Issues and affordances in studying children's drawings with a mathematical eye

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In this third consecutive MERGA symposium focused on young children's drawings, three separate groups of researchers discuss the benefits and issues of using drawings as a source of data in their studies. Although drawings are ubiquitous in early years classrooms and in studies of children's learning, there is no comprehensive framework for analysing children's drawings in mathematical contexts. The overarching purpose of these symposiums has been to explore the qualitative methods that researchers have developed in their distinct projects and advance our critical perspectives on interpreting drawings and understanding the role they can play in children's learning of mathematics.

Broadly, the researchers view drawings as an external representation of mathematical concepts, mathematical thinking, or perceptions of mathematical contexts. Typically, researchers trust that children's drawings express to some extent the developing internal systems of the child, including the affective domain. In studying the interplay between children's internal and external representations, researchers must grapple with the ambiguities of interpreting representational drawing, as explained in quotation below.

> "Internal systems, … include students' personal symbolization constructs and assignments of meaning to mathematical notations, as well as their natural language, their visual imagery and spatial representation, their problem-solving strategies and heuristics, and (very important) their affect in relation to mathematics. The *interaction* between internal and external representation is fundamental to effective teaching and learning. Whatever meanings and interpretations the teacher may bring to an external representation, it is the nature of the student's developing internal representation that must remain of primary interest." (Goldin & Shteingold, 2001, p.2).

In this symposium, as well as sharing results from recent research, the authors reflect on some of the issues and affordances in studying children's drawings with a mathematical eye.

Goldin, G. & Shteingold, N. (2001). Systems of representation and the development of mathematical concepts. In Cuoco, A. (Ed.), *The roles of representations in school mathematics,* NCTM 2001 Yearbook, (pp.1-23). Reston VA: NCTM.

Chair & Discussant: Jennifer Way

Paper 1: Jill Cheeseman, Ann Downton, Anne Roche & Sarah Ferguson *Drawings reveal young students' multiplicative visualisation*

Paper 2: Katherin Cartwright, Janette Bobis & Jennifer Way *Investigating students' drawings as communication and representation modes of mathematical fluency.*

Paper 3: Kate Quane, Mohan Chinnappan & Sven Trenholm *Children's drawings as a source of data to examine attitudes towards mathematics: Methodological affordances and issues*

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Children's drawings as a source of data to examine attitudes towards mathematics: Methodological affordances and issues

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Ascertaining young children's attitudes towards mathematics has its challenges. Methodologically, limitations exist regarding the type of research techniques that can be employed. The use of children's drawings as a data source has both methodological affordances and issues. The study was conducted with 106 children in Years 2 and 3 from three South Australian primary schools. This paper identifies some of the methodological affordances and issues of using children's drawings to ascertain and describe their attitudes towards mathematics.

For Vygotsky, a "young child's creative forces are concentrated on drawing not by chance, but because it is precisely drawing that provides the child with the opportunity to most easily express what concerns him at this stage" (Vygotsky, 2004, p. 43). Children's drawings act as a list or "graphical narration" about what a child is portraying (Vygotsky, 2004, p. 77). Numerous researchers have used children's drawings in the mathematics domain. However, few researchers have used children's drawings to ascertain and describe young children's attitudes towards mathematics. Bobis and Way (2018) state that "representations are an integral part of learning mathematics" (p. 56) and while these authors refer to representations primarily from a conceptual and working mathematically perspective, children representations of themselves are ubiquitous in their drawings. This research connects the ubiquitous nature of children's drawings of themselves with mathematics education by asking children to draw themselves "doing mathematics" as a means of ascertaining their attitudes towards mathematics.

The use of children's drawings is an innovative approach to ascertain an individual's attitude which moves away from traditional research methods such as attitudinal questionnaires. The use of children's drawings provides several affordances that traditional research methods do not allow, including providing a method to children to voice their attitudes which can then describe the nature of their attitudes in depth. Conversely, the innovative nature of this research raises several issues related to the interpretation and analyses of children's drawings. This paper examines some of the affordances and issues of using children's drawings to ascertain young children's attitudes towards mathematics.

The purpose of this study was to investigate the attitudes of young Australian children in Years 2 and 3 have towards mathematics. This investigation answered the broad question: *What are the range and nature of attitudes young children exhibit towards mathematics, in both lesson and non-lesson contexts?* It is essential to distinguish between the range and nature of young children's attitudes towards mathematics. In this paper, a distinction has been made to ensure clarity around the two words. Additionally, the words 'nature' and 'range' have often used interchangeably, but both describe specific aspects of this research. The range refers to the scope or extent of young children's attitudes towards mathematics, providing a broad view of the issue. The nature of attitude is descriptive, providing the basic

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qualities, structure, and the essence of individual attributes of children's attitudes towards mathematics. In other words, the nuances or fine-grain view of attitudes.

