

# Student and Teacher Beliefs About Helpful Teaching Practices in Mathematics Instruction

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## Introduction

This paper reports on a study which investigated the beliefs of 142 Year Six students and their mathematics teachers from six Catholic Primary Schools in Melbourne, with respect to the teaching actions perceived to be helpful in facilitating mathematical learning and their relationship to teaching practice in mathematics instruction. The insights of students and teachers add an important dimension to the advice offered by the informed mathematics education community and current mathematics curriculum documents in relation to effective mathematics teaching strategies, and may provide a stimulus for teachers to review and change their current practice. Additionally, the results suggest that mathematics teachers' practice is aligned to student beliefs concerning the helpfulness of teacher actions, rather than their own beliefs, the beliefs of the informed mathematics education community or those expressed in mathematics curriculum advice documents. This finding is of concern and has important implications for mathematics education and teacher professional development.

## Promoting Effective Mathematics Teaching

Throughout the past eight years there has been a number of initiatives aimed at improving the quality of learning and teaching in mathematics classrooms. In the context of Victorian Primary Schools, The Mathematics Framework P-10 (1988), the MCTP Professional Development

Package (1988), the Exploring Mathematics in Classrooms (E.M.I.C.) In-service Course (1990), A National Statement on Mathematics for Australian Schools (1990) and the Mathematics Curriculum and Standards Framework (1995) have been instrumental in advising teachers of improved strategies for teaching mathematics. These documents promote an image of a mathematics teacher who: (a) helps students develop positive attitudes towards mathematics; (b) helps students to understand that learning involves taking risks; (c) utilises constructivist learning approaches; (d) challenges students' existing conceptions; (e) provides opportunities for students to reflect on their learning; (f) provides feedback to students about their mathematical learning; (g) provides challenge within a supportive framework; (h) utilises co-operative learning models; (i) develops activities which are purposeful, interesting, and build upon and respect students' life experiences; (j) gives students the opportunity to talk and write about mathematics; (k) uses gender and culturally inclusive language, resources and activities; (l) Involves students in problem solving activities; (m) enables students to experience the process through which mathematics develops; (n) uses a variety of assessment strategies and records: paper and pencil tests, oral tests; practical skills tests, projects, work samples, group reports, anecdotal records, self-assessment and peer assessment.

One important dimension missing from the wealth of advice currently available

to teachers, is the insight of *students* regarding the helpfulness of particular teacher actions in facilitating their mathematical learning. Teachers who are able to reflect upon the actions which students believe to be helpful in assisting learning are able to select appropriate teaching strategies for their students from a more informed position; a position which, in addition to their own beliefs about effective mathematics teaching practices, takes into account the opinions of both students, the informed mathematics education community and curriculum advice.

For example, if the teaching actions arising from current mathematics curriculum advice were perceived by students to be helpful in facilitating mathematics learning, this would add support to the changes in mathematics teaching being advocated by current curriculum advice and may provide an incentive for teachers to adopt new actions or strategies. Alternatively, if certain teacher actions were perceived by students to be only sometimes or perhaps never helpful, this may point to a need to select alternative teaching strategies, or it may indicate a need to educate students about the importance of such actions for enhancing their mathematical learning.

### **Student Ideas About How We Should Teach Mathematics**

In order to gain some insight into the teaching actions students perceived to be helpful in facilitating their mathematical learning, 142 Year Six students and their mathematics teachers were surveyed using the Helpfulness of Teacher Actions Questionnaire (Gervasoni, 1994). This questionnaire asks respondents to rate the helpfulness of sixteen teacher actions on a four point Likert-type scale and to suggest any additional teacher actions believed to facilitate mathematical learning. A HOTAQ response of *always helpful* scored 3, a response of *usually helpful* scored 2, a response of *sometimes helpful*

scored 1 and a response of *never helpful* scored 0.

The mean response levels for each teacher action shown in Table 1 indicate that the Year Six students in the study were most likely to perceive the teacher actions described on the Helpfulness of Teacher Actions Questionnaire (HOTAQ) as *usually helpful* in facilitating mathematical learning. The only exception to this was Item D, *the teacher asks you to explain or write a report about how you completed a maths activity*. Students were most likely to rate this action as only *sometimes helpful*.

In contrast to the perceptions of the students, Table 1 suggests that the teachers surveyed had a more positive perception of the helpfulness of many of the teaching actions described. As a group, teachers perceived seven of the sixteen teacher actions as *always helpful*. This suggests that teachers perceive many of their teaching actions to be more helpful than their students actually find them.

