

# Constructing Classroom Contexts that Engage Students in the Learning of Mathematics: a Teacher's Perspective

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This paper explores the construction of classroom contexts facilitative of student engagement in Mathematics. Employing a form of discourse analysis framed within a participation approach to learning, the paper provides insights into the construction of such contexts. The affordances and constraints of constructing such a context are discussed in the light of the writings of one Year 7 teacher as she employed Collective Argumentation to re-construct her classroom context to better engage students in the learning of Mathematics.

The recent Ministerial review of Teacher Education in Australia (TEMAG, 2014), following the report from the Office of the Chief Scientist (2012), *Mathematics, Engineering and Science in the National Interest*, emphasised that an important aspect of “inspiring students to engage with Mathematics” was the need for teachers to “have the knowledge and confidence to present the curriculum imaginatively” (p. 25). Presenting the curriculum imaginatively requires the development by teachers of “broader pedagogical skills” that go beyond traditional approaches to teaching Mathematics and that include “inquiry-based teaching skills” (Office of the Chief Scientist, 2012, p. 21). Sullivan (2011), in a review of research informed strategies for the teaching of Mathematics, provides some insight into the nature of such teaching strategies when he highlights that teachers that afford students opportunities to make decisions, to use a variety of forms of representation, that foster communication both at the individual and group level, and that “use students’ reports to the class as learning opportunities” (p.28) can be facilitative of student engagement in the learning of Mathematics.

There is no paucity of literature on the nature of teacher strategies that facilitate student engagement in the learning of Mathematics. For example, Paul Cobb and his colleagues have researched, amongst other things, the teaching of classroom Mathematics to clarify the characteristics of classroom Mathematics traditions (Cobb, Wood, Yackel & McNeal, 1992), the emergence of mathematical meaning in the classroom (Cobb & Bauersfeld, 1995), the role of discourse, argumentation, reflection and autonomy in the learning of Mathematics (Yackel & Cobb, 1996), and norms of participation facilitative of student engagement in classroom Mathematics (Cobb, Yackel & Wood, 1989). However there has been little long term uptake of such research in the everyday classroom and constructing learning contexts that support a teacher’s use of such strategies and research findings in the everyday classroom is a key challenge for the field of Mathematics teaching and learning.

Teacher development of inquiry-based teaching strategies requires that teachers learn as they teach (Sherin, 2002). That is, that teachers are willing to change the routines that they have been comfortable with to teach Mathematics to better suit a focus on student decision making, multiple forms of representation, and individual, group and whole class talk about mathematical tasks. However, such changes teachers might make can often bring a good deal of variability in terms of their efficacy to engage students in the learning of Mathematics. For example, teachers may require students to engage in group work when doing Mathematics, but limit student participation in group activities through the use of a

form of classroom discourse that privileges teacher authority and individual accountability (Linehan & McCarthy, 2001). Teachers may endeavour to employ whole class discussion in their Mathematics classrooms, but interpret students' contributions in terms of individual competencies rather than in terms of participation in the discourse (Gresalfi, Martin, Hand & Greeno, 2009). Still, other teachers may wish to include aspects of inquiry learning into the Mathematics of the classroom, but are inconsistent when implementing such aspects due to their concerns about time constraints, scarcity of resources, standardised testing results and student behaviour (Leatham, 2006).

For the past ten years we have been interested in assisting teachers to construct learning contexts facilitative of student engagement with Mathematics. One of our goals has been to describe the affordances and constraints that arise from implementing a sociocultural approach to facilitating student engagement in everyday Mathematics classrooms. The sociocultural approach that we have used to assist in the construction of classroom learning contexts is Collective Argumentation (Brown & Renshaw, 2000).

