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The Absence of Tolerance

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Background

Many mathematics programs in schools rely on a textbook to guide the major part if not all of the mathematics instruction. Some few depart from this model and use a creative, exploratory, problem-centred approach to mathematics teaching and learning. A number of studies have investigated the student outcomes generated by these two different approaches. Ridlon (2009) found that the problem-centered learning (PCL) approach appeared to significantly enhance achievement and improve attitude towards mathematics in a group of sixth graders, particularly for low achievers, in comparison to the Explain-Practice (E-P) approach characteristic of textbook-driven instruction. Boaler (2008, 2006) found that a text-book based, repetitive example-and-practice approach produced lower achievement than a problem-centred exploratory approach. Contrasting two English high schools, Amber Hill and Phoenix Park, she found students' attitudes to mathematics were very different. Those at the textbook-driven Amber Hill thought mathematics was a set of rules that had to be memorized, while those at Phoenix Park saw it as a set of flexible problem solving tools used in an exploratory way that was interesting to them. This difference was echoed in the students' grades. Students at Phoenix Park attained significantly higher examination grades than those at Amber Hill in the English national examination taken at 16 years old. They also achieved higher grades than the national average, having started their schooling at significantly lower levels than the national average (Boaler, 2002). More recently, at Railside High School, students taught with a PLC approach outperformed students in a similar school that used a E-P approach by the end of their second year of high school (Boaler, 2008).

Research Questions

Given the historically lower participation by women in non-compulsory mathematics education, I wondered if women had a particular objection to the repetitive-example-and-practice (E-P) approach as common in Australian secondary schools as it is in English and American high schools, and if so, what that objection might be. A sample of 12 women, self-identified as disliking mathematics and as having had a predominantly E-P mathematics education, were interviewed about their attitudes and experiences of mathematics at high school in Australia.

Methods

The sample comprised six female teacher-education students (average age 23) and six professional women (average age 34).

They had self-identified their high school mathematics education as E-P (repetitive, example-and-practice) in agreeing that their mathematics education had been "heavily reliant on a textbook in which worked examples are given followed by many exercises practicing the same skill". Women who disliked mathematics and who had discontinued its study as soon as they were able to were selected from the group of volunteers who identified an E-P mathematics education. Ten of the twelve participants chosen had discontinued mathematics as soon as possible, generally by the age of sixteen.

A qualitative approach was taken to the study (Denzin & Lincoln, 2003). Semi-structured interviews were conducted to ascertain participants' experiences and attitudes to their mathematics education. As a start to these interviews, and as a check on the self-identification of style of mathematics education at high school, participants were given 20 descriptors of mathematics, written separately on cards, that contrasted The E-P approach with the PCL approach to mathematics education (Ridlon, 2009; Boaler, 2008, 2006, 2002).

Descriptors that represent an E-P (textbook-based, example-and-repetition) approach to mathematics education were Rules, Formal, Absolute, Abstract, Logical, Rational, Objective, Fair, Just, Deductive, Algorithm. Descriptors that represented a PCL (exploratory, problem-based) view of mathematics education were Intuitive, Creative, Models, Tolerant, Conjecture, Inductive, Relative, Hypothesis, Contextual.

Participants were asked to choose five words that accurately reflected what mathematics meant to them and to choose two words that definitely did not. They were asked to define what each word meant to them, and to discuss the meaning of these words in detail. The card-sort was thus used as a prompt for a discussion of their attitudes and values towards their high school mathematics education.

Frame

The card-sort was part of a larger study that was designed to elicit women's moral voices in mathematics education, using the work of Noddings (2005; 1993; 1984) on an ethic of care as a lens through which to interpret the findings. Noddings' model of relationship and its application to schooling was used to explore participants' responses.

Comments from participants demonstrated that they wished to have a relationship with mathematics; to care for mathematical ideas in the same way people care for music or art. When the mathematics is fixed, as it is in a traditional high school mathematics E-P approach, the student takes directions, orders; she in involved more in a dictatorship than a relationship. Participants' responses were explored using 'dictatorship' (command, obedience, orders) and 'relationship' (creativity, mutual contribution, flexibility) as guiding themes.

Of the 20 words that they could reject as a descriptor of their mathematics education, eight participants chose the same word. That word was *tolerant*. (Interestingly, seven participants also rejected the word *creative*. A paper describing that finding has been submitted to the ECER, Finland 2010 conference). Most participants emphatically declared that mathematics education was not tolerant as soon as they sighted the card labeled *tolerant*; and some very strong emotion was displayed.

Research findings

For most participants, the reason the word *tolerant* elicited such a strong negative reaction was the rigidity of the E-P approach, which allows little or no variation in problem-solving methods and only one correct solution for any problem.

For example, Heather's frustration with the fixity of her school mathematics experience is evident in her comment: "Tolerant, it can't be...it won't tolerate any little variation of it". Susan echoed this: "Maths is not tolerant in terms of being able to do things in a different way (to that prescribed by the textbook)". In this paper I argue that the control exerted by the E-P approach leads students such as these to conclude that mathematics education is intolerant. Viewing it as intolerant, they reject its control over them, and leave the study of mathematics.

In addition to students who belive their mathematics education to be intolerant, comments made by two participants suggested that some students may conclude that it is *they* who are rigid and intolerant. For example, Lesley said: "Maths was not tolerant because I wasn't very tolerant, sometimes, I'd get really frustrated, I'd go aarrgghh, and I think I'd just sometimes totally block it out and wouldn't allow them to teach me". When asked if her mathematics education was not tolerant of her as a learner, Lesley responded "I wasn't very tolerant because I didn't understand. I'd get really mad and frustrated and angry". Rejecting the production of intolerance in themselves, students like Lesley quit their mathematics education as soon as possible. They do not like the kind of person they become in relation to mathematics, and they discontinue its study as soon as possible.

Respect and responsibility are two of Boaler's (2008) educational aims for mathematics classrooms. Tolerance would surely fit within the concept of respect. A mathematics education that is perceived by

students as intolerant, or that leads students to conclude that they themselves become intolerant people when they are in the mathematics classroom, works against this aim. That eight of the twelve participants in this study rejected the same word, tolerant, as a descriptor of mathematics, gives pause; perhaps the E-P approach to mathematics education works against worthy educational goals such as the development of respect in the mathematics classroom.

This paper concludes with the suggestion that an E-P approach to mathematics education may generate an unworthy educational outcome such as intolerance, thus mitigating against the development of respect in the mathematics classroom.