Differentiated Success: Combining Theories to Explain Learning

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This paper explores the value of different paradigms to explain dispositions towards mathematics among primary school students from different social backgrounds. As part of a larger project designed to elicit students' thinking and attitudes towards mathematics, we seek to develop an explanatory model for the socially-differentiated outcomes in students' responses. The three paradigms – psychology, sociology and post-modernism – form the basis of the paper where the data we collected from three geographically close but socially different schools were analysed.

This paper is an exploratory theoretical paper. We have intentionally sought to unite three disparate paradigms to explain outcomes in a larger project. The fundamental premise underpinning this paper is that one theory is inadequate in explaining students' differentiated discussions about their experiences and dispositions towards mathematics in primary mathematics classrooms. This approach, of using two or more different theories to try to explain phenomenon, is not new and has been used by other researchers (see Williams, 2012) in mathematics education. The project sought to develop a tool that would allow students to provide honest feedback about their experiences and feelings towards mathematics. What emerged from the data were distinct patterns in responses that aligned with the socio-economic backgrounds, as indicated by ICSEA scores presented in Table One, of the students. To this end, focusing on the individual was limiting since it failed to recognise the structuring practices of mathematics classrooms and the habitus with which students entered these classrooms. Similarly, focusing on the social backgrounds of the students limited the richness in the responses offered by the students in terms of how they were actively constructing themselves as learners.

To frame this paper, we draw on Bourdieu (1997) who explains that educators need to understand the processes around the conversion of social and cultural backgrounds into school success. The responses offered by the students in this study, were highly varied and have consequences both for their relationship with school mathematics now, and also for future academic success in secondary school mathematics and beyond. This view is argued thus:

> To fully understand how students from different social backgrounds relate to the world of culture, and more precisely, to the institution of schooling, we need to recapture the logic through which the conversion of social heritage into scholastic heritage operates in different class situations (Bourdieu, Passeron, & de saint Martin, 1994, p. 53).

The notion of social heritage thus becomes a central variable in coming to understand differential success in school mathematics. In terms of this project, and for school mathematics in general, we suggest that it is salient to consider the social backgrounds of learners and how this is implicated in the differential outcomes for learners. Using a Bourdieuian framework, the lack of success for some social groups becomes a non-random event as success or otherwise is partially a product of institutionalised practices of which participants may be totally ignorant. When taking a Bourdieuian perspective, success in school mathematics is less to do with innate ability and more to do with the synergistic relationships between the culture of school mathematics and that which the learner brings

2015. In M. Marshman, V. Geiger, & A. Bennison (Eds.). *Mathematics education in the margins* (Proceedings of the 38th annual conference of the Mathematics Education Research Group of Australasia), pp. 325–332. Sunshine Coast: MERGA.

to the school context (Jorgensen, 2010). The greater the synergy between the habitus of the student and school mathematics, then there is greater probability of success. In Bourdieuian terms, the habitus thus becomes a form of capital that can be exchanged within the field of school mathematics for forms of recognition and validation that convert to symbolic forms of power. Thus, what becomes important for both psychological and sociological theories, is the ways in which learners internalise practices within school mathematics in relation to their positioning within those practices. For some students, the social and cultural habitus with which they enter mathematics classrooms aligns strongly with the practices and discourses within those classrooms. For these students, it is highly likely that they will see themselves as 'good' learners of mathematics. In contrast the reverse is the case for students whose habitus does not align with the practices and discourses valued within the field.

It is not our intent in this paper to provide a synopsis of the various paradigms as this would restrict the discussion of the data in terms of theory building. However, we will provide a brief discussion regarding the major shifts and foci within the divergent fields to illuminate key moves in contemporary thinking about the impact of individual construction of mathematical identities in terms of access (and marginalisation) in school mathematics.

Table 1
Key Paradigms in Mathematics Education

	Psychologistic	**Sociological**	**Post-Modernist**
Key terms	Affect, dispositions, learning, individualistic	Social groups Differences, equity	Identity formation Intersubjectivity
Explanatory concept	Individualistic	Habitus	Identity
Theorists	Hannulu	Bourdieu, Jorgensen	Foucault, Walshaw

An insight provided by Lewis (2013), with regard to subjective dispositions aligning with the psychologistic paradigm, suggests that "motivation and emotion may be more central to an understanding of the phenomenon of disaffection than that of a quantitative study of attitude" (p.70). Similarly Brown, Brown, and Biddy (2012) argued that there were psychological internalisations for students selecting to opt out of further study in mathematics.

