Using Q methodology to investigate perspectives of secondary school children presenting with number processing difficulties

This article describes part of a three year research project into problems with processing numerical information in secondary school children. In this section of the research the researcher was interested in identification of secondary school children who face this challenge and how their attitudes towards mathematics, learning and their future have been affected. Q methodology was identified as the chosen method to facilitate data collection due to the small sample size expected and the age of the students the researcher was working with. Students with number sense difficulties in Years 7, 8 and 9 (n=375) at a school in the UK were screened for number processing problems using a computerized screening program. 22 were identified. A Q sort was conducted with 34 students in total; 12 students presenting with number processing difficulties and 22 students who had no processing problems with numerical information (9 who were low achievers in mathematics and 13 that were competent in mathematics). The effectiveness of the research method in this context and a summary of the findings are discussed in this article.

Q methodology

Q methodology is a research technique developed by William Stephenson in 1965 which enables measurement of the attitudes of an individual, or group of individuals, to be analysed. It measures the level of agreement, and consequently disagreement, within a research area. It is ideally designed for researching attitudes as it acknowledges that they are subjective.

Q methodology combines both quantitative and qualitative techniques as it uses the principles of factor analysis and inverts them (quantitative). The resultant factors (viewpoints) are then interpreted (qualitative). The methodology requires participants to sort statements along a continuum from 'agree' to 'disagree' in a near normal distribution. It employs a forced choice method as all the statements must be ranked and each position on the deck must be used. The Q sorts generated from the study are then statistically analysed using a by person factor analysis, looking for correlations between the placement of the statements. This then shows how the items relate to one another in terms of strength of feeling. The analysis generates factors (or common viewpoints) represented by the similarities between Q sorts.

This element of the research was exploratory as the perspectives of secondary school children presenting with number processing problems had not been examined before in such a way. There were several reasons why it was felt Q methodology was a good choice for this part of the research.

Rationale for use of Q methodology in this research

The rationale behind choosing Q methodology as the research tool to examine the viewpoints of students took six key factors detailed below into account.

- Avoidance of numbers

A Q sort can be conducted without any presence of numbers as by designing the q deck with no numerals evident, any potential anxiety induced by seeing numbers can be avoided. Indeed, the sort is best conducted without a scale as it is how the items relate to one another, rather than a scale that is important with this methodology. This is a clear advantage when asking students with potential anxiety from numbers to use the Q sort.

- The age of the students

Q methodology is a non-confrontational and indirect method of gathering data in that it is conducted by the individual, on their own. With this particular population, this could be advantageous avoiding social desirability bias (Brener, Billy and Grady, 2003). The less prominent presence of the researcher in Q sort methodology could arguably elicit more truthful responses than alternative methods such as interviewing.

An alternative would have been to administer all the questionnaires that measure the constructs contained within the Q sort. However, Q method allows for the strength of feeling associated with each construct in comparison with other constructs. This is arguably a better representation of the individual students' voices, even though they are analysed together, their relative feelings and the similarities and differences of their attitudes can be reflected.

- Task similarity to classroom activity

Q methodology, from the participants' point of view is a kinaesthetic activity which, for the participants in this study, is similar to tasks they are asked to do in class. The familiarity of a task means that the research will induce less anxiety than an unfamiliar researcher questioning them. It also matches the context of the research in that it is conducted within a school.

- Exploratory nature of the research

The exploratory nature of this research means that Q methodology can be useful in highlighting further areas of research. Whilst there is theoretical underpinning in the compilation of the Q set (i.e. the items to be sorted) there is also the possibility of generation of further points that could be missed if questionnaires were administered instead. Q methodology also allows for participant input in terms of supplementary information.

The items have been compiled from constructs highlighted by previous research on learning difficulties (see The Q Set: Item choice). This is due to the paucity of research on psychological effects on students presenting with number processing difficulties.

- Sample size

A major influence in deciding to use Q methodology was the fact that the sample size was unlikely to meet a level where an inferential statistical test could be useful. At the outset, it was known from literature that the sample highlighted as indicating number processing difficulties could be as low as 3.6% (Reigosa-Crespo 2012). Conversely, the Q sort can be conducted on small sample sizes as it does not need to test statistical power or be representative of a population (Dennis, 1986). It is designed to sample attitudes, and, as these are often shared, the number is reduced. The potential sample size is likely to be further reduced due to reluctance of being involved in the research by the students, their parents or both groups. Moilanen (2007) found that 36% of parents gave consent for their secondary age child to participate in a hypothetical psychological research study which indicates that the numbers are restricted not only by suitability, but also permission to take part.

