TEACHING THE ETHEREAL: STUDYING TEACHING CREATIVITY IN THE MATHEMATICS CURRICULUM.

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This report outlines a study undertaken for a Master of Arts degree from University of Auckland, New Zealand (Clack, 2006). The study proposes a framework that, when refined, could be used to describe teaching approaches. These descriptions might then be used to aid our understanding of creativity in the mathematics classroom. The study highlighted the need for curricula to be clear about what is intended by 'teaching creativity' in the mathematics classroom and how teachers' varying interpretations of creativity affect both espoused and enacted practice. The long term goal is for a refined framework to be used in teacher training, aiding teachers with identifying ways of teaching and fostering creativity effectively in the mathematics classroom.

SUMMARY OF STUDY

'Problem solving' is a prominent feature of the mathematics curriculum in New Zealand (*MiNZC*) (Ministry of Education [MoE], 1992). It is a phrase liberally used throughout the curriculum and its possible interpretations are well defined throughout. We may therefore expect 'problem solving' (in whatever guise) to be present and observable in the mathematics classroom. 'Creativity' is also emphasised as highly important in the mathematics curriculum and again, is used liberally throughout the curriculum document, so, as with problem solving, we may expect to see 'creativity' to be an observable feature of primary mathematics classes. However, while *MiNZC* suggests that creativity should be encouraged, there is little guidance to what 'creativity in mathematics' may mean or how it may be realised in the mathematics classroom. While creativity and problem-solving are given strong emphasis in the curriculum, there is a marked difference between their explanations.

A detailed study of the literature suggested that a possible link between mathematics and creativity lay in problem solving, or more specifically problem *posing*. The characteristics of problem posing outlined by Brown and Walter (2005) show many similarities with the characteristics of creativity outlined by, for example, Robinson and Koshy (2004) and Craft (2001), such as divergent problem solving and self determination. It is possible to suggest therefore that there may be an apparent link between problem solving and creativity.

If we accept the view that creativity in the classroom is ultimately dependent upon the teacher (e.g. Fisher & Williams, 2004; Robinson & Koshy, 2004) then we must explore 'teaching creativity' if we are to understand creativity in students. The apparent link between problem solving and creativity in mathematics education suggested that one approach to studying teaching creativity in mathematics may lie in using an approach to studying problem solving.

The framework for describing teaching problem solving provided by Schroeder and Lester (1989) provides concise descriptions of teaching problem solving. It outlines three teaching approaches, teaching *for* problem solving, teaching *about* problem solving and teaching *via* problem solving, each with distinct teaching characteristics. These characteristics can be displayed in table form (Appendix 1).

This framework then provided a skeleton for the construction of a framework that described teaching creativity. The framework for teaching creativity also has three teaching approaches, teaching *for* creativity, teaching *about* creativity and teaching *via* creativity also with teaching characteristics specific to each teaching approach. As with Schroeder and Lester's framework, the characteristics for teaching creativity can be demonstrated in table form (Appendix 2).

STUDY DESIGN

The small-scale study aimed to investigate problem solving and creativity in primary mathematics education using classroom observation and interview data from three Year Six (10 to 11 years olds) teachers from two schools in central Auckland, New Zealand. Data was collected through video recording three 45 minute to one hour lessons and one tape recorded interview lasting approximately 45 minutes with each teacher The interviews focused on establishing the teachers' pedagogical beliefs about problem solving and creativity in mathematics education, while video evidence was used to note typical activity in during mathematics lessons.

Data analysis used a qualitative interpretive approach to establish a set of teaching characteristics for each participant, based on their espoused and observed teaching pedagogy. In the interview, the teacher's perceptions of 'problem solving' and 'creativity' in mathematics education were discussed. This provided data for espoused teaching practices toward teaching problem solving and teaching creativity. The video data provided information for enacted teaching practices. Through observation, it was possible to note traits of teaching that could be described as characteristic of each teacher.

These characteristics were then compared to a framework for teaching problem solving as described by Schroeder and Lester (1989) (Appendix 1) and also compared to a framework for teaching creativity as proposed by Clack (2006) (Appendix 2). This provided an opportunity to evaluate the effectiveness and utility of each of the frameworks – if teaching characteristics showed close links to one particular approach, the framework could be described as a useful tool in describing teaching.

