# Girls, mathematics and identity: creative approaches to gaining a girls'-eye view

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Drawing on my doctoral research, this paper explores some of the qualitative tools used to gain a small group of girls' perspectives on mathematics and how they make sense of their mathematical identities. It introduces a range of approaches including scrapbooking, digital photography, drawings, concept-mapping and metaphor elicitation used within a small-scale interpretive study, along with presenting some findings and implications for practice.

**Keywords: gender; scrapbooking; mathematical identity; mindset; disposition; visual methodology; metaphor elicitation**

## Introduction

Gender differences in mathematical attainment, study and career choices have been much studied over recent decades. These differences remain a particular issue in the United Kingdom, with girls less confident in their self-belief than boys with consequent impact on their intention to study mathematics into A-level and beyond (Sheldrake, Mujtaba, & Reiss, 2015), a widening attainment gap at the end of primary schooling at the top end of the attainment range in the most recent round of statistics (DfE, 2015), and a gender gap in self-efficacy amongst boys and girls performing equally in mathematics that is significantly above the OECD average (OECD, 2014). Rather than rehearsing the plethora of previous research regarding possible reasons for these reported differences, this paper focuses upon accessible ways of shedding light upon girls' mathematical identities with the hope of giving practitioners ways to understand and support the girls in their class.

## Gaining girls' perspectives

This research takes the stance that learning involves identity development rather than simply gaining knowledge (Wenger, 2000). Identity is recognized both as how "individuals know and name themselves" and how they are "recognized and looked upon by others" (Grootenboer, Lowrie, & Smith, 2006, p. 612).

In exploring how a particular group of girls perceived mathematics, characterized mathematicians, and positioned themselves as mathematicians, the research sought to place girls at the heart of the data collection process, aiming to redress the tendency of omission of learner perspectives from the research process (Walls, 2003) through adoption a 'mosaic' of qualitative approaches. Developed for use with pre-school children, the Mosaic approach essentially comprises gathering data through multiple methods, prior to piecing this information together for dialogue, reflection and interpretation (Clark & Moss, 2011). Data collection allowed for exploration of mindsets as these relate to mathematics following the work of Dweck (2007) and also the work of Kilpatrick, Swafford, and Findell (2001) in the United States in exploring factors related to dispositions towards mathematics of a small group of girls.

## Context of the research

The research took place in a one-form entry primary school in the south-east of England. The school had a history of strong results in mathematics, but with a gender gap in favour of boys at the top end of the attainment range. The girls in the study were the 14 female members of the Year 4 class, aged 8-9 at the start of the study, with data collection taking place over a period of approximately 15 months.

Full ethical procedures were followed, including gaining informed consent from the children, parents and school, with parents kept informed through an initial meeting and regular updates. All of the girls were at least at nationally expected levels of attainment, and pseudonyms are used throughout.

Data collection took place in the home (led by children) through scrapbooking and digital photography, and on the school premises during the school day in a range of classroom-base, group and individual contexts. Taking a constructivist grounded approach, the data was analysed using a process of open and focused coding, using sensitizing concepts (Charmaz, 2014) such as self-concept, resilience, mindset, productive disposition and gendered identity formation. The rest of the paper will provide a brief overview of each data collection tool in turn, together with an insight into the type of data it provided and conclusions it allowed.

### *Scrapbooks and digital photography*

Scrapbooks, journals and diaries have emerged over the last couple of decades as a strategy within mathematics education research (Coles & Banfield, 2012; Kostos & Shin, 2010), often as a tool for children to record and explore their emerging mathematical understanding. An advantage of scrapbooks is the opportunity to extend children's contact with research when the researcher is not present.

Within this research, girls were asked to put anything to do with mathematics into their scrapbooks. This led to a fascinating range of responses too numerous to illustrate here. Instead, three emerging themes will be touched upon. The first was the existence of a reassuring range of real-world mathematical application, from baking and calculating percentage discounts to playing musical instruments and sorting toolbox contents according to size and usage. However, this was overwhelmed by the second theme, the overwhelming predominance of number and calculation (in particular times tables), coupled with unbidden rehearsal of school mathematics and the tendency to invent contrived word problems. Finally, a noticeable feature was the justification of including artefacts such as dice and rulers not because they were mathematical themselves, but because they incorporated numbers; apparently a key indicator that something really is mathematical in the eyes of this group of girls (see Figure 1).