- The possible heterogeneity of attitudes

In establishing the attitudes of the target group it is likely that there will be many other variables that could affect those viewpoints. Therefore it is unlikely that a generalisation over the full group is appropriate. The compilation of factors means that the variety of viewpoints can be ascertained. Furthermore, the strength of the underpinning influences can also be established using Q methodology.

The Design

The Q set used 33 items. This is less than traditionally used by Q methodology practitioners (Curt 1994). The standard is seen to be between 40 and 80. However upon consideration this was felt to be too many due to the age of the intended audience and the time needed for the task (Watts and Stenner, 2012). An illustration of the Q deck formation used is shown in figure 1.
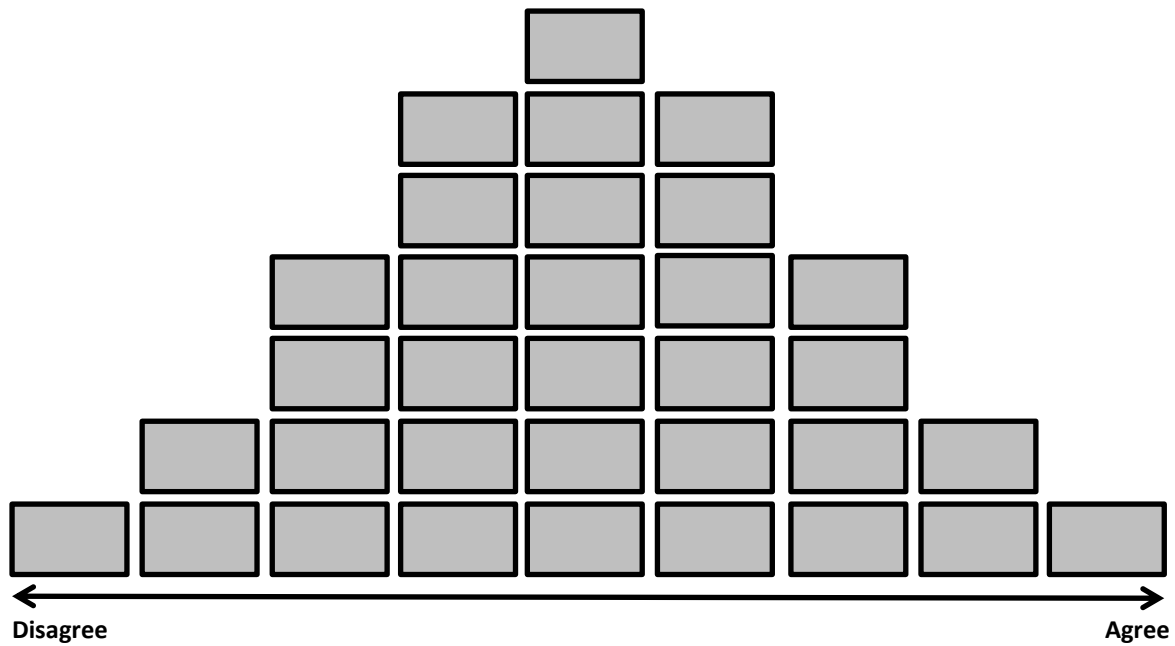
Disagree   **Agree**

Figure 1 Q deck formation

The Q Set: Item choice

As the research is exploratory it was necessary to go to the literature for compilation of the Q set. The following constructs were highlighted as being relevant to attitudes in the age group and the literature that supported inclusion is added.

Aspirations (Joseph Rowntree Foundation report, Goodman et al., 2010; Murray and Farrington, 2010)

Items selected from The Student Aspirations Survey (Plucker and Quaglia 1998):

- 'It is likely I will have a job with good pay later'
- 'It is likely I will be able to save money later as an adult'
- 'I expect to have a happy family life'

Engagement (Anderman and Maehr, 1994; You ,2011; Finn, 1989).

