How do images of mathematics held by a teacher and students manifest in one Steiner-Waldorf setting?

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Images of mathematics held by students and teachers are complex, with varying attributable characteristics. Affective factors such as beliefs and attitudes have been found to be significant in influencing outcomes. This case study examines the images of mathematics held by three adolescents and their teacher in a Steiner school in the UK. The Steiner-Waldorf curriculum approaches mathematics through cognitive, emotional, physical, and spiritual aspects. The findings indicate that a quality of relationship to mathematics, involving imagination, as expressed in the curriculum, is common to a teacher and students.

Keywords: imagination; adolescent; Steiner-Waldorf; contradiction.

Background

The importance of beliefs and attitudes towards mathematics and the consequent effect on engagement and achievement has been increasingly recognised (Lim & Ernest, 2000; Schoenfeld, 1989). Public images of mathematics as largely negative are widespread and many images have been found to be related to attitudes, feelings, and emotions about mathematics, including past experiences (Lim & Ernest, 2000). Wilkins and Ma (2003) found that readiness to use mathematics in everyday life related as much to beliefs as to content knowledge. Studies vary widely due to the varying meanings ascribed to beliefs, attitudes, and images; and to the viewpoint taken.

The influence of teachers on their students' images of mathematics has also been looked at both in terms of the teachers' practices and the students' behaviours (Beswick, 2007; Schoenfeld, 1989). Looking at teachers' beliefs relevant to classroom teaching practice, Beswick (2007) found a complicated relationship of co-evolution of beliefs and practices. Beliefs were not distinct but occurred as part of a system, and they were often contextual with the surrounding environment, including interactions with other people. Practices often contradicted underlying beliefs, and similar practices across classrooms could arise from dissimilar beliefs (Beswick, 2007). These contradictions were also found by Schoenfeld (1989) in students' behaviours, where irrespective of their stated beliefs students behaved according to previous experience in the classroom (e.g., students believed that mathematics was creative yet that it mostly involved memorising).

Brown (1992) was surprised to find a strong correlation between the images of mathematics of all students studied and the teacher's beliefs and suggests that there may be strategies and behaviours that could be transferred to other teaching environments. Likewise, the beliefs underlying teachers' practices matter most, in making a difference for students, according to Beswick (2007), rather than materials or methods.

While there has been evidence of students' negative beliefs leading to negative outcomes, such as reduced participation and performance, Wilkins and Ma (2003) examine the change in these beliefs and attitudes with age. Accepting that changes are gradual, they found a negative trend in the beliefs and attitudes of adolescents towards mathematics; in secondary school, students were increasingly negative regarding their enjoyment and the social importance of mathematics (Wilkins & Ma, 2003). It is pertinent then that, when teaching mathematics to adolescents, taking developmental factors into account can have a beneficial effect (Watson, 2010; Steiner, 1951/1980).

It is in this complicated context that the study was situated, the objective being to examine images of mathematics with a focus on adolescents, and in a Steiner school, where the influence of feelings and ways of thinking are fundamental to the ethos (Rawson & Richter, 2003).

Steiner-Waldorf Education

Mathematics education in Steiner-Waldorf schools is approached through a model of child development that focuses on movement and bodily experience in the first seven years of life; on engagement through the feelings in the second seven years; and with an emphasis on thinking in the subsequent seven-year period. Geometry and imagination, as well as human and historical perspectives of mathematics are strongly embedded in the curriculum (Rawson & Richter, 2003).

Theoretical framework and methodology

The framework used was based upon Lim and Ernest's (2000) work on public images of mathematics; the five categories emerging from their study were beliefs (about mathematical potential), attitudes (feelings), process of learning, value of mathematics and nature of mathematics. The motivation for this study and the structure used drew upon Eichler's (2006) study of student and teacher beliefs.

From a class of seventeen students, aged 14 to 15 years, studying mathematics GCSE alongside the Steiner-Waldorf mathematics curriculum, three students and the teacher are presented. The teacher, as the only Steiner-trained mathematics teacher in the school, was a purposive sample. The students, where three were required and three volunteered, were an opportunity sample. The teacher was not involved in the process of recruitment and the students were told that the teacher would not be informed which students had participated.

A qualitative data collection method was required to examine images of mathematics of the students and teacher. Owing to time constraints and because participating students were previously unknown to me (the researcher), I used a questionnaire. Open-ended questions aimed to give the students an opportunity to offer rich responses including views they may not have divulged in a face-to-face interview - an important consideration when seeking the personal views of adolescents. For the teacher, who had little free time, the interview was decided upon as a more efficient method. The questions for the interview and questionnaire were themed and ordered for ease of answering (Table 1).

The teacher interview was semi-structured, adhering to each of the five categories while allowing free responses within the category, with prompts as needed (e.g., The value of mathematics. What value does mathematics have to you? What value in the world? What is the purpose of learning it? How is it used? How do you use it?). The same format was used in the questionnaire.