> The analysis supports findings that perceived difficulty and lack of confidence are important reasons for students not continuing with mathematics, and that perceived dislike and boredom, and lack of relevance, are also factors. There is a close relationship between reasons for non-participation and predicted grade, and a weaker relation to gender. An analysis of the effects of schools, demonstrates that enjoyment is the main factor differentiating schools with high and low participation indices. (p.3)

In contrast to the embodiment and internalisation of dispositions towards mathematics as an individual phenomenon, others have suggested that the practices of school mathematics may create opportunities to overtly and/or covertly marginalise particular groups of students (See Jorgensen, Gates, & Roper, 2014).

Another school of thought with implications for mathematics education is post-modernism. Walshaw (2011) describes this position as

> Multiple factors have brought about postmodernism. They include political and social crises of legitimation, and the resulting changing nature of economies and social structures in Western societies. These changes place complex and sometimes conflicting demands on people in ways that they are barely able to understand or predict. The effects of these processes for mathematics education are unsettling. Conceptual tools and frameworks from postmodern thinking help us to develop an understanding of those effects. They help us to understand ideas that are central to mathematics education from beyond the standard categories of thought. In particular, they help us to understand cognition and subjectivity. (p. 7)

Each of the three theoretical paradigms briefly discussed has a unique contribution to make regarding mathematics education. For us, coming to understand the constructions that students from diverse backgrounds are making of themselves and mathematics needs to be understood from an interdisciplinary approach. It is limiting to see construction as individualistic as this view fails to recognise the structuring practices of mathematics; conversely, failing to recognise the agentic power of each individual limits the understanding of how students can rise above restrictive practices in mathematics classrooms.

Approach

The approach adopted in this project was adapted from Noyes' (2004) study where a 'big brother' technique was employed. Students were able to withdraw from the classroom and speak (confidentially) into an iPad recording their thoughts and feelings towards mathematics. The approach was designed to elicit responses from students that may be more valid given that participation was optional and confidential. The recordings were directly between the students and the researchers. We have outlined the approach in more detail in other papers, also discussing strengths and limitations of the approach (see Larkin & Jorgensen, 2014; 2015). As the project has evolved, we also modified the approach to maximise student confidentiality in the iPad diary process.

Data from three primary schools (two from Qld and one from NSW), each representing very different social strata, are included in this paper. The schools were included by purposive selection so that an exploration of social differences could be undertaken. Due to the sample size, statistical significance cannot be established; however, the sample is large enough to allow exploration of the tool for accessing students' perceptions of school mathematics, and for the development of theory. A synopsis of the schools is provided below in Table Two. Data are taken from the My School site for each school. The data are from the 2013 data set which represents the periods within which the data were collected.

Table 2
Key Characteristics of the Three Schools

	School A	**School B**	**School C**
Type of school	State school	State school	Independent girls school, High fees
Year Levels	P-6	P-6	P-12
ICSEA score (2013)	1055	970	1135
Enrolments	922	268	1154
Location	QLD	NSW	QLD

The two state schools performed relatively similar to each other on NAPLAN with no remarkable differences. The Independent girls' school consistently scored better, or significantly better, than the national average in numeracy across all years for the past three reported periods (2011-2013) on NAPLAN. With the ICSEA score representing 1000 as the national mean for a measure of social dis/advantage, each 100 points represents one standard deviation from the mean. Our schools are at least 80 points different from each other and thus are relatively disparate in terms of social advantage.

The data were analysed using Leximancer – a software package that undertakes thematic analysis of the frequency of words as well as establishing relationships between terms used by participants. Leximancer allows researchers to see visually, the trends and themes that appear in the data set/s. The interview data for the three schools were run through the Leximancer program and key themes emerged for each school. The visual reporting shows relative frequency by the size of each theme, and then relationships between themes through connecting lines and overlap of themes. From the Leximancer analysis it was clear that the responses of the students were quite different in their relative frequency in referring to various (key) aspects of mathematics. School C students were more engaged with mathematics (in terms of their articulation around concepts) and had a much stronger sense of themselves as learners of mathematics. In contrast, the students at School A were less likely to enjoy mathematics and focused more on low level mathematics (such as operations) in their articulations. The students at School B were more likely to talk about mathematics being fun and focused on number work. Figure 1 provides a pictorial representation of words used frequently by students in School A.

