# Using iPad Digital Diaries to Investigate Attitudes towards Mathematics


## Author

Larkin, Kevin, Jorgensen, Robyn



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# USING IPAD DIGITAL DIARIES TO INVESTIGATE ATTITUDES TOWARDS MATHEMATICS

Kevin Larkin Robyn Jorgensen

Griffith University Canberra University

*In this paper we report on early findings from a project in which we developed a methodology to elicit young students' thinking about mathematics. We describe the use of iPad diaries to collect data so as to better understand students' experiences of mathematics, from three economically and socially distinct schools, at two key junctures - Year 3 and 6. This paper focuses on the unique methodology we developed over three iterations and on the student attitudinal comments regarding mathematics as these give significant insights into the experiences and possibilities for mathematics education of young learners.*

This project explores a methodology that enables learners to recount experiences, feelings, emotions or thoughts in relation to their mathematics learning. Modifying a 'Big Brother' methodology by using iPads, students were able to enter a neutral space set up in the school to talk freely (to the iPad) about their experiences. This method sought to elicit the experiences of young learners in ways that would allow researchers access to their "true" feelings, at least insofar as they were prepared to discuss them. Recognising that interviews or surveys, can produce biased results, the electronic diaries approach offers a more robust and reliable account of students' lived experiences (Buchwald, Schantz-Laursen, & Delmar, 2009) and provides greater opportunity for students to discuss any aspect of mathematics they chose (Di Martino & Zan, 2010; Larkin & Jorgensen, 2015).

## LITERATURE REVIEW

We present here initially a snapshot of the literature on student attitudes towards mathematics, much of which suggests that secondary school students, where they have the choice, are "opting out" of mathematics (Brown, 2009). In a primary school context, students do not have this option but may be psychologically distancing themselves from engagement with mathematics (which may pre-empt the later physical withdrawal in secondary years). The literature suggests that this "opting out" is based upon negative experiences of, and attitudes towards, mathematics and that these attitudes and experiences are often associated with, shame, inadequacy, anxiety and hopelessness resulting in declined performance (Lewis, 2014). Research into beliefs, attitudes and emotions has indicated an important, and inseparable, relationship between cognitive and affective mathematical domains. Ma and Kishor (1997) suggest that "there is a cognitive component to every affective objective and an affective component to every cognitive objective" (p.26) suggesting that any investigation into reasons for non-participation in mathematics must include an examination of both domains. Although significant research into beliefs and attitudes on mathematics has been conducted with older students (See Carter, 2014), we need

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to investigate when the first signs of mathematical withdrawal occurs to determine "how the 'curiosity machine' [the student] turns into a 'mathematical idiot" (Di Martino and Zan, 2010, p. 28) and how this aversion to mathematics may be avoided or at the very least minimised.

## Collecting Authentic Data on Student Attitudes

In this research we used iPads as a tool for collecting information about student attitudes. Proponents of using video research (Buchwald, Schantz-Laursen, & Delmar, 2009; Lundström, 2013; Noyes, 2004) argue that using videos enables researchers to collect data of a more profound, compelling quality than the data normally collected in interviews, surveys, or observations. One purpose of this research was to gain knowledge concerning the students' thoughts, feelings and emotions as they engaged with school mathematics and thus we relied heavily on student voice, mathematics talk regarding the context of learning mathematics and ongoing narratives regarding their experiences of mathematics. The limited literature available suggests that the use of videos encourages students' voice and the telling of personal narratives (Buchwald, et al., 2009) and that student voice is critical as it can often be problematic for adult researchers to understand the world view of students. Di Martino and Zan (2010), Lundström (2013), and Noyes (2004) each suggest that video diaries can be a means of empowering participants to speak authentically of the experience under investigation and to thereby "create representations of their own experiences" (p. 7).

In the previous cited research, the students were able to video themselves whenever they chose; however, they were not able to delete their videos. Therefore, the use of the iPads to self-record electronic diaries adds a high degree of autonomy for the students in our research as they are in complete control of the entire recording process. This means that students had control over creating a digital diary entry or not; determining what they would like to say; and then deleting the material afterwards if they were not satisfied with the result. In addition, the act of recording a diary entry demonstrates a degree of comfort in the process and a willingness to share personal narratives (Buchwald et al., 2009). This willingness to share is of particular import if we are to a) uncover more clearly student attitudes towards mathematics and b) improve the teaching of mathematics as a consequence of an increased understanding of the attitudes and emotions students bring to, or experience, whilst completing mathematical activities. From the literature the following question emerged: *What attitudes and emotions towards mathematics were reported; and are there any patterns in this self-reporting that coincide with two junctures in primary schooling?*