### Theoretical Framework

Collective Argumentation (CA) is a format for teaching and learning designed to engage students in constructing understanding through the use of a key word scaffold. This scaffold utilises the inquiry-based strategies of representing, comparing, explaining, justifying, agreeing and validating to support student activity at the small-group and whole-class levels. Derived from sociocultural theory (Vygotsky, 1981) that assumes that changes in the sophistication of a person's understanding of a concept can only be understood when learning is viewed as being a dialogue of collaboration between expert and novice, Collective Argumentation requires that the curriculum be problematised for students and delivered through tasks that require them to work individually to *represent* their solution or ideas about solving a Mathematics task, to join with others to *compare* representations, to *explain* and *justify* their representations, to reach consensus with others at the small group level and to construct a group response to the task that can be presented to the class for discussion and *validation*. During the presentation, the class and the teacher are expected to engage in a mathematical discussion with the presenting group. An important element of Collective Argumentation that supports the teacher and students in engaging in the learning of the classroom is the negotiation of a class charter of values. The values negotiated reflect social qualities of engagement such as courage, honesty, persistence and affirmation, and together with the key word scaffold guide activity and participation in the classroom.

In this paper we present the written reflections of a Year 7 teacher who used Collective Argumentation in her classroom to engage students in the learning of Mathematics. Reflections are discussed in terms of the affordances and constraints that arose for this teacher from using a sociocultural approach to construct a classroom context to facilitate student engagement in the learning of Mathematics.

### Method

The design of the research, aspects of which are reported in this paper, was based on a 'teaching experiment' (Cobb, 2000). The 'teaching experiment' is an elaboration of Vygotsky's (1987) experimental-developmental method designed to provide insights into the influence of social and cultural contexts on learning and development.

### *Participants*

The original study from which this research was taken involved 20 primary, middle school and senior secondary teachers and their students located in 6 schools in Queensland. After an initial phase of design, development and dissemination, 4 primary and 4 secondary teachers and their classes were involved in a 3 year study to determine what aspects of Collective Argumentation (a) can be appropriated by teachers in the curriculum area of Mathematics, (b) can be employed by teachers to improve the overall quality of the teaching and learning relationship in the Mathematics classroom, and (c) can be used by teachers to promote productive student engagement with higher-order thinking strategies. This paper reports on one female Year 7 teacher (Jackie) and her written perceptions of the affordances and constraints of using Collective Argumentation to construct learning contexts facilitative of student engagement with Mathematics. This teacher was chosen as the focus for this paper due to her commitment to using Collective Argumentation in the subject domain of Mathematics over an extended period of time (9+ years). Over this extensive period, Jackie taught in metropolitan, co-educational primary schools.

### *Data Sources*

The original study required each class of students and their teachers to be video/audio taped twice during the year when using Collective Argumentation in their Mathematics classrooms. Anecdotal records relating to teacher-student and student-student interactions were made on a regular basis. Teachers were asked to provide a written or oral report about their experiences using Collective Argumentation at professional development days. Towards the end of each intervention teachers was interviewed about their perceptions of doing Collective Argumentation in their Mathematics lessons. Generally the teachers were asked about what aspects of Collective Argumentation facilitated student engagement in the learning of Mathematics in their particular classroom context. These interviews employed stimulated recall as a tool for collecting data. Teachers were also asked to keep a diary throughout the intervention and to record on a lesson by lesson basis their perceptions of the affordances and constraints of using Collective Argumentation to engage students in the learning of Mathematics. A follow up interview was conducted with selected teachers a year or two later to determine what aspects of Collective Argumentation proved useful in their everyday teaching of Mathematics. This paper focuses on the written diary and report of Jackie, a year 7 teacher. Journal/Report writing in Mathematics has been associated with providing worthwhile information on Mathematics classrooms (Clarke, Waywood & Stephens, 1993).