RESULTS

The match between the framework for teaching problem solving provided by Schroeder and Lester (1989) and those of the espoused and enacted data were strong, allowing each of the three teachers to be described by one of the three teaching approaches in the framework. Characteristics displayed by each teacher showed close matches to one specific teaching approach, with few outlying characteristics. Appendix 3 shows an example of how the espoused and enacted characteristics displayed by one teacher fit within one approach. This example is indicative of all three teachers. In contrast, when focusing on creativity, the match between the framework for teaching creativity and teachers' espoused and enacted practice, was less strong. Appendix 4, for example, shows how the characteristics displayed by the teacher are 'spread' across the framework and characteristics are apparent in all three of the teaching approaches.

When considering teaching problem solving, all three teachers' espoused practice showed strong matches to the enacted practice, that is, the characteristics of the teachers were present in the same teaching approach in the framework, as can be seen in Appendix 4. In contrast, there were often notable differences between interview and observation data, that is, espoused data did not match with, and even directly contradicted what was seen in the classroom. Appendix 5 provides a good example of this. 'Georgia' professed to no interest in creativity in her classroom at all, and thus none of her espoused characteristics appeared in any of the framework approaches. However, she did demonstrate many of the teaching characteristics present in the teaching *via* creativity approach. This meant that inevitably espoused and enacted characteristics could not be matched to the same teaching approach in the framework as they had in the framework for teaching problem solving.

The data indicated that the framework provided by Schroeder and Lester (1989) is a useful tool for describing approaches to teaching problem solving. The data also suggested that the framework for teaching creativity needs modifying if it is to provide closer matches and provide a useful tool for studying creativity in primary mathematics education.

DISCUSSION

The aim of constructing a framework for teaching creativity was to provide a tool by which we could describe teaching approaches in the classroom. These descriptions would help us understand what 'teaching creativity' in mathematics may mean. The data showed that the matches of teaching approaches to the framework for teaching creativity were less strong. This suggests that the framework will need modification and refining if it is to achieve its aim of providing a useful tool for describing 'teaching creativity' in mathematics education. The framework was originally constructed using information from the literature. The need for refinement may suggest that the framework needs to be built on observed practice rather than, or indeed in addition to, literature analysis.

The data often demonstrated a disparity between espoused and enacted practice for 'teaching creativity' as shown in Appendix 5, in contrast to teaching problem solving, where there was little disparity between espoused and enacted data, shown in Appendix 3. This may suggest that teaching problem solving and its implications are more widely understood than 'teaching creativity'. The disparity in espoused and enacted practice in teaching creativity could be explained by the teachers having different interpretations of creativity to one used in the study (as seen in Appendix 5) or of differing interpretations of how creativity is operationalised (Appendix 4). The multiple interpretations of creativity and the disparity between espoused and enacted practice may show the extent to which creativity in mathematics education is (perhaps poorly) understood.

The study raised three questions that need to be addressed in future research.

1) How can we be clearer about what may be intended by creativity in mathematics education?
2) How can we establish a greater common understanding and acceptance of what creativity in mathematics education is?
3) How can we establish a usable definition of creativity in the mathematics classroom?

The answer to the first two questions may merely be to encourage curriculum and policy writers to be more explicit in their interpretation and expectation of creativity in mathematics education. However, this would be over simplifying the matter. Curricula should, or indeed must be based on research evidence. It is therefore important that research into creativity is, in the future, extensive to provide evidence for such curricular content. Fisher and Williams (2004), for example, suggest that "creativity may not have an exact nature" (p. 7) and thus it may not be possible to establish an exact definition. This is not to say we cannot establish a *usable* definition of creativity for the mathematics classroom. The search for a usable definition for creativity may be far more beneficial and fruitful than an effort for a definitive, all encompassing one.

In effect, these three questions can, in fact, be treated as a single question. Without a practical, useable definition of creativity in the mathematics classroom, we are unlikely to gain a common acceptance of what creativity is and thus be clearer about what we might expect to see in the classroom. This is not to say we must work from 'top' down. Determining what we might see as 'creativity' in the classroom may lead to a common acceptance of what creativity is, and from this form a usable definition.

As a Master of Arts thesis, the research project had many limitations, most notably time and educational research experience of the researcher. Both of these will, in the near future, be addressed. The purpose of presenting this work here, therefore, is not to hold the study up not necessarily for its methodological integrity but more to demonstrate a way of studying teaching creativity in mathematics education by using an approach for studying teaching problem solving as a template for teaching creativity. This study has constructed what will hopefully, once refined, be a useful tool for future research

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APPENDICES

Appendix 1: Framework for teaching problem solving
Appendix 2: Framework for teaching creativity
Appendix 3: Sample data: Teaching creativity characteristics of Teacher one, 'John'
Appendix 4: Sample data: Teaching creativity characteristics of Teacher two, 'Paul'
Appendix 5: Sample data: Teaching creativity characteristics of Teacher three, 'Georgia'