Drawing on Brown's (1992) and Beswick's (2007) studies, three sources - interview, questionnaires, and curriculum documents - were examined for matches between student and teacher responses, using thematical analysis to identify emerging themes. For a response to be deemed significant three strands of data were required to be alike (e.g., two students and the teacher; or one student, teacher, and curriculum).

Table 1. Themes for questions

Questionnaire for students	Interview with teacher
Attitude towards mathematics	Nature of mathematics
Nature of mathematics	Value of mathematics
Value of mathematics	Process of learning mathematics
Process of learning mathematics	Approach to teaching mathematics
Potential in mathematics	Attitude towards mathematics

Results

The following thumbnail sketches of the participants are drawn from the vocabulary they used in describing themselves and their experiences.

Harry likes mathematics and always has. He considers it a useful skill, relating it to practical applications such as construction, and helping his father with projects, as well as intellectual and social functions such as decision making and working with others. He thinks he will get a good grade, compares himself to others favourably and expects to continue to A-level study.

Mathematics is Tessa's favourite subject. She sees it everywhere in the world, considers it an important tool that everybody gains from and is grateful that she is able, though she describes it as both frustrating and satisfying. She links it to her personal development as an aid to finding peace and helping her to focus, and to both push and surprise herself. She knows that she will have to work hard but she sees herself as determined, expects to get the highest grade and is excited for the future.

Jason thinks mathematics is great and loves that it can be found in nature. He thinks it can be useful for some jobs and unnecessary for others and describes it as a very hard subject. He sees it in all areas of life from business to martial arts and says he uses it every day. He thinks anyone can learn mathematics if they are eager, and knows that he can achieve a lot if he puts in the work. He enjoys mathematics but finds a lot of it useless and does not like the way it is taught.

Teacher Alex describes mathematics as universal, related to the underlying structure of the universe. He considers its core value as pertaining to its depth and beauty and the possibility it gives to use the imagination. He recognises the constraints of the curriculum and of certain environments but thinks you can find a way to reach pretty much anyone by opening students' minds to flexible ways of mathematising. Alex refers to the inner work required of a Steiner teacher, in attending to a developing understanding of the human being. He describes his teaching as traditional and oddly boring, yet he mentions dialogue, open questions and interested students. He dislikes high stakes testing though finds some GCSE questions satisfying and sees this reflected back in his students' behaviour.

Three key themes emerged from the analysis: opportunity and participation; applicability and usefulness; and contradiction, and I now deal with each in turn.

Opportunity and participation

Displayed in all data sources were statements connected with opportunities for learning and participation. They stemmed from comments regarding mindset, teaching style, effort, learning style, and beliefs of competence. Students stated the need for an openness to fascination and to be open-minded. Aligned with that was the teacher's comment that a level of curiosity was required. Both students and teacher claimed that anyone can learn mathematics.

The teacher expressed the importance of effort:

> Alex: Any effort anyone makes is a positive thing. Expectations of students is that they'll give things a go…that they'll have a try

and the students recognised their own responsibility:

> Tessa: It gets to a point when the teacher can't do anything else and it is up to the student to put the effort in.
>
> Jason: I know how to revise; I know how to do well in lessons e.t.c. I just need to work more.

None of the students referred directly to Alex's teaching, rather using comments such as, *it needs to be taught...*, *a teacher should…, the way the school system teaches subjects.* Nor did they mention their performance or achievement in relation to Alex.

Applicability and usefulness

The theme of applicability and usefulness was drawn from comments concerning where and how mathematics is found in the world, how it can be used personally, its value generally, and everyday use. There was full accord on the ubiquity of mathematics – *it is everywhere*, *in lives every day*, *in nature*, *basically everything*, *universal*. Equally agreed was its usefulness both generally – *it is a great skill*, *good subject*, *helpful*, *worth learning*, *huge value*, *important*, *everybody would gain*; and specifically – it is used in *construction*, *finance*, *logic*, *science* and *mechanics.*

Students' comments revealed an extensive applicability of mathematics:

> Harry: Maths is a way you can manage your life without wholly relying what someone tells you, knowing if you are being pulled into something that is wrong… Maths is used to build things, understand things that do not exist around us and work with others fairly.
>
> Tessa: I use maths as a form of therapy. It helps me forget and stop stressing.
>
> Jason: Maths is the way you look at things. I use mathematics from the time I wake up to the time I go to school. Mathematics is an amazing thing.

These are far from the everyday purposes that might usually be associated with mathematics. In a similar vein is Alex's skimming over the everyday use of mathematics to focus upon the more esoteric elements:

> Alex: There are utilitarian purposes for learning maths. There are things that it's useful for. Ultimately, I don't think that's anything to do with why we should teach maths. It's actually imaginative aspects that are the real value in teaching maths.