### *Journal Writing Framework*

To inform teaching practice and to provide a record of day to day observations each teacher was provided with a 'journal writing reflection sheet' and asked to record their perceptions of doing Collective Argumentation for each lesson. As can be seen in Table 1, this journal reflection sheet provided opportunities for the teacher to record his/her perceived level of (a) influence over the direction of the lesson's proceedings (Questions 1, 3, & 4), (b) on-line assessment and monitoring of student activity (Question 2, & 10), (c) affect associated with participating in the lesson (Questions 6, 7, & 9), and (d) personal learning and difficulties associated with implementing the lesson (Questions 5 & 8). For the purpose of providing insights into the affordances and constraints that arose for Jackie from using Collective Argumentation to construct a classroom context to facilitate student engagement with

Mathematics, questions 5 to 10 of Jackie’s journal reflections about implementing a Mathematics unit on Area ( 6 lessons) will be the focus of this paper.

Table 1  
*Journal reflection sheet*

Teacher’s Journal Reflection Sheet	
Time Learning Session Started: Date:	Learning Session Finished: Learning Session Topic:
(1) Today’s learning session was about? (2) Who did you work with during today’s learning session? (3) What did you do in today’s learning session? (4) Why did you do it that way? (5) What did you learn in today’s session? (6) What did you enjoy in today’s learning session? (7) What didn’t you enjoy in today’s learning session? (8) What difficulties did you have in today’s learning session? (9) How did you feel about today’s learning session? (10) Any other observations important to today’s session?	

### *Report Writing Context*

Jackie’s written report on her classroom activity was written for and delivered by Jackie at a professional conference of Mathematics teachers and educators. The report was a reflection by Jackie on her own teacher practices and covered the following topics: (a) Why Jackie considered using Collective Argumentation in her Mathematics lessons, (b) What effect this consideration had on her students, (c) the good points and difficult points of using Collective Argumentation to teach Mathematics, and (d) how using Collective Argumentation did or did not fit with current curriculum expectations and classroom planning.

### *Analytic Framework*

Jackie’s written reflections and report were subjected to a form of analysis derived from methods associated with the sociocultural family of theories related to the work of authors such Lave & Wenger (1991), Wenger (1998), and James Wertsch (1991), and framed around Vadeboncoeur’s (2006) participation framework. This framework centres on the broad categories of *location* (How is the classroom organised?), *relationships* (What roles and responsibilities are visible in the classroom?), *content* (What type of knowledge is privileged in the classroom?), *pedagogy* (What do the teacher and students do in the classroom?), and *assessment* (What is valued in the classroom?) and was employed to allow researchers to see aspects of learning contexts that may afford or constrain student participation in Mathematics lessons across a number of data sources and contexts (Vadeboncoeur, 2006). In this paper we focus on the categories of content, pedagogy and assessment. This focus was chosen for this paper due to the emphasis given to these categories in national school curricula documents.

## Analysis of Journal and Report Writing

### *Content: Memorising versus Understanding*

For Jackie, teaching curriculum and skills emerges in partnership with engaging ‘kids’ with learning Mathematics, offering them opportunities to engage with Mathematics content on ‘a level that suits them’, where they can feel safe to ‘express trouble’ with mathematical concepts and where they can ‘re-clarify’ their understanding through small discussions.

I love the fact that the children can operate on a level that suits them. One or two children had trouble expressing ‘What is length?’ This is a revelation for me as these children have covered length every year for 7 years. This led to a small discussion on length and next lesson will hopefully re-clarify length, width vs columns, rows vs area. (Journal entry, 1/06)

The aim, for Jackie, is not only to teach students Mathematics knowledge and skills, but to engage students with their learning style of Mathematics as illustrated in the following entry,

One girl in particular is communicating mathematical ideas beautifully in the oral situation. I have not seen this ability to grasp concepts in any of her ‘normal’ maths lessons. I believe we have really tapped into her learning style. (Journal entry, 1/06)

These aspects of privileging understanding and engagement are further highlighted in Jackie’s report where she writes,

When planning I will read what is required by the syllabus and then spend time reading the syllabus materials, and other educational materials, to design what I believe are rich tasks, (inquiry type tasks). Sometimes the students will make an enquiry during class and this will form its own lesson e.g., “Is a decimal fraction the same as a remainder?” (Report entry p. 5)

