DESCRIBING TEACHING: CATEGORIES FROM TEACHER EDUCATORS' DESCRIPTIONS OF QUALITY PRACTICE

PETER SULLIVAN
Australian Catholic University
Christ Campus

JUDITH MOUSLEY
Deakin University
Geelong Campus

Survey responses of 125 teacher educators and experienced teachers on an open-response item on aspects of mathematics teaching are presented. A qualitative analysis of the responses using the NUDIST program resulted in six major categories of responses. These were Communication, Problem solving, Building understanding, Engagement, Task orientation and Teacher concern. Within each of these categories, the frequency of use of particular phrases and descriptors indicates general beliefs about the important characteristics of quality mathematics teaching. These categories and qualifications are presented as a starting point for further discussions about the development of a common language for describing teaching.

This paper is an attempt to initiate discussion on ways to describe teaching. It presents a list of categories which arose from a survey of teacher educators on ways of describing quality teaching, and then discusses how these can inform our understanding of the task of teaching. The survey, which had mainly fixed format items and some open response items, was first trialled by twelve teacher educators who were asked to complete the questionnaire with an observer present. The educators were requested to think aloud while responding to the items to determine the appropriateness of questionnaire items and wording. All comments and queries were recorded, then after appropriate revision the trial process was repeated with a further four teacher educators completing the survey and being interviewed.

The revised survey was mailed to three groups. There were 40 survey responses from graduate students in mathematics education (100% return), 56 from Victorian teacher educators (80% return), and 29 from American teacher educators (40% return). These groups were selected because they represented an informed view of current issues in teaching and learning.

The focus here is one open-response item in which respondents could give their own impressions of the important features of teaching. There was a huge diversity in the actions which were rated as important as well as the language used to describe these. This article is an attempt to extract some common themes from the diversity.

ANALYSING FREE FORMAT RESPONSES

The data presented here are the responses to one open-response item, presented as follows:

> Throughout this survey we want you to imagine a mathematics lesson, at any year level, where the students are learning, for example, to estimate the mass of various objects, or to add fractions, or to record given information as a graph. Before turning the page, please write down the most important characteristics which a **quality** mathematics lesson on any of these concepts/skills would usually have.

Respondents were asked to complete this item first, before they read any categories or actions presented by the researchers. In this way, it was hoped that responses would represent natural views.

Initially, all 125 responses were typed and categorised by hand under general sub-headings. In summary, this stage of the research involved the following actions:

- Responses were typed and stored on computer disks.
- Key ideas were identified; these are called nodes (e.g. *communication*).
- Subsidiary ideas were noted; these are called sub-nodes (e.g. *recording*).
- Each phrase in the responses was coded according to the node and sub-node.
- The qualitative analysis program NUDIST was used to group the phrases together.

The collections of phrases were examined to determine whether they formed a coherent set. The phrases which were not congruent with the others in the set were moved to a different sub-node.
The sub-nodes were regrouped.
These last two steps were repeated until we were satisfied.
The data are presented.

RESULTS

As with most research, our goal is to organise, summarise, and present the data in a coherent way in order to allow readers to interpret the findings in the light of their own practices. The data are organised here into six nodes. These nodes are presented in the order of the frequency with which phrases were coded under the node. While there is no suggestion that these nodes should be compared quantitatively, it gives some insights into the priorities of the respondents.

There is a summary table for each node to indicate the frequency of phrases which were assigned to each sub-node. For the commonly cited sub-nodes, a list of some phrases is presented. It is not appropriate to produce lists of frequency tables for each sub node, but to give an indication of the frequency of each type of statement, frequently occurring statements (say greater than 10 times) are printed in larger font, statements given often (3 - 9 times) are normal size, and statements given infrequently (1 or 2 times) are presented in small font.

Building understanding.

The frequency of use of phrases categorised under each of the sub-nodes of building understanding are presented in Table 1.

Table 1: Number of entries under each sub-node of **building understanding**

Sub-node	No. of entries
Materials	36
Prior knowledge	21
Mathematical thinking	15
Connections	14
Conceptual understanding	10
Reflection	6
Sequence	4
Review	6

Building understanding relates to comments which seemed to refer to a role which the teacher assumes in order to convey some pre-determined meaning to students. It is a recognition of a content to be covered, and of strategies to achieve this end by building on existing knowledge, using material to explain and clarify concepts, choosing appropriate sequences, helping students to make connections and form relationships, and to know the meaning of terms. There is a strong inference of decision-making, direction, explanations and control by teachers.

We coded as "materials" statements like the following:

Concrete representations

Aids that can be manipulated

This was the most commonly listed sub-node overall.