Method

This paper discusses findings from the non-lesson context where children drew a picture of themselves doing mathematics, provided a written description of their drawing and participated in a semi-structured interview. One hundred and six children, aged between 7 and 9 years of age, participated in a mixed-method research design where children's drawings started a conversation about their attitudes towards mathematics.

Utilising the work of Bachman et al. (2016) the prompt "Draw yourself doing mathematics" was given to participants on an A3 piece of paper. The researcher read a prompt (see Quane et al., 2019) to children with no time limit given to children to produce their drawing. Children provided a written description of their drawing and then participated in a semi-structured interview. Using the three research techniques is viewed as "complementary methods" to "understand children's lived experiences" (Macdonald, 2009, p. 48). The generated data from the three research techniques was analysed using a modified version Three Dimensional Model of Attitude (TMA) (Zan & Di Martino, 2007). The original TMA framework comprised of three aspects of attitude: an emotional dimension; a vision of mathematics; and perceived competence. In the discussion below we take up the methodological affordances of using children's drawings in terms of TMA, in the course of our research.

Findings and Discussion

The use of children's drawings was effective in identifying the range and describing the nature of young children's attitudes towards mathematics. However, while the use of children's drawing as a research technique has benefits, it raises some issues. In this discussion, the affordances and issues pertaining to the use of children's drawings is reviewed.

Attitude is a multi-dimensional construct (Zan & Di Martino, 2007) that can be complex to unpack. Any research method employed to ascertain attitudes towards mathematics needs to disentangle the different strands of this complexity. That is, the use of children's drawings as a research tool needs to be sensitive to the multi-faceted nature of the construct in question, namely attitude. Additionally, data about attitudes towards mathematics has to capture the dynamic interplay between the dimensions of attitudes.

Drawings constitute an accessible vehicle for communication, expressing what is important for the child. Unlike surveys, drawings are open-ended, expressive and are child-centred tasks (Stiles et al., 2008). Stiles and colleagues (2008), found that "attitudes towards mathematics expressed in drawings significantly correlated with attitudes expressed in the TIMSS [The International Mathematics and Science Study] statements about mathematics" (p. 1) and are "superior to the TIMSS statements" (p.13).

Drawing affords children to express what is important to them in a medium that they feel comfortable. Further, children could express a variety of emotions, as shown in Figures 1 – 3. Children articulated connections between the emotions that they expressed to specific mathematical topics and their perceived competence in mathematics.

The second dimension of attitude is children's vision of mathematics (Di Martino & Zan, 2011). For this research, children's vision of mathematics was characterised by the topics, tasks, and processes that they depicted and described as well as their value and appreciation.

The use of children's drawings provided insights into children's vision of mathematics in terms of how children depicted the mathematics that they were doing. The drawings show the interconnectedness of the three dimensions of attitude with children indicating their emotion and self-concept. Figures 4 – 6 show the mathematical topics and the children's representations of these topics. Further data from the non-lesson context provided insight into children's perceived competence, particularly their mathematical mindset and self-concept. For example, C16 (Figure 1) indicated that she hated mathematics, finds it hard but wants to try "make friends" indicating she has a low perceived competence in mathematics.

