggests two main kinds of contexts in which the interpretation of graphs might be developed: 'enquiry' and 'reading'. In *enquiry* contexts the people act as 'data producers' and usually have to interpret their own data and report their findings (e.g. researchers and statisticians). The *reading* contexts emerge in everyday situations in which people see and interpret graphs. However the learning and teaching of graphing activities is developed in *school* contexts that have particular features which make them distinct from the two others cited (Monteiro and Ainley, 2003). Specifically, we believe that the application of the term "context" on the study of critical sense in graphing might be related to the "content" of the pedagogical task as well as to the "situation" in which the graph is interpreted.

We wish to study Critical Sense in student teachers as a way of helping us, and them, think about teaching and learning graphing in ways that will support the development of Critical Sense. We have asked student teachers to interpret media graphs which do not have noticeable "unusual" features, and which have a certain level of familiarity for the readers (i.e. participants' prior knowledge about topic, mathematical content, and graphical form, Curcio, 1987). The figure 3 is a graph used in the interviews.

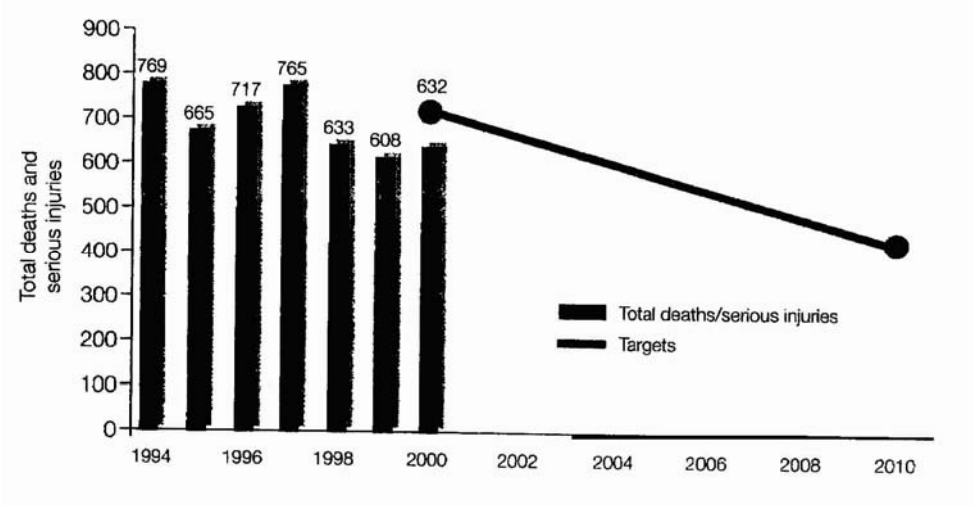

Figure 3: graphs reprinted from *Quality of life in Warwickshire*, September 2001, pp. 93-94.

R "What's your prediction for death rate and serious injury in 2001?"

H In 2001? Right. Hum…Yeah… I would say… eh… It would be… I mean I know it is going up… I know it is going up a little bit there. I think it would be down again about … says 600. At moment is going up at… Yeah… I think it will reduce it…I am not really going by… the graph, the flow of the graph… I am just going by a gut feeling more than anything. You'd like to think that it's coming down.

In this part of the interview, the student begins by looking closely at the graph, noticing the upward trend over the last two years, but then responds in terms of her feelings about the issue of traffic accidents. The interviewer then encourages her to try to specify a prediction.

R So do you think it would be some… If you guess some number, some rate?

H Yeah, again… I am not… it's very hard to say because… I'm thinking that it's… I am just thinking of… basically the media coverage on this type of thing… And… especially around Christmas time around… there is always a focus to control the number of accidents on the road, and I think this country… Well, I know this is Warwickshire, but I think this … the government does do… does make an effort … and obviously there are reductions. So I am basing my information on that, not just what the graph is telling me. But obviously going from last… Going from year 2000. And …

> yeah… hum… 600. I don't think there will a dramatic decline. But yeah... if I would say figure, say 600.

When asked for a "figure" she gives reasons for the limits of her answer, in terms of her knowledge about attempts to improve road safety. She tried to get a balance between the information displayed, her "feelings" and the social context in which the "figure" might be related. At the ending of her interpretation she gave a reasonable conclusion based on the different aspects that were involved in her reading.

CONCLUSIONS

We emphasise that traditional pedagogic contexts, where the purposes of the tasks set and the activities undertaken in graphing are different from those, which apply to out-of-school contexts, will be unlikely opportunities for the development of Critical Sense. Bringing media graphs into the classroom will not, in itself, create such opportunities if the tasks, which are set, remain narrowly focussed pedagogic tasks. Cooper and Dunne (2000) have demonstrated the difficulties, which children encounter in answering mathematical questions that are set in 'everyday' contexts. They identify this difficulty as arising from the need to understand how much attention should be paid to the contextual content of the task. In pedagogical contexts, the 'correct' balance of attention between everyday knowledge and the mathematical knowledge is likely to be pre-determined by the teacher, and so there is no opportunity for pupils to experience the need to make a choice for themselves about the balance that is most appropriate for a particular purpose: in other words, to develop Critical Sense.

Our analyses of data collected indicate that is quite difficult to fit the student teacher's responses into hierarchical classifications. These analyses seem to give evidence that critical sense might be a skill which enables the readers to balance several knowledge aspects involved in the interpretation of a graph. The participants read through the data, building an interpretation which combines different kinds of previous and emergent knowledge, experiences and feelings, that play am important role in their reading of the graph.

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