A key component of learning is making links with the students' existing knowledge. We coded as *prior knowledge* phrases like the following :

Prior knowledge of children, existing understanding of concepts

Appropriate to learner

The making of connections is an activity which the student does, but which can also be the focus of the attention of the teacher. These can also have a mathematical emphasis. We coded as *connections* statements like:

Mathematical connections

Constructing relationships

We coded as *mathematical thinking*, including the use of appropriate language, phrases like the following:

Significant mathematical issues arise in a natural way out

Present a strong "sense" of number

We coded as *conceptual understanding*:

Build understanding of concepts or procedures including meaning

Coherence and development of ideas and concepts in both teaching and learning

This, as with most sub-nodes in this node, is about concepts, mathematical ideas, developing links and perhaps most refers to the Skemp (1976) notion of relational understanding. The node overall refers to an orientation on the part of the teacher to plan and teach mathematics in an orderly, coherent, sequenced, and connected way.

Communication.

Communication is widely acknowledged as an essential component of learning mathematics, but for which there is often inadequate definition or explanation which allows an appreciation of what is actually meant by the term and associated issues. In grouping the responses, this node was used to include statements related to opportunities for talking, explaining, describing, listening, asking, clarifying, sharing, writing, reporting, and recording. Table 2 presents the sub-nodes which form this node and indicates the frequency of occurrence of phrases which were placed within each sub-node.

Table 2: Number of entries under each sub-node of **communication**

Sub-node	No. of entries
Discussion between pupils	34
Sharing strategies	20
Co-operative situations	15
Recording	6

Under the sub-node *discussion between pupils* phrases like the following were used:

Discussion can occur between children

Lots of discourse

This is an example of the dilemmas we meet when describing teaching. Clearly discussion is an avenue to other goals. It has limited value in itself. This suggests that the language we use to describe this aspect of teaching needs to be more explicit and less open to interpretation by the listener.

The second sub-node was termed *sharing strategies*. Within this the various terms used were:

...alternate solution strategies

Sharing children's own strategies

This is a development of the first sub-node, with an assumption that the teacher is facilitating some structured sharing of ideas. Again it is an avenue to a broader goal.

Under the sub-node termed *co-operative situations* phases like the following were used

Co-operative group work

Interacting with peers

The same comment as above is relevant. The goal is not the co-operative situation, nor even the interaction, but how such situations lead to opportunities for learning. While the development of co-operative skills is useful and is seen as a necessary competency for industry (e.g. The Mayer Committee, 1992), it is also a strategy designed to achieve some other goal.

Engagement.

This node is about the students' involvement in their own learning. This has always been recognised as important by good teachers but has had renewed impetus with recent conceptions of knowledge as constructed by the learner. Table 3 shows the nodes used to compose this factor.

Table 3: Number of entries under each sub-node of **engagement**

Sub-node	No. of entries
Active involvement	34
Personally relevant	16
Enjoyment	5
Real world	7
Motivation	6
Variety	6

We coded as application to *real world* the following:

Based on real world situations

Opportunities to apply skills and understandings

A somewhat significant dilemma arises here. Is the use of real world examples merely an aid to some other goal, or is it in fact a goal in itself, or some combination? This perhaps is an issue which could provoke some debate among mathematics educators, but it is clear that the issue is not resolved by examination of curriculum documents.

We coded as *personally relevant*:

Experiences/activities have relevance to children

Personally meaningful and relevant to students

A link to a situation children can relate to

The notion of active involvement was the second most frequently cited phrase. However, by itself it has no real meaning. Does it presume some physical activity? Is physical activity enough? It is another example of a term which is used loosely and which serve to reinforce the readers' or listeners' predisposition but which does not necessarily convey the meaning intended by the communicator. We coded as *active involvement* terms such as the following:

Students will be actively involved in the learning process

Engagement in solving interesting problems

Physical involvement

Students are "immersed" in the mathematics they will be learning

We coded as *motivation:*

Interested in what they are doing

Engagement in solving interesting problems

Excitement at exploring

Students enthusiastically embracing the task

The refers to a rationale for encouraging the students to become engaged in their learning or, in other words, to want to learn.

Problem-solving.

Problem-solving has been a major strand in considerations about mathematics teaching and learning for over 30 years (e.g. Polya, 1957). Nevertheless the term problem solving has been used to mean many things in many situations. It is not surprising that some variation of the term problem-solving was used frequently by respondents. As with other terms discussed here, use of the term problem-solving does not convey to an intended audience any specific meaning.

In the analysis, the phrases grouped in this node were those which relate to students working out for themselves how to perform mathematical tasks in such a way that it is the students' own work and they know that it is. It refers to activities such as risk-taking, challenging, exploring, investigating, thinking, asking, and posing. Table 4 presents the sub-nodes which form this node and indicates the frequency of occurrence of phrases which were placed within each sub-node.

Table 4: Number of entries under each sub-node of **problem-solving**

Sub-node	No. of entries
Investigation/problem-solving	27
Open-ended activities	14
Challenging	6
Problem posing	6

The *investigation/problem solving* node was made up of the following comments.

Student active involvement in investigations

Engagement in solving interesting problems

Promotes thinking

Under the heading *open-ended*, the following descriptions were coded

Open-ended questions

Opportunities to explore

The use of a term such as problem solving is not adequate in itself, and it may be necessary to use qualifying phrases in order to make the meaning clear.

