A Phenomenological Approach to Upper Primary Mathematics Teachers And Their Beliefs About Specific Teaching Behaviours

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This paper reports upon a study that examined the responses of NSW upper primary teachers of mathematics to a series of questions about typical teaching behaviours. A phenomenographical approach was used to conduct the research. The study uncovered a range of conceptions held by the teachers and some of the findings are presented. The results provide information which can assist teachers in their critical reflection upon current practice whilst increasing our understanding of how teachers understand and experience their world.

Almost all NSW primary teachers are required to teach mathematics, a powerful and adaptable mental tool. Quite an amount of research has been completed dealing with the teaching and learning of mathematics (Grouws, 1992), yet:

> After more than twenty years of effort to improve mathematical education, there appears to have been little improvement. The problem is widespread. Unless we can identify at least some of the reasons why mathematics is still a problem subject for many, there is no reason to suppose that future efforts will be more successful than those of the past.(Skemp, 1989, p. 30).

It is possible to argue that one of the reasons for mathematics retaining its reputation as a problem subject, is the performance of the teacher (Siemon, 1989). There has also been growing evidence to suggest that rather than trying to prescribe how teachers should behave, the problems of teaching and learning should be approached by developing techniques that help teachers critically reflect upon their current teaching and learning practices (Prosser, 1994, p. 39). A phenomenographical approach (Marton 1981, 1986) was chosen because it is a useful technique in providing data for this reflective process due to its sharper focus upon peoples' current ideas and upon how their world is conceptualised Phenomenography seeks to uncover the qualitatively different ways in which people experience or think about various phenomena. The analysis involves the formation of categories of description to reflect these conceptions. It is essentially a process of identification, construction, delimitation and refinement of the descriptions of the differing conceptions held by teachers towards the set of specific teaching behaviours.

Galbraith (1995) uses the term paradigm to mean a basic set of beliefs or assumptions which are used as a reference point for research and for guiding further activity. Cohen & Manion (1994) present a summary of the differing viewpoints that have existed for some time between two broad theoretical positions: the 'normative' paradigm adopting an objectivist (positivist) stance and the 'interpretative' paradigm. Patton (1980) presents another point of view with his 'paradigm of choices'. Presenting his debate from a pragmatic, empirical perspective, Patton sees the paradigms as the endpoints upon a continuum. All research is to be found somewhere between the two ideal ends. Nisbett (1980) refers to the choice between paradigms as a spectrum with one side being the 'agricultural model' with controlled experiments to improve the product (positivist) and the other side being the 'go and live there and see what it is like' model. Others such as Lather (1991) provide alternative paradigms. Irrespective of which argument is the more appealing, an important implication of these models is that a paradigm is not a monolithic entity, but contains a variety of possible choices. "One approach may appear radically phenomenological; another, mildly positivistic in style, tone, and formation" (Fetterman, 1988, p. 5). Thus while the phenomenographic methodology falls within the interpretive paradigm and shares common ground with

phenomenology it also has a difference of perspective. Marton (1981) regards phenomenology as seeking to orient the researcher to the world by making statements about it. Whereas the perspective of phenomenography seeks to examine other peoples' ideas about the world and their experience of it. It aims to analyse and describe differences in conceptions of a certain phenomenon from the subject's perspective.

A thorough examination of the issues arising from the theoretical positioning of this study is beyond the scope of this paper. However what is crucial is the intentions and perspective of the researcher. The theory of intentionality which proposes that humans are always related to reality through the intentional character of the consciousness is at the heart of this study (Husserl, 1970, p.1900-01). Thus

> the categories of description produced within phenomenography are not externally related to reality, in contrast with the view within the positivistic research tradition. Instead, the categories of description are internally related or, more precisely, intentionally related to the statements expressed by the individuals investigated (Sandberg, in press, p. 10).

As the researcher, I cannot escape from being intentionally related to the research object and the categories of description are intentionally constructed through the researcher's interpretation. Thus the methodology raises a number of important issues such as "its perceived lack of validity, lack of predictive power, researcher bias and denial of the voice of the individual through categorisation" (Bowden & Walsh, 1994, p.2). There is not the time nor space to devote to these issues. However I will briefly add two often quoted arguments given in defense of the methodology.