Items selected from the 'Attitudes Toward Mathematics Inventory (ATMI)' (Tapia and Marsh 2004) Inventory:

- 'I hate studying for a maths test'
- 'No matter how much I like or dislike a class, I still try to learn from it'
- 'Maths is my worst lesson'
- 'I find the way maths is taught makes it hard to understand'
- 'I often lose track of what is being taught in maths lessons'

Locus of Control (Bosworth and Murray, 1983, Maier and Seligman, 1976)

Items selected from the Locus of Control Scale (Rotter 1971):

- 'There really is no such thing as "luck"
- 'How many friends you have depends upon how nice a person you are'
- 'What happens to me is my own fault'
- 'I feel I have control over my life'
- 'Doing well in life is a matter of hard work'
- 'Getting a good job depends mainly on being in the right place at the right time'
- 'I am often confused by things that happen to me'

Sense of coherence (Antonovsky, 1979; Ingesson, 2007)

Items selected:

- 'I feel I am treated unfairly'
- 'I am happy most of the time'
- 'I can usually solve problems that others find difficult'

These items were taken from the Brief Assessment of Sense of Coherence (BASOC) SCALE (Schumann, Hapke et al. 2003).

Academic competence (Joseph Murray and Farrington, 2010; Marks, 2014; Stringer and Heath, 2008)

Items selected from the Attitudes Toward Mathematics Inventory (ATMI):

- 'If I do badly in maths it makes me feel like I'm no good at anything'
- 'I have a problem understanding maths nearly every lesson'
- 'There is always something I can do to improve my maths'
- 'I am one of the better students in my maths class'
- 'It bothers me when others perform better than me on a test'

Relevance of subject contents (NIACE Committee of Inquiry on Adult Numeracy Learning, 2011; Onion, 2004; Ashby, 2009)

Items selected:

- 'I see maths as a subject I will rarely use in the future'
- 'I'll need the maths I learn in my future work'

These items were adapted from the Attitudes toward Mathematics Inventory (ATMI) as previously outlined in the 'engagement' and 'academic competence' constructs.

Mathematics anxiety (Hembree, 1990; Brynner and Parsons, 2006; Ma, 1999; Ma and Xu, 2004)

Items selected from Mathematics Anxiety Rating Scale (MARS):

- 'I get stressed when I have to add up a pile of money in a shop'
- 'I like being asked to write an answer on the board in front of my maths class'
- 'I get worried working out how much time I have left to complete a task'
- 'Being asked a maths question by a teacher stresses me'

Social competence (Ingesson, 2007; Toro et al., 1990)

Research on other learning difficulties is unclear on this construct. Some work shows an effect, other work does not.

Items included from a review by Fetro, Rhodes et al. 2010:

- 'I find it easy to talk about my emotions'
- 'I can work well in a group'
- 'I have better abilities than people of my age'

Link to home

Item included:

- 'My parents/ carers like maths'

It was felt that the selected Q sort items had insufficient reference to the influence of parents and the home. The final item included therefore was a researcher authored item which referenced how parents or carers felt about mathematics. As the research was exploratory, this addition was speculative.

Participants

There were three groups of students who completed the Q sort. The first group, 'Presenting with number processing difficulties', were students highlighted as having number processing difficulties by the screener (n=12). The second group were described as 'Low achievers/ no processing problems evident' who were students from the low attainment sets who were not identified as having number processing issues(n=9) and lastly 'Mathematics competent' (n=13)who were students who were in the high achieving sets and had no processing problems.

Following administration of ethics forms, the students were then given the cards and started the task. The researcher sat to their right hand side about a metre away so that she was available for questions. She read whilst they were completing the task unless it was evident they wished to talk to her. If the students talked whilst completing the task and made any salient points she asked the participants if they would mind her writing what they said down, as it could be helpful. Some participants were talkative, others stayed quiet and completed the task entirely without speaking.

Students were told that there was no 'right answer' and that they should feel free to ask questions throughout if they wished. They were also encouraged to volunteer any further information that they felt would be useful to the researcher. It was explained to them that there was no time limit for completion of the Q sort and that they should not feel rushed. The researcher explained that she would be sitting near them but that she would not be watching them complete the task. If they needed help she made it clear that she was available to answer questions.

When they had finished the task the researcher thanked them and asked if they had any more points to make or questions to ask. She also asked them how difficult they found the task to do.