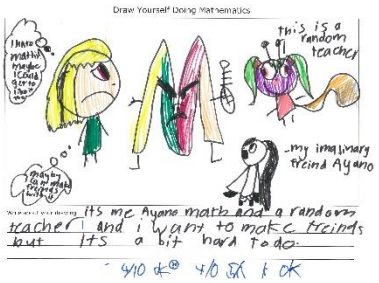

Figure 1. C16; female, negative attitude

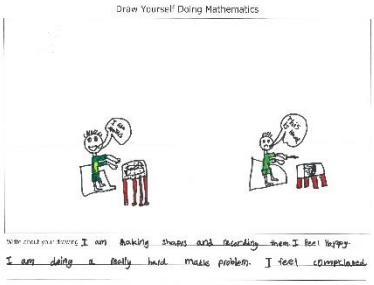

Figure 2. B8; male, neutral attitude

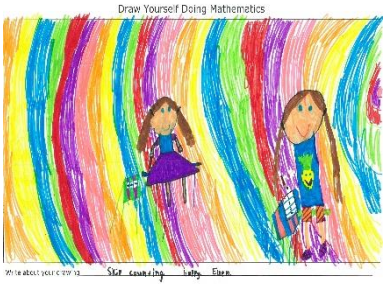

Figure 3. A25; female, positive attitude

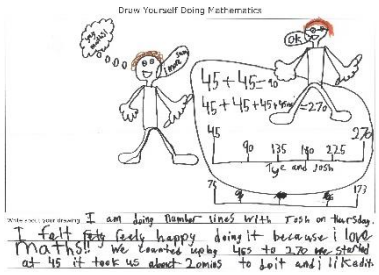

Figure 4. A13; male, extremely positive attitude

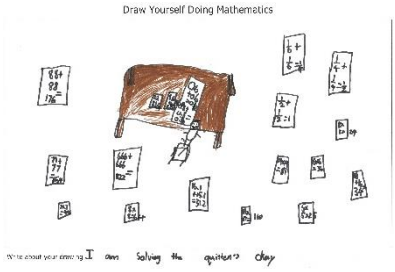

Figure 5. B45; male, positive attitude

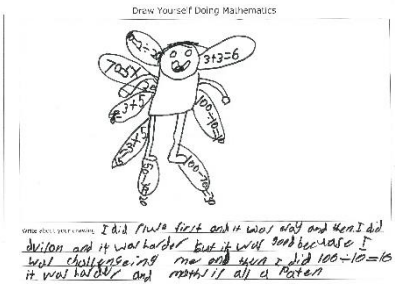

Figure 6. C6; male, positive attitude

Lowenfeld and Brittam (1964) were instrumental in describing the developmental nature of children's drawings. In so doing, these authors drew attention to the principle of 'deviation' as a means for children to emphasise, exaggerate or omit pictorial elements. It is important to note how an observer views these three principles. Lowenfeld and Brittam (1964) cautioned the observer of a drawing regarding making incorrect judgments about a child's intention of using disproportional elements within a drawing. Correct judgements and interpretations can only be made by asking the child about their drawing to understand the reasons for using disproportionally or drew a particular object. When children have used the three types of deviations, the child has drawn what is real, significant, and relevant to them (Lowenfeld & Brittam, 1964).

The principle of deviation is seen in A25's drawing (Figure 3), where she has emphasised the background of her drawing. The child explained that she loved patterns. The emphasis that the child placed on her rainbow background would not have been realised without asking the child open-ended questions about her drawing. The background in A25's drawing consumed A25's attention and focus including her responses to the interview questions. Understanding the importance A25 has placed on the background was required to minimise the potential for the generation data that may have been unreliable. Asking the child about the other elements within her drawing and other open-ended questions such as "what is maths?" provided indicators for all three dimensions of her attitude.

A second emerging issue with using children's drawings as a research technique is the interpretation. The following example illustrates the potential for misinterpretation. Two boys have used the same colour for their face, but the reasons for their colour choice is very different. B17 (Figure 7) has chosen the colour as he believes it reflects his skin colour. B42 (Figure 8) has chosen the colour to show that he is feeling frustrated. Examining the drawings in isolation from the other data sources may produce very different conclusions. It is only when the child is asked about what they have drawn and why they have chosen to draw it in the way that they have, do we truly understand the meaning in their drawings.

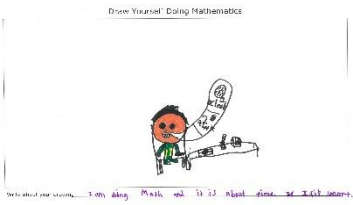

Figure 7: B17; male, extremely positive attitude

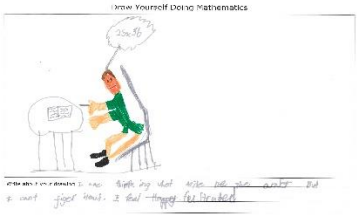

Figure 8: B42; male, neutral attitude

Conclusion

The use of 'Draw yourself doing mathematics' elicits children's drawings that were personal stories about their complex relationship with mathematics revealing their attitude towards mathematics. The process of drawing was a means for children to feel comfortable sharing their thoughts in a familiar manner (Macdonald, 2013). Children were given the time to "comprehensively explain the intended meanings of their drawings through extended conversations and further questioning" (Macdonald, 2013, p. 72). An affordance not offered in quantitative measures. Children's written responses complemented the visual and verbal accounts adding further insights into what was important to them. By providing children multiple opportunities to share their thoughts about mathematics, rich narratives were told about individual attitudes towards mathematics.

In conclusion, our experiences thus far showed that there are challenges in using drawings particularly in unpacking the developmental aspects of attitude. On balance, however, the affordances outweigh the hindrances in deploying the technique. The affordances of using children's drawings can be summarised as giving children the freedom to choose what they depict and how they portray themselves. For children's drawings to be understood by adults, Anning and Ring (2004) offer the following: "We need a society that can listen to children and recognise that perhaps their drawings may tell us much more about childhood than we ever imagined" (p 125).

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