The first is that phenomenography passes the test of Miller and Parlett (1974) who claim that one of the best guides to the validity of a work lies in the extent of its 'recognizable reality'. Because of its success with the test, phenomenography has spread widely to other groups and countries and the 'cross-pollination' among various research groups had an important formative influence on the emerging descriptions of student learning (Entwistle & Marton, 1984). More recently, it has been used to describe only the learning outcomes or subject's conceptions of specific phenomena (Marton, 1988). For example, studies have been undertaken in subject areas such as Physics (Walsh, Bowden & Dall' Alba, 1995), Chemistry (Lybeck, Marton, Stromdahl & Tullberg, 1988), Economics (Dahlgren, 1984), History (Hounsell, 1984), Mathematics (Marton & Neuman, 1990), Business Administration (Sandberg, 1991), and Literary Texts (Marton, Asplund Carlson & Halasz, 1992).

The second involves the issue of scientific procedures and is usually concerned with the question: 'will another researcher independently arrive at the same set of categories of description by studying the same data?' Marton would argue that finding the categories is a form of discovery and as such it does not have to be replicated. However once the categories have been found, it should be possible to reach a high degree of intersubjective agreement. "Structually it is a distinction similar to that between inventing an experiment and carrying it out. Nobody would require different researchers independently to invent the same experiment; once it is invented, it should be possible, however, for it to be carried out in different places by different researchers with similar results" (Marton, 1988, p. 183).

While these two points are an inadequate response to the many theoretical issues raised by other paradigms a careful consideration can be found in the work of Bowden & Walsh (1994). It should also be noted that some researchers reject the notion of making a defence and propose the creation of new understandings for the terms reliability and validity are needed, which will be different to those accepted by the positivists (Sandberg, in press).

THE STUDY

This paper reports briefly upon an experimental phase of a much larger study and involves the use of a questionnaire. This questionnaire contained six scenarios with

spaces provided for the teachers to record their responses to a number of questions. The teachers were asked to read each scenario and to imagine behaving in the manner described by the scenario and to record their reasons for doing so. They were also asked for reasons why they might refrain from teaching in the manner described. There were further questions investigating salient referents and relevant demographic information which will not be included in this report.

Participants

The sample was randomly selected from across the population of primary teachers who worked at a NSW Department of School Education (DSE) primary school and who taught mathematics to years 5 and/or 6. The teachers that were approached, belonged to schools:

(i) that had an enrollment above 100 against their listing in the 1993 Directory of Government Schools in New South Wales (DSE, 1993). The purpose of this condition was to eliminate the very small schools. It was felt that these schools would have composite classes with too broad a range of abilities in the one class. That is, the class would have three or more year levels within the one class (years 4-6). It is argued that the teaching strategies employed by the teachers at these schools are likely to be different from those employed in larger schools. A question was included to monitor the levels within the classes of the teachers in the study. A disadvantage, however of this condition, is the reduction in the number of country schools in the sample.

(ii) that were not designated as a 'special' (SSP) school. Again it is argued that the teaching strategies employed by the teachers are different from those employed in larger schools.

There were 116 schools chosen and after obtaining approval from the Department of School Education, a letter was sent to the Principals of these schools seeking permission to approach teachers at their school and asking for a list of the teachers names. A total of 55 Principals gave their consent, and using the names provided from these schools, 150 teachers were sent a questionnaire and eighty-nine teachers completed and returned the questionnaire.

The analysis

A phenomenographical approach (Marton, 1981, 1986) was used to analyse the results of this questionnaire. This phase aimed to produce a set of descriptive categories which encapsulated the variety of conceptions from the data and thus indicated the differences in the ways the phenomenon is understood. The nature of these differences can be obtained by comparing the categories. The categories were formed by the researcher interpreting the data from his or her own perspective and constructing descriptions of the relationships of the subjects to the phenomenon. The methodology assumes that the data will be refined via an iterative process in order to construct a set of categories that are internally consistent and related to each other in a way that is satisfactory for later use. "There is an inevitable tension between being faithful to the data and at the same time creating, from the point of view of the researcher, a tidy construction that is useful for some further explanatory or educational purpose" (Walsh, 1994, p. 19). The possible problems of this phase are: the imposition of a logical framework upon the data which is not justified ; an over-reliance upon the framework of the researcher so that the interpretation of the data is skewed; and the making of adjustments to categories that are not supported by the data. To reduce these dangers, the data was analysed by a team of three who were familiar with the methodology but with two members who were not familiar with the purpose of the study. It is argued that this will reduce the chance of one view dominating the construction phase. The procedure consisted of distributing to each member, two weeks before the first meeting, a common set of copies of twenty responses randomly selected from the total sample. Trigwell (1994, p. 59) favours the use of between 15-20 scripts when initially analysising phenomenographic interview data. "At the lower end, about 15 are required to have a reasonable chance of getting the extremes