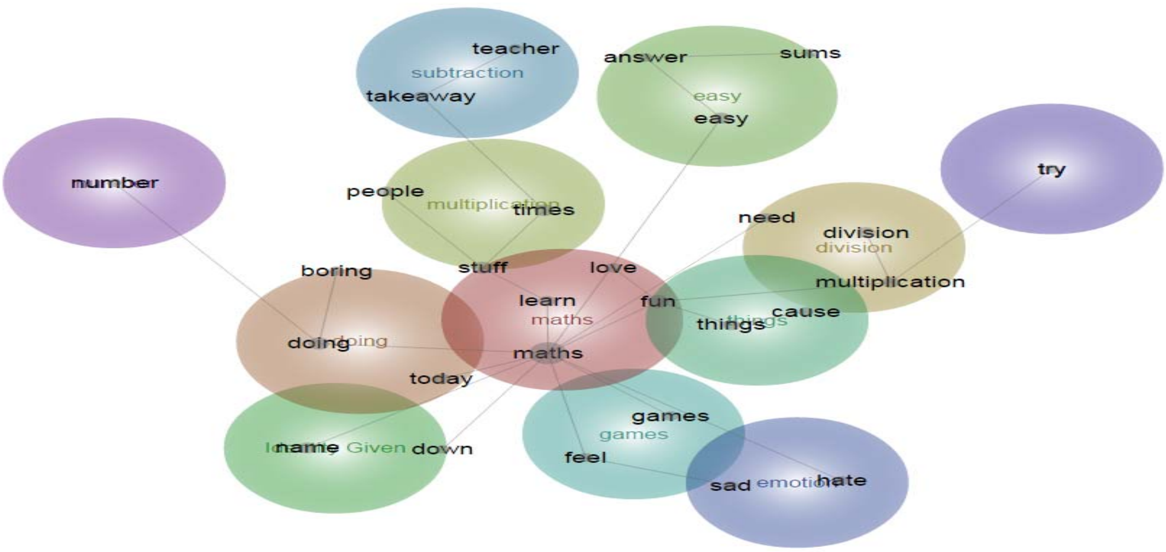

Figure 1. Visual Output from Leximancer – School A

The visual output from Leximancer shows the relationships between concepts for a given unit of analysis (in this example, School A). The distance between concepts gives some sense of the relationships (close or far) between concepts and the lines show the direct relationships between various concepts. This is provided for illustrative purposes to show the ways in which Leximancer draws relationships between concepts. Each school map was quite different in terms of the major concepts and relationships but cannot be included due to the limits of a conference paper. Suffice to say, at this point, there are marked differences between the schools' maps. To provide some rigour to the differences between the schools, a further analysis can be undertaken through tabular representations of the counts associated with concepts. While the program does not differentiate among the use of concepts, for our purposes it was illuminating to see the concepts to which the students referred. This summary is provided in Table 3 below.

Table 3
Frequency Counts for Key Terms Combined and then Individually 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*	39	23	**Teacher**	39	15	Groups	36	21
Easy	91	15	Division	37	22	Times*	33	11	Feel	26	15
Times*	81	13	Feel	19	11	Numbers	27	10	Fraction	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	**Teachers**	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

What this thematic analysis shows us is a number of key differences between the schools. This can be seen, for example, in the differences between the frequency of the concepts *teachers* and *easy*. There is also a notable difference in the emotive words used by the students across the schools. For example, the students in School A referred to maths being easy and the role of the teachers was profiled quite low in the relative comments made by the participants. Conversely, the students in the other schools referred to the teacher more often than their School A peers and there was less reference to the ease of mathematics. Similarly, the table alerts us to differences in the comments being made about mathematics, in terms of content as well as emotional/affective reactions to mathematics. For example the students at School A referred to maths using terms such as *boring*, *hate love*, *sad* while the students at School B only used the term *difficult* and school C students only used *love*. These differences are further expanded in the detailed transcripts of the students.

Student Comments

In this section, we provide more detailed comments as to the responses offered by the students from the different schools. The student comments provide insights into their thinking about what is mathematics, but also their relationship with mathematics, teachers and learning. With the limitations on a brief conference paper, we again use these for illustrative purposes to build our theory.