Teacher concern (for students).

The reviews of teacher effectiveness use the term "family like atmosphere" as being a component of classrooms where the children have comparatively high achievement. It is hard to know the significance of that phrase but a recurring thread in the listed features of a quality lesson were characteristics which suggested that the teacher is sensitive to the needs of the students as individuals.

Table 5: Number of entries under each sub-node of **teacher concern**

Sub-node	No. of entries
Catering for levels of ability	11
Non-threatening	10
Rapport	9
Relationships	4
Goal setting	2
Enthusiasm	8

The phrases related to *catering for abilities* were as follows

Allowing for levels of ability
Challenging but caters for individual differences

The phrases related to *non-threatening* were like:

Some in-built success
Students should feel comfortable within taking risks

The sub-nodes are explicit about a relationship developed between the teacher and pupils. The task is not just to teach mathematics but to teach students as well. While the best ways to teach mathematics is to cater for the range of abilities and develop rapport, nevertheless we suspect that the node **teacher concern** is a more a recognition that teaching and learning is a two-way process and that there is something natural in the expert/novice relationship which includes a nurturing component.

Task orientation.

Task orientation, a factor often cited in reviews of teaching effectiveness (e.g. Good, Grouws & Ebmeier, 1983), refers to actions designed to keep the students working towards achieving the lesson's goals. We took it to mean decisions made by the teacher about a specific focus for what would happen in the lesson and a commitment to pursuing that focus and to communicating the focus to the students.

Table 6: Number of entries under each sub-node of **task orientation**

Sub-node	No. of entries
Clear purpose	14
Clear instruction	7
Organisation	4
Questions	3
Assessment	4

The phrases coded as *clear purpose* were like the following:

The teacher making clear what is the purpose of the lesson
A set of clear objectives which connect to what pupils already know

The obvious assumption is that the teacher will have selected a direction or goal for the lesson, that this is communicated to the students in some way, and even that it could be identified by an observer. A similar comment can be made about the next two sub-nodes, *clear instructions* and *organisation*.

SUMMARY

The statements listed above are responses from 125 experienced mathematics educators to an open survey item which sought views on features of quality lessons. The first observation was of the diversity of replies. Given that teaching is highly complex it was anticipated that a broad range of factors would contribute to an impression of a quality lesson. Nevertheless we were surprised by the lack of commonality in the responses. It seemed that there was little professional language taken as shared by the community represented by the replies. We see this as an important issue. The purpose of our professional interactions, in papers and reports, at conferences and elsewhere, is to develop sets of shared meanings. We suggest that there needs to be attention to the practical and theoretical meanings of the constructs which comprise our understanding of the tasks of teaching and research about teaching. We need to subject our professional language to detailed examination and to test our individual interpretations in practical situations.

In an attempt to seek some commonality in this diversity we dissected responses into phrases and then grouped them together to seek trends and features. Six factors emerged as components of the replies. The six nodes, along with summary descriptions are as follows:

Building understanding: This is about a recognition of a content to be covered, and of strategies to achieve this end by building on existing knowledge, using materials to explain and clarify concepts, choosing appropriate sequences, helping students to make connections and to form relationships, and knowing the meaning of terms. In this node, strong inferences of teacher decision, teacher direction, teacher explanations and teacher control are evident.

Communication: Under this node were included statements related to opportunities for talking, explaining, describing, listening, asking, clarifying, sharing, writing, reporting, and recording. The emphasis within this node is on expressing and communicating mathematics.

Engagement: This is about facilitating student involvement in their own learning. It includes actively involving the students in their learning, and motivating students to learn. This can be done by using personally relevant material or real world situations, and by seeking to make learning enjoyable.

Problem solving: This refers to activities such as risk taking, challenging, exploring, investigating, thinking, asking, and posing. It is about students using their own conceptions to interpret unfamiliar situations and becoming comfortable with their own ability to do this.

Task orientation: This includes a focus by the teacher on specific goals which are made explicit, clear instructions, good organisation and some assessment of the achievement of the lessons' aims.

Teacher concern: This is about treating the students as individuals, the creation of non-threatening environments which support opportunities for success by all students, the development of mutually positive relationships between teacher and students, and about shared goal setting.

While these six factors present a summary of the responses, the factors are different in both the focus and the locus of responsibility. For example, the node **building understanding** was outstanding in terms of the number of times respondents referred to its features (112 times). Upon reflection, it seemed that each of the other nodes could be considered a vehicle for building mathematical understanding. For instance, the phrases listed under **task orientation** seemed directed at teacher actions which in turn would lead to building understanding. There were even sub-nodes of **building understanding** which were merely mechanisms for achieving the goal; *materials* is such a sub-node. While other nodes, such as **communication**, may be significant in themselves, the main purpose of the comments within the node seem to be aimed at building understanding.

Overall, it seems that the challenges for teacher educators are to find ways to define and communicate goals of teaching and to differentiate between goals and tools.

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