In order to make some comparison between the beliefs of students and teachers and the advice offered by curriculum documents, a HOTAQ was completed by the researcher on behalf of these documents [*The Mathematics Framework P-10* (1988), *the Exploring Mathematics in Classrooms (E.M.I.C.) In-service Course* (1990) and *A National Statement on Mathematics for Australian Schools* (1990)]. The resulting responses suggest that these documents are more positive about the teacher actions described on the HOTAQ than the students, but less positive than the teacher group. Additionally, small sample of members of the informed mathematics education community from Victoria, Australia and Georgia, USA were also surveyed. This group was more positive about several actions than the students, but less positive about others, perceiving several items to be only sometimes important in facilitating mathematical learning. Generally, the

informed community groups were less positive about the sixteen teacher actions

than the teacher group, perceiving only four actions each to be always important.

**Table 1** HOTAQ group response means with corresponding response statements shown in brackets. Responses derived from mathematics curriculum advice documents are also shown.

HOTAQ ITEMS	HOTAQ Response Means				Mathematics Curriculum Documents
	Year Six Mathematics Students (n=142)	Year Six Mathematics Teachers (n=8)	Victorian Informed Community (n=6)	USA Informed Community (n=5)	
a. The teacher explains to the whole class exactly how to complete each maths activity and shows an example.	2.3 (usually)	2.1 (usually)	1.2 (sometimes)	1.0 (sometimes)	sometimes
b. The teacher encourages you to complete your maths activities in groups.	1.7 (usually)	2.0 (usually)	1.3 (sometimes)	2.2 (usually)	usually
c. The teacher encourages you to use blocks, models, counters, pictures, calculators or other materials to help you complete maths activities.	1.6 (usually)	2.3 (usually)	1.8 (usually)	2.2 (usually)	always
d. The teacher asks you to explain or write a report about how you completed a maths activity.	1.2 (sometimes)	2.1 (usually)	1.7 (usually)	1.8 (usually)	usually
e. The teacher asks different students in the class to explain to everyone how they completed a maths activity.	1.8 (usually)	2.4 (usually)	1.7 (usually)	1.8 (usually)	usually
f. The teacher gives you maths projects and problems requiring you to investigate the world at home, at school, in the community or the environment.	1.5 (usually)	2.5 (always)	1.7 (usually)	2.8 (always)	always
g. The teacher encourages you to work out your own way of completing maths activities.	2.0 (usually)	1.9 (usually)	2.5 (always)	2.2 (usually)	always
h. The teacher asks you special questions when you don't understand something, which helps you to work out for yourself what to do.	2.1 (usually)	2.4 (usually)	2.7 (always)	2.8 (always)	usually
i. The teacher keeps checking to make sure that you understand.	2.3 (usually)	2.9 (always)	1.3 (sometimes)	2.8 (always)	always
j. The teacher says things to encourage you when you're doing maths.	2.0 (usually)	3.0 (always)	2.0 (usually)	2.8 (always)	always
k. The teacher asks you to explain what types of maths activities you find difficult, and then organises some special activities to help them.	1.8 (usually)	2.4 (usually)	2.5 (always)	2.2 (usually)	usually
l. The teacher makes maths lessons enjoyable and fun.	1.9 (usually)	2.9 (always)	1.5 (usually)	2.4 (usually)	usually
m. The teacher gives you a test to check that you understand.	2.1 (usually)	2.1 (usually)	1.8 (usually)	1.2 (sometimes)	usually
n. The teacher gives regular tables activities to help you learn your tables.	2.3 (usually)	2.5 (always)	1.5 (usually)	1.2 (sometimes)	usually
o. The teacher explains how to solve a problem when you don't understand.	2.3 (usually)	2.5 (always)	1.2 (sometimes)	1.4 (sometimes)	usually
p. The teacher encourages you to discuss ideas and help each other	1.9 (usually)	2.5 (always)	2.5 (always)	**	always

\*\*The USA Version of the HOTAQ did not include this item

## Additional Helpful Teacher Actions.

Additional to the actions described on the HOTAQ, 126 teacher actions were suggested by respondents as helpful in facilitating mathematical learning. These actions were found to have six main features. These features are listed below along with several examples of teacher actions described by students as helpful in facilitating their mathematical learning. It is interesting to note that actions associated with facilitating the

development of deeper mathematical understanding, and engaging students' intellects and interests through appropriate tasks were identified most often. The frequency with which students indicated the helpfulness of teacher actions associated with building deeper mathematical understanding suggests a desire to "understand" mathematics, rather than simply "learn" mathematics.