## METHOD

Using electronic diaries as a means for identifying students' experiences in primary mathematics, we sought to develop the method using iPads. Students used either the iPad camera or AudioNote (iPad App) to create a digital diary. Students were invited to be part of the project and consent was gained prior to their involvement. Written prompts (e.g. what would I tell my mum and dad about what I did in maths today?) were placed within a small tent which we used to create a "mathematical thinking space" (See Larkin & Jorgensen, 2015 for a detailed explanation of methodology). School A is a Queensland State School (2014 ICSEA: 1055) and involved 105 students. School B is a NSW Public School (2014 ICSEA: 970) and involved 96 students. School C is a private girls school (2014 ICSEA: 1135) and involved 67 students. [ICSEA is an index used by the Australian Curriculum and Assessment and Reporting Authority to indicate relative social dis/advantage. The national average is 1000 with each standard deviation being 100.] Three different data collection methodologies were deployed. School A and B were similar and in both these schools a shared iPad was placed in the tent where students could record their video. In School A, the lead author downloaded the videos and in school B a research assistant did so. We had ethical concerns regarding this method as students (and possibly their teachers) could view the recordings of others. In order to maximise the security of the data, in School C we used a generic email account on each of the iPads such that the students could record their diary entry, email it to a secure researcher email address, and then delete their diary (email and internet access were not permitted in Schools A and B). In future research, we will encourage schools to use the AudioNote-email methodology as this fully guarantees both the anonymity and security of the diary entries.

## FINDINGS

From the number of digital diaries recorded (Table 1) it is apparent that students from school A and B recorded more diary entries than those in School C; however, this is somewhat counteracted by the fact that the entries from School C were quite lengthy – some almost five minutes long, whereas many of the entries from students in Schools A and B were much shorter – some only a couple of sentences in length.

| **School / Year Level** | **Year 2/3** | **Year 5/6** | **Total** |
|---|---|---|---|
| **A** | 76 | 37 | 113 |
| **B** | 65 | 40 | 105 |
| **C** | 20 | 20 | 40 |
| **Combined** | 161 | 97 | 258 |

Table 1. Total number of video / audio entries by School and year level.

Regardless, the data suggests that the students were very comfortable in recording a diary. We take this as evidence for the success of the iPad as a means of accessing student thoughts about mathematics.

## Leximancer – Quantitative and Qualitative analysis

Leximancer was used to initially analyse the data which had been transcribed from the digital diaries. Concept and theme mapping was completed and frequency counts were generated for the entire cohort and then by individual schools (See Table 2).

*Table 2: Frequency tables for entire cohort and categorised by school*

| Entire Cohort | | | School A | | | School B | | | School C | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Word* | *Count* | *Rel* | *Word* | *Count* | *Rel* | *Word* | *Count* | *Rel* | *Word* | *Count* | *Rel* |
| maths | 607 | 100% | maths | 170 | 100% | maths | 262 | 100% | maths | 175 | 100% |
| fun | 163 | 27% | fun | 59 | 35% | fun | 53 | 20% | fun | 51 | 29% |
| feel | 96 | 16% | easy | 50 | 30% | feel | 51 | 19% | teacher | 40 | 23% |
| teacher | 95 | 16% | times (multi) | 39 | 23% | teacher | 39 | 15% | groups | 36 | 21% |
| easy | 91 | 15% | division | 37 | 22% | times (multi) | 33 | 11% | feel | 26 | 15% |
| times (multi) | 81 | 13% | feel | 19 | 11% | numbers | 27 | 10% | fractions | 24 | 14% |
| groups | 70 | 12% | boring | 18 | 11% | groups | 25 | 10% | easy | 19 | 11% |
| division | 57 | 9% | hate | 17 | 10% | difficult | 22 | 8% | love | 18 | 10% |
| difficult | 48 | 8% | love | 16 | 9% | easy | 22 | 8% | probability | 15 | 9% |
| numbers | 46 | 8% | teacher | 16 | 9% | division | 18 | 7% | diagrams | 12 | 6% |
| love | 43 | 7% | sad | 11 | 7% | pods | 12 | 5% | chunking | 11 | 6% |
| fractions | 41 | 7% | numbers | 10 | 6% | | | | difficult | 11 | 6% |