School A student comments

These comments provide insights into the students' thinking about mathematics. There is a marked difference in the ways that pedagogy is described and their relationship to mathematics.

> I don't like doing maths because I don't get trading and borrowing because it's hard and I don't get how you trade and how you borrow. Thank you. (Gr 3)
>
> I learnt in math today. I learnt how to do dividing and stuff. Let's see, what I don't like about maths. I hate math, I don't really like it. It's not fun. What I like about math is stuff, just stuff and all that because sometimes math can be easy and all that. I don't feel happy when I do maths because it's really hard. What I find difficult in maths. A lot of things basically. So bye-bye, I'm out.

School B Student Comments

The examples from School B also provide illustrations of the students' reactions to mathematics.

> In maths today I learnt about square numbers and I'm sort of finding them out but I don't know what I'm going to use them for but they're got to teach what they've got to teach. And I think we should do maths groups. (Gr 2/3)
>
> I do like maths, a little bit, so I'm like in the middle. A lot of the maths we do is pretty hard for me. Because I just find things hard like most kids, I still try my hardest and people think I'm dumb and the teacher knows that I struggle so she will help me sometimes. Today we did a really, really hard thing. I got it but the teacher said I could stop and do another maths thing because it was hard for me, so I'll show you what it was. (Gr 5/6)

School C Student Comments

The comments below indicate how the students positioned themselves as learners of mathematics and gave insights in the pedagogies being used (groups) and strategies being taught to the students (chunking).

> I think maths is pretty good. Sometimes I like it and sometimes I get a bit bored doing it. Sometimes I feel pretty confident with some things, sometimes I get a bit stuck with other things. I found my favourite strategy is the chunking strategy. I find it very easy and that's why I love it so much. I use it all the time because sometimes I get stuck with sums and I sometimes really don't know what the answer is so I use the chunking strategy. … Thankyou. (Gr 3)
>
> I like maths because we do fun activities to do with the topic. The topics are always fun, like fractions. I like fractions because you can show them in many different ways like in numbers and pictures. It's also really fun because you get to work in groups. That's a bonus because you get to work with your friends. (Gr 6)

As indicated these data are provided for illustrative purposes and have been selected to show some of the differences observed across the schools. The most surprising outcome was the very strong positive dispositions that were evident among the students from School C towards mathematics. It is this difference we seek to explore in the remainder of the paper.

Discussion

The data presented through the iPad diaries alerted us to two key phenomena that we now discuss. First we saw that the students are School C were more likely than their peers at Schools A and B to have strong mathematical identity and more likely to describe mathematics using a mathematically-rich vocabulary e.g. chunking or strategies. The students at Schools A and B were more likely than the students at School C to describe negative feelings towards mathematics, indicate negative identities towards mathematics, and provide low level descriptions of mathematical content. From a psychologistic perspective, it can be argued that the motivations and affective domains for the students were potentially empowering or disempowering in terms of mathematical success. Having favourable dispositions towards mathematics is likely to facilitate the attainment of successful learning outcomes. What can be seen from both the frequency data (Table 3), and reinforced in the quotes from the students is their relationship with mathematics knowledge, not only in terms of the content covered but also in the amount of discussion of mathematics concepts. It is clear from the data in Table 3, that mathematics discipline knowledge for the students at School C is more frequently reported than for the students at Schools A and School B. For the students at Schools A and B, their reporting was more focused on internalisation of dispositions and feelings towards mathematics than was the case for students at School C.

What is also of value to our discussion is a different reading of these data. From a Bourdieuian perspective, it is apparent that the students from School C have dispositions of themselves, and towards mathematics, that are likely to result in improved outcomes when compared to their peers in the other schools. This is not just an individualistic construction since, as Bourdieu has suggested, the social and cultural habitus of the students at the all-girls school (who are likely to be from middle to upper class families) is one that aligns with mathematics and hence, becomes reified through success in mathematics – however defined (either as a disposition or mathematically). The girls at School C have been exposed to practices that they articulate as being strong mathematical, and that have helped them to build a habitus that is empowering in terms of future mathematical studies. The girls have been able to build scholastic capital that is not as apparent, nor as strong, in the students from Schools A and B. Further, from a postmodernist perspective, we can see how the practices position students in particular ways and that these offer various subject positions for learners – some who see themselves as productive learners of mathematics, while others have become positioned as marginalised learners.