### Features of Helpful Teacher Actions

1. The teacher acting to facilitate the development of deeper mathematical understandings;

Examples: (a) the teacher sits down and explains something until you understand; (b) the teacher writes different ways to solve a problem so that you could choose which way was easier for you; (c) the teacher uses pizza, fruit or chocolate in helping us to understand.

2. The teacher orchestrating classroom discourse for building mathematical understanding;

Examples: (a) the teacher encourages us to request help from others if we don't understand the question;

(b) the teacher goes around the class asking every person to solve a sum on the blackboard; (c) the teacher asks us to share ways of doing things to work out new ways of solving problems.

3. The teacher engaging students' intellects and interests through appropriate mathematical tasks;

Examples: (a) the teacher lets us do maths investigations of our own choice; (b) the teacher gives you maths questions that are fun and you can relate to them; (c) the teacher gives extra extension activities to smart people.

4. The teacher monitoring student mathematical learning and the learning environment;

Examples: (a) the teacher takes everything at your own pace; (b) the teacher walks around and asks students if they understand what they are doing.

5. The teacher nurturing students;

Examples: (a) the teacher is approachable when you have a problem; (b) when the teacher says that you are doing well.

6. The teacher orientating students to tasks with clear goals and instructions.

Examples: (a) when the teacher explains maths homework; (b) the teacher should explain the sheet several times.

### **Relationship Between Reported Teaching Practice And Beliefs Concerning The Helpfulness Of Teacher Actions**

The informed mathematics education community is largely responsible for the development of mathematics curriculum documents and for the provision of teacher professional development in the area of mathematics. It could therefore be expected that the frequency with which teachers adopt various actions as part of their practice would be related not only to their personal set of beliefs, but also to the importance placed on such actions by the informed mathematics education community and by current curriculum initiatives and advice documents. It could also be expected that teachers' practice would be related to their students perceptions of each actions helpfulness.

In order to determine whether such relationships exist, students and their teachers were asked to report on the frequency with which the 16 teacher actions focused upon in this study were adopted using the Frequency of Teacher Actions Questionnaire (Gervasoni, 1994). Correlations of teacher and student item means with student, teacher, Victorian informed community, USA informed community and mathematics curriculum advice HOTAQ item means were calculated (see Table 2 and Table 3). The correlation co-efficients suggest that a significant positive correlation exists

between the *frequency* with which both students and teachers perceive teacher actions to be adopted and the *helpfulness* students perceive these actions to have in facilitating their mathematical learning. However, no significant correlation exists between the frequency with which students and teachers perceive the sixteen actions to be adopted

and the degree of helpfulness or importance placed on these actions by the teachers, representatives of the Victorian informed mathematics education community, representatives of the USA informed mathematics education community or current mathematics curriculum documents.

**Table 2** Correlation Matrix of Teacher FOTAQ means with group HOTAQ means.

	STUDENT HOTAQ	VIC. INFORMED HOTAQ	USA INFORMED HOTAQ	DOCUMENTS HOTAQ
TEACHER FOTAQ	0.675 ( $p < 0.05$ )	0.179	0.301	0.062

**Table 3** Correlation Matrix of Student FOTAQ means with group HOTAQ means.

	STUDENT HOTAQ	TEACHER HOTAQ	VIC. INFORMED HOTAQ	USA INFORMED HOTAQ	DOCUMENTS HOTAQ
STUDENT FOTAQ	0.944 ( $p < 0.05$ )	0.283	- 0.301	- 0.406	- 0.461

Thus, it appears that teaching practice in mathematics instruction is highly consistent with student beliefs about the helpfulness of teacher actions, but is not consistent with either the beliefs of teachers, the views of the informed mathematics education community, or the views derived from mathematics curriculum documents.

The lack of consistency between teachers' beliefs concerning the helpfulness of teacher actions and the frequency with which these actions are adopted is of some concern, and corroborates Thompson's (1984) finding that teachers' conceptions were not related in a simple way to their instructional decisions and behaviour. Such a finding has enormous implications for professional development in the area of mathematics, as one the major goals of professional development activities has been to assist teachers clarify and develop their beliefs about effective teaching strategies, and then implement teaching practices reflecting these beliefs. However, it appears that teaching practice is influenced more by student beliefs than teacher beliefs. It is important that the discrepancy suggested

between teachers' beliefs and practices is investigated further in order to inform those responsible for teacher professional development. Clearly, if changes in mathematics teaching practice are desired by the informed mathematics

education community, it may be more important to initially convince students about the importance of particular teaching actions in facilitating learning, than to convince teachers! The reasons why teachers' practices do not reflect their beliefs about the helpfulness of the actions are likely to be due to several causes: teachers may not consider that their teaching practices need to reflect their beliefs about the way students most effectively learn; teachers may find that the school policies and programs they are required to implement do not reflect their personal beliefs; or teachers may find that the practices they believe to most helpful are not viable in practice.