**Excluded concepts:** doing; things; stuff; today; use; name; food; animals; favourite

The count is a raw score of the number of times a word was used and the relevance (rel) is calculated by dividing the frequency of a selected word by the frequency of the most often used word expressed as a percentage. Some words are used more frequently, and thus are more relevant, in particular schools. For example, the word easy is (15% relevant to the entire cohort, but respectively 30%, 8% and 11% per school). Some words appear on the overall list but, as they did not reach the 5% relevancy threshold at individual schools, do not appear on all of the separate lists (however, their frequency still contributes to the overall relevance). Some words have been excluded from analysis e.g. words such as “doing”, “stuff”, “things” did not contribute to any understanding of their attitude to maths; and words such as “food”, “animals”, “favourite” were excluded as they formed part of the prompt questions which many students read prior to answering. An important observation is that the frequency count does not provide information regarding the specific context of the comments; e.g. “I have fun doing fractions” and “I don’t have fun doing fractions” contribute two counts for both fun and fractions and yet have opposite attitudinal content. Hence, in this paper we have used the frequency count to support a grounded theory approach (Strauss & Corbin, 1997) to point us in the direction of further inquiry and the generation of the themes for later discussion. Using this approach, we were able to locate the statements containing the frequently used words, identify the context in which they were used, and then use these insights to generate themes so that we can provide insights into the mathematical lifeworlds (Boylan, 2010) of these students.

## FEELINGS AND ATTITUDES ASSOCIATED WITH MATHEMATICS

Due to the limited space available in this paper, we will only discuss the main themes that emerge across the three cohorts. The major themes that emerged from the data were a) various emotions regarding mathematics; b) relative ease or difficulty with mathematics; c) the influence of the teacher; and d) grouping and streaming.

### Emotional Responses to Mathematics

A range of words were used by the students to describe their feelings about mathematics. Besides the obvious use of the word maths or mathematics, frequently used words include fun, feel, love, hatred, boring, sad and useful. The frequency of the word fun (Overall 27%, A 35%, B 20%, C29%) is interesting in that it was used in both positive (mainly School C) and negative (mainly School A) contexts. It is also interesting as a component of an increasingly common discourse in educational language where learning is only a consequence of, or at least greatly enhanced, when students are having fun. Investigating the validity of this discourse is beyond the scope of this paper; here we will take the students attitudes at face value and use the word association as an indication of attitude towards mathematics. Students who used the word fun in a positive context spoke largely in terms of it occurring when: a) mathematics involved activity (e.g. measurement, outside tasks, use of materials); b) involved new learning (e.g. money, Cartesian Plane, Probability, Problem Solving); c) included games (e.g. puzzles, mathletics) and d) included working with peers (pairs or groups - but not when streamed). In contrast, students who use the word in a negative context would often use a stem e.g. "Sometimes maths is fun but"… it is often boring; made them sad and frustrated; only when the maths isn't challenging; only when we are in groups; and markedly, only when it is easy. The use of a large range and frequency of highly emotive, negative words (boredom, sadness, wanting to be sick, to cry, hatred) in relation to why maths is not fun, and more broadly in their description of mathematics, is concerning. In School A, and to a decreasing extent in Schools B and C, these negative attitudes were common place at both junctures. We expected to reflect the findings from PISA and TIMMS that Australian students had positive attitudes towards mathematics - around 66% in Year 3 then dropping away to around 30% in Year 7/8 (Brown, 2009). However, in this research, many of the Year 2/3 students had already developed negative attitudes and dispositions towards mathematics and were beginning to identify that they were not Maths people e.g. "I'm just more of an English kind of person". When words such as hatred, hate, dislike, don't like were used they related to: a) mathematics as a subject; or b) elements within mathematics – e.g. fractions; or c) the method that was used to teach mathematics – e.g. worksheets, excessive copying from the board or, in School C, the practice of streaming. Some students were negative, but used less emotive terms such as frustration, confusion and annoyance. Again, these words followed the same pattern as before in relation to mathematics as a subject, specific content areas within mathematics, and methods of teaching mathematics.