What we see as important in the discussion in this paper is that one theory may limit how we come to understand students' experiences of mathematics. Relying on one theory may offer some explanation of these data but is also limiting. What struck us when analysing the data across the three schools were the marked differences in the students comments. Clearly the students at School C have a strong sense of themselves as learners of mathematics. Relying solely on a psychologistic perspective would only allow an understanding of mathematics as an individualistic construction; however by incorporating a sociological perspective (particularly that of a critical sociology), we are better able to understand the structuring of these differences and how they may result in differential access to mathematics learning. Combining the various theories enables a much richer perspective on understanding the ways in which the students come to see themselves in relation to mathematics.

Limitations

While this paper is theoretical in its approach and primarily sought to develop an explanatory approach to the differences in the data collected, we acknowledge that the small sample (3 schools) limits the claims we can make as a much larger sample would help to establish the validity of our analysis. We also acknowledge that some of the differences expressed by students could be due to the teaching practices at the schools, rather than social background *per se*. While this may be a methodological limitation, we also contend that the outcomes are noteworthy. The social stratification that is evident in these students' responses reinforce both psychological (embodied) and sociological (social) theories of learning and access. We also acknowledge that there are limitations of solely relying on the Leximancer word count as exploring the comments that surround those concepts is equally as important. Leximancer does, however, provide a very useful tool for beginning explorations into the differences and similarities among cohorts.

References

Angus, D., Rintal, S., & Wiles, J. (2013). Making sense of big text: A visual-fist approach for analysing text data using Leximancer and Discursis. *International Journal of Social Research Methodology, 16*(3), 261-267.

Australian Curriculum Assessment and Reporting Association (2015). *My school*. Accessed Feb 14, 2015.

Bourdieu, P. (1977). *Outline of a theory of practice*. Cambridge: Cambridge University Press.

Brown, M., Brown, P., & Bibby, T. (2012) "I would rather die": reasons given by 16-year-olds for not continuing their study of mathematics. *Research in Mathematics Education, 10*(1), 3-18.

Hannulu, M. (2012). Exploring new dimensions of mathematics-related affect: embodied and social theories. *Research in Mathematics Education, 14*(2), 137-161.

Jorgensen, R., Gates, P., & Roper, V. (2014). Structural exclusion through school mathematics: Using Bourdieu to understand mathematics as a social practice, *Educational Studies in Mathematics, 87*(2), 221-239.

Jorgensen (Zevenbergen), R. (2010). Language, culture and learning mathematics: A Bourdieuian analysis of Indigenous learning. In C. Wyatt-Smith, J. Elkins, & S. Gunn (Eds.), *Multiple Perspectives on Difficulties in Learning Literacy and Numeracy* (pp. 315-329). Dordrecht: Springer.

Larkin, K., & Jorgensen, R. (2014). Using video diaries to record student attitudes and emotions towards mathematics in year three and year six students. In J. Anderson, M. Cavanagh & A. Prescott (Eds.). *Curriculum in focus: Research guided practice* (Proceedings of the 37th annual conference of the Mathematics Education Research Group of Australasia, pp. 373-380). Sydney: MERGA.

Larkin, K., & Jorgensen, R. (2015). 'I hate maths: Why do we need to do maths?' Using iPad video diaries to investigate attitudes and emotions towards mathematics in Year 3 and Year 6 students. *International Journal of Science and Mathematics Education*, 1-20. doi: 10.1007/s10763-015-9621-x

Lewis, G. (2013). Emotion and disaffection in school mathematics. *Research in Mathematics Education, 15*(1), 70-86.

Noyes, A. (2004). Video diary: A method for exploring learning dispositions. *Cambridge Journal of Education, 34*(2), 193-209. doi: http://dx.doi.org/10.1080/0305764041000170056l

Walshaw, M. (2011). Positive possibilities of rethinking (urban) mathematics education within a postmodern frame. *Journal of Urban Mathematics Education. 4*(2), 7-14.

Williams, J. (2012). Use and exchange value in mathematics education: Contemporary CHAT meets Bourdieu's sociology. *Educational Studies in Mathematics*, *80*(1-2), 57-82.

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