Analysis

The PQ Method software (http://schmolck.userweb.mwn.de/qmethod/downpqwin.htm) was used for the initial analysis of data. The strategy used for analysis was a Centroid factor analysis and a varimax rotation.

Feedback on the task from participants

The pilot study suggested that the task was suitable for the age group, as all three of the students completed the Q sort satisfactorily. This also seemed to be the case with the main study. A content analysis of the responses to the question of 'How difficult did you find the task to do?, categorised them into Easy, Neutral and Difficult (to complete) . A summary table of the responses from each of the groups is shown in Table 1 below. In terms of coding, the categories all responses actually stating 'easy or 'hard' were counted as such, all others such as 'quite easy' or 'ok' were counted as neutral. In reality a continuous measure of the level of easiness would have facilitated a more sensitive method of analysis but it would also have required a numerical response from participants. It was felt, given the focus of the research that this was better avoided and so a non-numerical description was the chosen method of response.

The table below shows the frequency of response in each category and the percentage of responses that the figure represented as all groups were not equal.

Group	Easy total	Neutral total	Difficult total
Presenting with number processing problems	3	8	1
Low achievers/ no number processing problems evident	4	5	0
Mathematics competent	5	8	0
All students	12	21	1

Although the numbers are not large, there is a clear indication that the majority of students felt the task was do-able. This can therefore be argued to support its suitability in this context.

Summary of the findings:

Seven factors (viewpoints) in total were identified by the analysis. The number identified was restricted by the number of responses (Watts and Stenner, 2012).

Presenting with number processing problems:

6 of the 12 Q sorts loaded significantly on one of the two factors at the $p \leq 0.01$ level, so these two factors represented 50% of the views of the students who completed the Q sort. The factors were interpreted and the attitudes expressed in the factors seemed to indicate a difference in terms of perseverance. The factors were named Helpless mathematicians and Persistent mathematicians. This demonstrates a difference in outlook within the students presenting with number processing difficulties, which seems to be underpinned by the mind-set held.

Low achievers/ no processing problems evident

All of the Q sorts loaded onto these two factors named Future-focused Optimists (which represented 7 of the Q sorts) and Happy mathematicians which represented the final two Q sorts in this group. Both these factors had a positive feel, despite the input being from students who struggled with mathematics.

Mathematics competent

3 factors were extracted. These were identified as 'Secure competents' (with 7 sorts significantly loaded), Anxious competents (with 2 sorts significantly loaded) and Baffled competents (with 2 sorts significantly loaded).

All 7 factors from the three groups were compared qualitatively by looking for differences of response on each item. There were several distinguishing constructs between the factors from all the groups. The focus was on how the factors elicited from the number processing difficulties group compared with the other factors. There was an attitude split. Factor 1: Helpless mathematicians were distinguishable by the overarching negativity of their responses. These were particularly with respect to items that were focused on mathematics. Factor 2: Persistent mathematicians had a very positive feel and as such showed a contrast to factor 1. However, this was a pattern observed in the other factors with Mathematics competent array 2: Anxious competents showing a very negative feel in the placing of their items. This suggests that presenting with number processing difficulties can make an individual more susceptible to holding a negative attitude, particularly about mathematics, but that this occurs throughout the student population too, regardless of ability. The positive feel of the Factor 2: Persistent mathematicians also indicates that experiencing

problems processing numerical information by no means precludes a negative attitude towards mathematics. This is perhaps quite a surprising, and encouraging finding. Overall, when comparing the factors (viewpoints) to emerge from the Q sort, mind set and resilience are suggested as constructs which may mediate the formation of a positive or negative attitude to mathematics learning.

Reflection

This experience has led the researcher to advocate the use of Q methodology in gathering attitudes and perspectives of secondary school children, especially in a school context. When the students were asked to complete the task and reassured that there was no 'right answer' they were visibly relaxed and relieved. This suggests its reliability and validity with the age group is good, due to the way they respond.

In terms of findings, the viewpoints that were expressed in the research also suggest that the challenges faced by students with mathematics processing problems do not always mean their attitude is negative. However, there are students for whom number processing difficulties means they carry a negative viewpoint towards learning numeracy and mathematics and this leads to the need for early diagnosis and intervention to reduce the barriers they might face through their time in school and beyond.

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