Incorporated within the scrapbooks were photographs taken by the children using small, shock- and waterproof cameras provided by the researcher. Placing cameras into the hands of the children provided a fun and engaging method of gaining and listening to children's perspectives and a way of gathering evidence that did not rely on purely language-based methods (Morgan, 2007; Rose, 2013). Analysis of the photographs was incorporated into analysis of the scrapbooks and individual pupil conferences when the photographs were discussed.

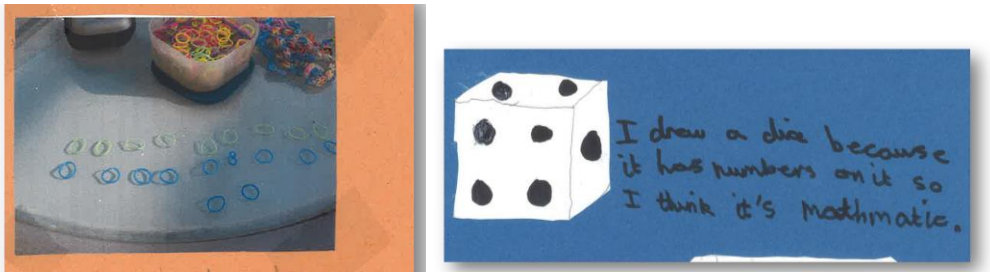


Figure 1: Extracts from children's scrapbooks

### *Concept maps and relationship wheels*

Concept mapping is based on constructivist understandings of learning and provides a strategy for gaining insight into how children conceptualise a particular subject (Prosser & Burke, 2011). After looking at a concept map representing food and generating one for English, girls worked individually to create a concept map representing mathematics. Analysis revealed a number of themes, from the expected (predominance of number and calculation, skills to be learnt and facts to be remembered), to the unexpected (for example the inclusion of emotional reactions, effort, pain, excitement and social contexts for carrying out mathematics).

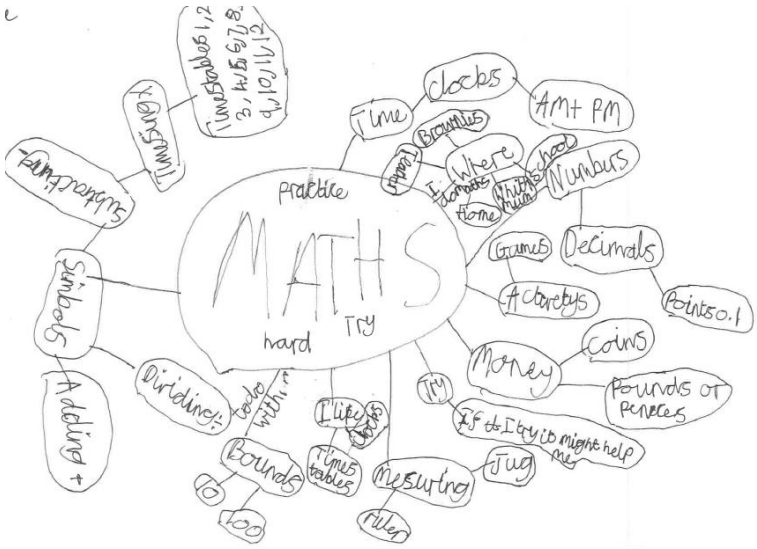


Figure 2: Lauren's concept map

The inclusion of relationship wheels was intended to shed light on the influential figures in the formation of the girls' mathematical identity, adapting the word-wheel technique deployed by McDonough and Sullivan (2014). Children were asked to draw themselves in the middle and put anyone they would link with mathematics around the outside.