Contradiction

Contradictions occurred in conflicting responses given by an individual in one area of the framework (e.g., attitudes), and in incongruities between responses in differing

areas of the framework (e.g., attitudes versus teaching and learning). Jason said mathematics was both *great* and of *high interest* yet also *a lot of it quite useless*; it was *helpful,* and it was *unnecessary*. Tessa showed similar inconsistency in her statement that *maths is frustration, satisfaction and completely mind-blowing!* In their respective remarks, Tessa and Alex agreed that maths *wakens your brain* and *opens students' minds*. In contrast Jason spoke of *killing your brain with knowledge.*

Jason highlighted the discord between the nature of mathematics and the way it is taught:

> Jason: Mathematics is an amazing thing, but it's hard to enjoy learning it. Maths isn't taught for your own knowledge or to enjoy it, it's taught to be tested on.

The teacher makes an analogous point in referring to the disconnect between elements of teaching and learning:

> Alex: …a large part of the teacher's job in maths is to engender a sense of curiosity and playfulness actually, and imagination … which can be difficult given how constrained our curriculum is and how packed our curriculum is.

Discussion

There certainly seem to be beliefs and attitudes, and views about the nature and value of mathematics, in common between teacher and students, shown by comparable terms used, the alignment of which may not be very surprising as all students claim to enjoy and be competent in the subject (Eichler, 2006; Wilkins & Ma, 2003). As likely motivations for volunteering for the study, it cannot be assumed that this coherence of images with the teacher is reflected in the rest of the class members.

The responsibility shown by students for their learning, whilst omitting to refer directly to Alex in connection with either their participation or their outcomes, demonstrates an independence and maturity of thought, also reflected in the far-reaching and nuanced relationships to mathematics communicated by all participants in the applicability theme. Such indications support a fulfilment of an aim of the Steiner curriculum to educate free-thinking individuals (Rawson & Richter, 2003).

The unsettling nature of adolescence might explain some of the contradictions conveyed by the students. Changes in the way of thinking experienced in adolescence can provoke dissonance when ideas and activities seem non-intuitive and high stakes testing presents further pressure, leading to disaffection (Steiner, 1951/1980; Watson, 2010). Yet Alex, the teacher, conveyed the same oppositions, echoing Brown's (1992) finding that teachers and students expressed similar kinds of contradictions. Potentially, therefore, of more significance are the images given that are not directly comparable in the views expressed but which may be connected at a deeper level, as shown in the applicability theme. Here, the students describe very different stances in their relationships to mathematics, all of which are wide ranging and deep-rooted, with the potential for a considerable impact on the individual. Although there is no connection in either the words used or the disparate ideas articulated, it is noteworthy: first, that Steiner's view of the imagination incorporates a revelation of the interwoven relationships in the universe; second, that Alex refers to the imagination as well as to his inner work; and third, that the students' expressions of their relationships to mathematics display profound connections with the world. Students' and teacher's images meet at this deeper level.

Conclusion

Contradictions, arising in the study, made sense when viewed from a deeper level. Leatham (2006) speaks of teachers' beliefs as *sensible systems* and that, far from being inconsistent, teachers are inherently sensible. What a teacher educator or researcher may perceive as teacher inconsistency is an opportunity to look more deeply. In the context of this study, when we look more deeply, what appears to be contradictory in students' and teacher's images, is in harmony in the realm of the imagination.

The scope and richness of responses from participants, paired with the expressed dissonance between the nature and value of mathematics versus the learning and teaching of mathematics, suggests further research could be undertaken to investigate ways to improve adolescents' experiences. With a focus on imagination, workshops using creative methods would give students an opportunity to create their vision of what mathematics lessons *could* look like.

References

Beswick, K. (2007). Teachers' beliefs that matter in secondary mathematics classrooms. *Educational Studies in Mathematics, 65*(1), 95-120.

Brown, L. (1992). The Influence of teachers on children's image of mathematics. *For the Learning of Mathematics, 12*(2), 29-33.

Eichler, A. (2006). Teachers, classroom, students - A holistic view on beliefs concerning the educational practice. In J. Novotná, H. Moraová, M. Krátká, & N. Stehlíková (Eds.), *Proceedings 30th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 3, pp. 17-24). PME.

Leatham, K. (2006). Viewing mathematics teachers' beliefs as sensible systems. *Journal of Mathematics Teacher Education, 9*, 91-102.

Lim, S., & Ernest, P. (2000). A survey of public images of mathematics. *Research in Mathematics Education, 2*(1), 193-206.

Rawson, M., & Richter, T. (Eds.). (2003). *The educational tasks and content of the Steiner Waldorf curriculum.* Steiner Fellowship Publications.

Schoenfeld, A. (1989). Explorations of students' mathematical beliefs and behavior. *Journal for Research in Mathematics Education, 20*(4), 338-355.

Steiner, R. (1980). *Waldorf Education for adolescence.* Kolisko Archive Publications. (Original work published in 1951)

Watson, A. (2010). Shifts of mathematical thinking in adolescence. *Research in Mathematics Education, 12*(2), 133-148.

Wilkins, J., & Ma, X. (2003). Modeling change in student attitude toward and beliefs about mathematics. *The Journal of Educational Research, 97*(1), 52-63.