of the range", with the problem of too much detail as you go beyond twenty. Two meetings were then held in order to produce a common set of categories for each scenario. This formation process involved an iterative procedure whereby the categories were refined upon the basis of evidence provided by the scripts. The set of transcripts were arranged into categories to exhibit a hierarchial structure whereby a particular conception was subsumed and extended in a higher category. This ordering of categories, however, is based upon the nature of the understanding from the perspective of the subject (e.g. mathematics teaching) and not imposed in advance upon the data by the researcher. During these meetings, a second unseen sample of five responses randomly chosen were also coded by each member according to the agreed category descriptions and any differences were discussed and the clarified. The meetings were taped and a summary of each meeting was submitted to the members to ascertain if they agreed that it was an accurate record and to make further observations and comments.

The iterative process consisted of a number of stages. The first stage was achieved by identifying and marking comments which were deemed relevant. What was deemed to be relevant went beyond the mere meaning of words and "in general, the interpretation had to be made in relation to the context within which that comment had been made" (Marton & Säljö, 1984, p. 38). These comments formed a pool of meaning for the following stages. The following stages required a change of focus away from the individual subjects and to the meanings embedded within the comments regardless of whether these different meanings came from the same individual or not. Hence the boundaries between the subjects were discarded. Categorising these comments became a process whereby a decision was made about the specific level of the comments in relation to the other transcripts. Also when a response was unclear, it was examined within the context of what was said in the rest of the transcript (Bowden, 1994, p. 11). Thus this reading for meaning strategy required the members of the team to think about what was being stated rather than just categorising the responses according to key words. It is a process of considering the similarities and differences. The similarities contribute the detail within each category and the differences help set the limits of each category in relation to the others. The characteristics of each category are described by using the language of the scripts that are classified against that category.

> The process involves the *reduction* of unimportant dissimilarities e.g. terminology or other superficial characteristics, and the integration and generalization of important similarities i.e. a specification of the core elements which make up the content and structure of a given category (Dahlgren, 1984, p.24).

The format of each category scale consists of a number of levels with the first receiving a score of zero for a blank or nonresponse. The next level received a score of one and was reserved for answers that were off task and were unable to be categorised. The decison to do this was based upon Biggs and Collis's (1982) work with the SOLO Taxonomy which uses a score of one for the prestructural responses. The rest of the scale is hierarchial and the steps are inclusive. Using the category coding guides, the researcher then coded the 89 survey responses. Again the reading for meaning strategy was adopted and as a check, the researcher examined the correlation between the twenty-five examples coded in the team meetings and the code allocated during the coding of the whole group.

RESULTS

"To provide a full description of the categories identified necessitates the presentation of the whole range of quotations covering the delimiting instances" (Entwistle, 1984, p. 17). This presents a difficulty and so I have chosen to present only a part of the results for one scenario and to present the data in the following manner:
(i)   Firstly, the scenario is presented;
(ii)   Next, a frequency distribution of the responses (Table 1) and the coding categories assigned *for not* teaching in the manner described by the scenario; and

(iii)   The coding categories, descriptions and examples of the reasons *for not* using a prepared stencil described by the scenario (Table 2). Direct quotes from the survey are used.

Scenario description: You are teaching mathematics to your class at the usual time and place. You have recently finished teaching some mathematics to your class and decide they need some practice. You consider various options but decide to use a prepared stencil. (In this study a prepared stencil is considered to be a teacher or commercially produced sheet containing a set of questions with spaces provided for working and/or answers).

Table 1: Frequency and Percentage Distribution of the categories of reasons for not using a stencil (n = 89).

	Category Code	*Frequency*	*Percentage**
0.	Non response.	4	4.5
1.	Prestructural.	0	0
2.	Teacher administration.	13	14.6
3.	Curriculum reasons.	17	19.1
4.	Narrow medium.	23	25.8
5.	Doesn't cater for individuals.	21	23.6
6.	Language and reading difficulties.	8	9.0
7.	Cheating.	3	3.4
	Total	89	100

Table 2: Coding categories, descriptions and examples of the reasons for not using a prepared stencil

Code	Category Description
0.	Non response
1.	Prestructural

2.   Administration - lack of paper or time, not convenient, presentation factors
e.g.
"Children are not properly focused on topic. Waste of paper. Children take longer answering questions. When work is written on the blackboard they must try to keep up".