Additionally, it is of concern to discover that the beliefs expoused in current mathematics curriculum documents and by the informed community are not significantly reflected in teachers' practice. This lack of consistency between the practice of

teachers and the beliefs of the informed community and curriculum documents also calls for further investigation, and may be due to several causes. Teachers may be unaware of the current beliefs about the most effective way to enhance mathematical learning expressed by the informed mathematics education community and current curriculum advice. On the other hand, teachers may be choosing to disregard this advice because it does not match the reality of the mathematics classroom. Such teachers would not respond well to current curriculum documents or professional development activities. Ideally, all sections of the mathematics education community should be operating under a similar set of assumptions in a co-ordinated approach. The discrepancy in the beliefs of the key players in mathematics education must be rectified if mathematics education is to improve.

### **Implications For Teaching Practice**

Insights gained from this study concerning the teaching actions Year Six students perceive to be helpful in facilitating mathematical learning, suggest several recommendations for mathematics teaching practice:

*Teachers should discuss with their students the benefits of the teaching practices they are adopting. Students may need to be educated about the benefits of strategies such as co-operative learning, student explanations and report writing in mathematics;*

*Teachers should find out the practices their own students find helpful in facilitating mathematical learning;*

*Students perceive the action of the teacher asking them to explain or write a report about how they completed a maths activity, to be only SOMETIMES helpful. Current thinking suggests this action to be important in facilitating*

*mathematical learning. Teachers may therefore need to give more attention to this action, and explain to students the importance of communicating about their mathematical activities. Teachers may need to provide models of ways to communicate mathematically if students are not proficient at this skill.*

### **Implications For Further Research**

This study suggests that teachers' practice is not necessarily related to their beliefs concerning the helpfulness of teaching actions, but is more closely aligned to student beliefs concerning the helpfulness of teacher actions in facilitating mathematical learning. This finding has serious implications for teacher professional development and the promotion of teacher change in the area of mathematics education. More needs to be learned about the relationship between teachers' beliefs and their practice. It is therefore recommended that:

- Further research is undertaken to determine why the practices of mathematics teachers do not reflect their beliefs about the helpfulness of the actions they adopt.

Further research is undertaken to determine how the practices of mathematics teachers are influenced by student beliefs concerning the helpfulness of the actions they adopt. Instruments such as the HOTAQ and FOTAQ are trialed as part of a professional development activity for mathematics teachers which aims to increase teachers' awareness of their students' beliefs regarding effective teaching practices as a method of initiating teacher change.

Similarly, in the current environment of change in regard to mathematics teaching, it is apparent that there are significant differences among sections of the mathematics education community

regarding the actions associated with effective mathematics teaching. It is important to learn about the source of this variance if a co-ordinated approach to mathematics education is to be developed. It is therefore recommended that further research, with larger teacher and informed community samples, be undertaken to verify the results of this study in respect to:

Why no significant positive relationship was found to exist between the frequency with which Year Six teachers perceive themselves as adopting teaching actions, and the degree of importance placed on these actions by curriculum documents and representatives of the Victorian and USA informed communities;

What is the source of the variance of student, teacher, Victorian and USA informed community opinions in respect to the helpfulness of teacher actions in facilitating mathematical learning;

Why no significant positive relationship was found to exist between teacher perceptions of the helpfulness of teacher actions and perceptions of the importance of teacher actions advocated in current mathematics curriculum documents;

Why no significant positive relationship was found to exist between perceptions of the importance of teaching actions by representatives of the Victorian informed community and curriculum advice documents, when a significant positive correlation was found to exist between perceptions of the USA informed community and current advice documents.

## Conclusion

This study provides a significant insight into the minds of Year Six

students with regard to the teaching actions they perceive to be helpful in facilitating mathematical learning. This insight adds an important dimension to the advice offered by the informed mathematics education community and current mathematics curriculum documents, and offers teachers the opportunity to reflect on the appropriateness of their own teaching practices. Additionally, the study suggests that mathematics teachers' practice is aligned with student beliefs concerning the helpfulness of teacher actions rather than their own beliefs, the beliefs expressed in mathematics curriculum advice documents and initiatives or the beliefs of the informed mathematics education community. This situation warrants further investigation and has serious implications for teacher professional development.

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