## Ease or difficulty with mathematics

There was a significant level of commentary from students regarding, perhaps paradoxically, the ease (Overall 15%, A 30%, B 8%, C 11%) or the difficulty (Overall 8%, A 35%, B 8%, C 6%) of mathematics. This paradox happened across the three schools but also within year levels in individual schools. Where easy was used, it related to either how they felt about mathematics in general (in most cases it made mathematics fun, but in a number of cases easy was linked to a dislike of mathematics), or related to specific content. Similarly, for the many students who referred to mathematics as difficult, this related in minor cases to specific content but more often to mathematics as a discipline. Further work is needed on the notions of easy and difficult in terms of how they become operationalised within learners' ideas of learning and progress. The various positive and negative connotations attached to both easy and difficult mathematics suggests a significant challenge for teachers to target mathematics at the appropriate learning level for each student. Although mathematics being too easy generated some negativity, by and large the stronger emotions occurred in relation to difficulties in mathematics and these difficulties generated feelings of hatred, anger, frustration, annoyance, and confusion - attitudes which seemed to manifest themselves in one of two ways; sadness or boredom. These were evident at each of the research schools, albeit less so in School C, and across both year levels. It is of significant concern to us that Year 2/3 students were reporting levels of sadness, crying, feeling sickness, or complaining of headaches when doing mathematics and is indicative of a strong physiological response to the experience of mathematics. An additional symptom, or perhaps cause of the sadness, was boredom. Reasons given for the boredom included: the overreliance on worksheets; significant levels of copying work from the board; lack of adequate instruction; repeatedly completing work they already knew how to do; and work that was very easy for them.

## The impact of the teacher

The word teacher (Overall 16%, A 16%, B 15%, C 23%) was, like the use of the word fun, used in positive and negative contexts. In terms of positives, many of the students commented that their teacher was very helpful; that they were very influential when they needed to learn new things; that they loved mathematics because of their teacher; and, particularly in School C, mathematics was positive when they had their normal class teacher. When the word teacher was related negatively to mathematics it was in terms of: over-reliance on students copying work down from the board or on worksheets; teachers' attitudes including shouting, not spending enough time with individual students, or expecting that students should be able to do the work; incorrect or inadequate teaching – e.g. teacher confusion between positive / negative integers on a number line (indicating cardinality) and positive / negative numerals in the Cartesian plane (indicating location) and the use of incorrect mathematical language such as "plusses", "takeaways", "minuses, and "times"; and when they were taught mathematics by someone other than their normal class teacher.

### Groupings and Streaming in Mathematics

The high frequency of the word group (Overall 12%, A <5%, B 10%, C 21%) was reflective of some initiatives that were being trialled in Schools B and C. School B was using mathematics groups with their Year 2/3 students (largely seen as a positive by students) and School C had recently introduced streaming for their Year 3 and Year 6 students (where a mixed but generally negative response) was forthcoming from the students. In this paper group work is that which occurs within the home classroom and streaming is ability groupings with different teachers. Positives regarding group work (including paired work and streaming) across the three schools were: the value of getting to know other students from a social cohesion perspective as well as the peer-support they provide; the opportunity to learn at their appropriate level; support of the teachers in small group scenarios; and the likelihood of games and activities being higher with group work. The negatives were: streaming in School C because they were identified as not being good at mathematics; having to work with a teacher who did not know them as learners; likelihood of distraction and off task behaviour; and group dynamics issues such as not being listened to, being made fun off and lack of co-operation. Issues around group work contributed significantly to the number of hate, dislike, sad comments noted earlier. The issue of mixed, but often negative, student attitudes towards group work within classrooms (and the more predominant negative commentary when the groups were formed according to ability and taught by a second teacher) has clear implications for schools considering the employment of specialist teachers of mathematics in the early and middle years as, at least as evidenced in this research, may be counterproductive in the long run in terms of student attitude towards mathematics.

## IMPLICATIONS

Although there was a range of emotional responses to mathematics, including that mathematics is fun and that teachers are supportive, what we found alarming was the strong negative reports from the students across the three schools. As our data indicates, there are many areas for concern here. If students are developing negative attitudes towards mathematics in primary school, as appears to be the case for many students in this study, we suggest that this is a strong indicator for later withdrawal from mathematics in secondary school when this becomes an option for them. From this stage in the research process, we now have some very clear issues that have been raised by the students. The process made possible through Leximancer has highlighted areas that are needed to be explored in greater detail. The analysis has highlighted the salient concerns and positives articulated by the students. The concommitment analysis across the diversity of schools (based on social background in particular) allows further scrutiny of potential differences between the three sites. We now have a robust basis from which to undertake a rich analysis of the data. As is commonly noted as a criticism of grounded theory, the categories identified by the researcher/s may be based on personal bias. The use of Leximancer eliminates much of this bias. It has allowed the creation of categories across our three schools, but also has highlighted the differences between the schools. We are able to move confidently into a much richer analysis of the data using grounded theory knowing that the categories that have been identified through Leximancer have an empirical basis to them. **Acknowledgement:** *This project was funded through a Griffith AEL research grant scheme. We also acknowledge the contribution of Associate Professor Peter Gates (Nottingham University) to the writing of this paper. An article based on School A data is currently in press (IJSME) and we refer to some of those findings in this paper.*

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