3.   Curriculum - doesn't cater for all topics or activities; it may not be relevant; or is used as a whole class tool.
e.g.
" some activities e.g. measurement, volume etc are not relevent to be dealt with by stencil - may not deal exactly with work covered".
"activities might involve the use of concrete materials eg.volume, 3D shapes & nets, compassses".

4.   Too narrow a medium: limited to pen and paper; ignores alternative methods which are available.
e.g.
" If it has been decided that more practice is needed then it is assumed that not all students have adequately achieved the desired outcomes. Therefore a reteaching (either by inventing a new strategy or by
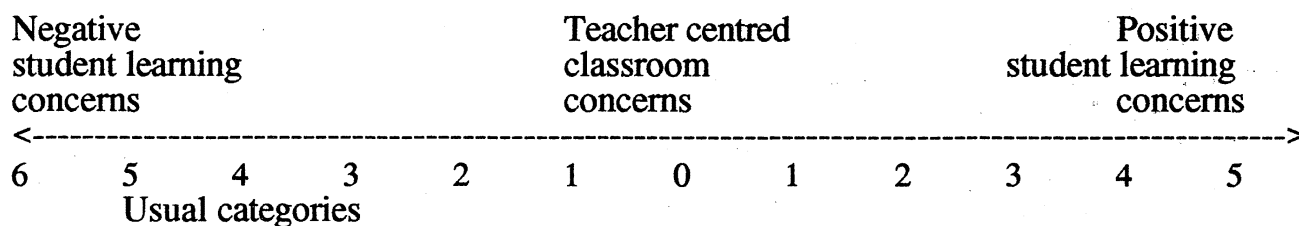
rehashing a previous lesson) of concepts is needed rather than student practising something they can't do".

5.   Doesn't cater for all the the students - individual learning styles
e.g.
"May not be exactly appropriate, wrong level, too easy/hard. Not stimulating. If chn can do the process etc. why repeat the process 20 times. Just a time filler".
"Boring repetition not best practice. Commercial sheets cannot solve problems children may be experiencing".

6.   Language and reading difficulties
e.g.
"Some ch'n have mathematical skills but are unable to reproduce them in written form because they don't have the "reading" skills that are often required.
Paper usage - we are constantly being asked to 'cut back' ".

7.   Cheating: the students can't be trusted to be responsible for their learning.
e.g.
"Less opportunity to identify individual problems
no certainty that student has done work if done at home; doubles time taken if follow-up lesson required".

Discussion

During the initial consideration of each scenario it became apparent to the panel that there was a movement in the quality and quantity of the responses. In those questions considering the reasons for doing a particular behaviour there was a movement in the focus of responses going from teacher reasons only, to a combination of teacher and child reasons, and in some cases to student focused reasons. This movement seemingly progressed beyond an inward looking model with its emphasis upon the teacher and so concentrating upon administration and management concerns to a more outward looking model which considered factors which would enhance the student learning within the class. A similar movement was also observable in the responses to the quesions considering the reasons for not doing a particular behaviour. However this movement had a negative focus. From these observations it was possible to construct a continuum (Fig. 1) which provided an overview of the descriptions of the conceptions contained within the responses to all of the scenarios and the relationships within the categories used in the coding phase.

Fig. 1: Continuum of responses given to the scenarios and their relationship with the categories

Negative student learning concerns	Teacher centred classroom concerns	Positive student learning concerns

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6   5   4   3   2   1   0   1   2   3   4   5
     Usual categories

CONCLUSION

The outcomes of this research study were a set of categories describing the range of the conceptions held by upper primary school teachers of mathematics towards a

specific teaching behaviour contained within each scenario. While presenting only a very small selection of data, nevertheless it was possible via the continuum to provide a clear picture of the relationships existing between the conceptions held by this group of teachers. These conceptions are relational and peculiar to each individual teacher within a particular context. The categories although hierarchial in nature, do not represent a developmental progression. Thus, it is not argued that because there is a range of conceptions resulting from the study that it means that people have attained a particular conception by moving through the lower ones (such as Van Hiele's (1985) developmental hierarchy for geometrical thought). Similarly, it is not argued that in order to foster a higher level conception, one should address all the issues between the current and the desired conception. Nevertheless, "it would not be a misuse of the results to use the relations between conceptions to develop a mechanism to facilitate conceptual change" (Trigwell, 1994, p. 71). For although arising from a contextual understanding, the descriptions are really decontextualised and can be used in contexts other than the original one. Thus these complex categories of description can: be a useful tool in the task of understanding how other teachers think about and experience their world; and provide teachers with a resource to assist in a critical reflection of their current teaching and learning practices.

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