Amongst the insights provided by the relationship wheels two are worthy of particular mention. The first, unexpectedly, was the context embedded within the wheels: providing help whilst 'stuck' was by far the most common reason for someone being included, well ahead of teaching or collaborating – this went for teachers, friends and family members. Secondly, there was an absence of anyone not directly known to the child. Mathematics was connected with teachers, friends and extended family members, but in no case was there mention of any current or historical recognised mathematician.

### *Metaphor elicitation and drawings*

Inspired by the work of Rehner (2004) and Özgün-Koca (2010), metaphor elicitation was used as a strategy to provide insight into unconscious beliefs. The girls were given the prompts 'if mathematics was a food/kind of weather, colour, animal or vehicle, it would be … because …' and encouraged to explain and illustrate their ideas. The metaphors revealed themes such as the size and speed of mathematics (often as portrayed by less confident mathematicians), and recognition of the complex and challenging nature of the subject ('mathematics is like a sandwich because there are many things inside it and it is sometimes tricky to make'). They also revealed contrasting relationships with mathematics. Lauren portrayed mathematics as like a lorry because it is 'big and hard to carry'. However Taylor, high attaining but with a carefully calibrated sense of a comfortable level of challenge, reported that if mathematics were an animal it would be a dog, because 'I like dogs sometimes, but I don't like them when they jump'. The notion of identity being complex, fluid and situated (Thomson & Hall, 2008) was reinforced by the data arising from this task.

Children's drawings have become well-established as a data source allowing children to communicate ideas they may not be able to articulate verbally, providing insight into children's perceptions in well-established and more recent mathematical research (Borthwick, 2011; Rock & Shaw, 2000). Here, children were asked to draw themselves doing mathematics and annotate to show what they were thinking.

Drawings revealed a view of mathematics as a deskbound, number and calculation-oriented subject, with 11/14 drawings showing calculation-based work carried out in the classroom. Out of the remaining three, one portrayed a child chanting times-tables in bed to help them get to sleep, the second sitting at a desk outside in the woods carrying out written calculations, and the third demonstrating calculations to the class. This final example was the only instance in which the child portrayed any kind of social interaction, despite learning in a classroom where talk partners and mathematics buddies were embedded in practice. Perhaps the most poignant illustration came from Taylor, who explained that the image in Figure 3 did not represent how she typically felt, but that this was her experience when confused:


Figure 3: Taylor's drawing of herself doing mathematics

Carrying out this research and uncovering images such as this confirmed the necessity of researchers, as well as practitioners, taking time to give children age-appropriate ways to make their views and voices heard.

### *Individual pupil conferences*

These semi-structured interviews inspired by the techniques of McDonough and Sullivan (2014) began by discussing the previously collected data, with prompts such as 'tell me about your picture' or 'could you say a little more about…'. They then moved into a more traditional interview exploring perceptions around mathematics.

The interviews confirmed many themes arising from other data collection tools, such as the importance of mathematical relationships with teachers, family and friends, vision of people who were 'good' at mathematics being clever and quick, and struggle for connections between mathematics, the rest of the curriculum and possible future career aspirations. Perhaps the most striking features were the constant comparisons girls made between themselves and others, and the responsibility they took for their own mathematical development. Far from holding a 'fixed' mindset (Dweck, 2007), many of them had a far more productive disposition (Kilpatrick et al., 2001), believing that with diligence and effort they could and would improve. In fact, for some the extent of this responsibility was worrying: they believed that they needed to work ever harder, and felt guilty that they were not already making more progress.

## Conclusion

If we are to tackle the intransigent problems of low take-up of post-compulsory mathematical study, self-efficacy amongst girls lagging behind that of equally capable boys, and under-representation of girls at the higher end of the attainment range, we need to find new ways to listen to what they have to say about their mathematical worlds. The approaches presented within this paper have illustrated how photography, drawing, scrapbooking, use of metaphor and visual diagrams can empower girls to reveal their perceptions of mathematics as a subject, identities and relationships. By presenting a range of techniques readily accessible to the classroom practitioner, it is hoped that this paper will support those working with girls to allow them space and time to explore and express their mathematical identity, share responsibility for their growth as a mathematician, and allow their voices to be heard.

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