### *Pedagogy: Extending versus Limiting*

Teaching emerges from Jackie’s journal reflections as having to do with extending ways of knowing and doing Mathematics into those practices valued by adult mathematical communities (engineers, economists, etc.). Teaching, for Jackie, is about students showing ‘persistence’ and ‘determination’,

The persistence of the children impressed me. I enjoyed the determination of two groups to get as exact as possible. (Journal entry 26/05)

It is about students ‘remaining on task’, ‘attempting difficult problems’ and about ‘challenging’ the ideas of others,

I enjoyed that an ADHD child remained on task, that three girls who normally are disinterested in maths persisted for 1.5hrs to solve a problem, that three ‘average’ girls attempted the most difficult problem and the determination of two boys to challenge the teacher’s presentation. Their reasons were clear and enlightening. (Journal entry 14/06)

This approach to extending students’ participation in Mathematics is revisited in Jackie’s written report where it is emphasised that teaching is about encouraging students’ construction of ‘understanding’ through engagement in meaningful tasks and through linking individual understandings to those of others through the ‘diagnosis of error patterns’ and through the provision of ‘constructive feedback’,

The students are encouraged to present work in a way that makes ‘sense to them’ and this provides students with a variety of ways to come to an understanding. The more capable students are challenged to diagnose errors and/or error patterns thus extending their thinking. All students know their work and efforts are valued as we take the time to discuss and explain these errors thus providing constructive feedback and meeting the needs of the individual. (Report entry p. 3)

### *Assessment: Doing versus Knowing*

For Jackie, assessment seems to be concerned not only with what students can and cannot achieve, but also with ‘creativity’ and ‘variety’ mediated through the ‘embarrassment free’ process of ‘making errors’ and providing ‘student explanations’.

The creativity and variety of solutions was interesting and revealing as to the cognitive level of the child. (Journal entry 26/05)

When the two groups who made errors with  $r^2$  presented their work they realized their mistakes after questioning from myself, and other classmates were able to explain the errors also. The children are no longer embarrassed about making a mistake. (Journal entry 14/06)

This use of ‘errors’ by Jackie as a form of assessment is reinforced in her report writing where ‘errors’ provide the teacher with a diagnostic assessment tool and a strength of participating in her classroom context is ‘immediate feedback’. Within Jackie’s classroom assessment is conducted in a context where ‘fear of failure’ is ‘diminished’, thus providing students with the potential to develop competencies related to the ‘doing’ of Mathematics.

A further strength of using CA is that this feedback is immediate, not a day or a week later, which is often the case with work handed in for marking, and errors are seen as a way of learning; they are used as a diagnostic tool for everybody and the fear of failure or looking foolish is diminished. (Report entry p. 2)

### Discussion

This paper set out to describe the affordances and constraints, as reflected in the writings of one teacher, of using a sociocultural approach to construct a classroom context to facilitate student engagement in the learning of Mathematics. As can be seen in the analysis above, Jackie’s classroom is organised around the sociocultural principles of Collective Argumentation.

According to Jackie, Collective Argumentation is providing her with the necessary tools to engage her students in a productive teaching learning relationship around the subject of school Mathematics. It is well known that student engagement with Mathematics declines over the middle years of schooling, years 6 to 9 (Sullivan, 2011). Jackie’s perceived improvement in student engagement implies, therefore, a change in her own classroom practice from being a teacher to being an expert participant in the Mathematics of the classroom. This change required from Jackie a shift in the way authority is distributed across the classroom, a shift where teacher and students are seen as being equal stakeholders in the learning of the classroom, a classroom requiring more symmetrical, participatory and collaborative forms of interaction between teachers and students. Such a shift is necessary for the formation of a classroom learning community (Linehan & McCarthy, 2001) and important for the development of teacher student relationships productive of engagement in the learning of Mathematics (Gresalfi, Martin, Hand & Greeno, 2009).

This transformation in Jackie’s classroom context is further evidenced in the type of knowledge that is privileged in the classroom. Not only is the academic knowledge of Mathematics privileged, but also the ways of knowing and doing of a mathematical community of learners. These ways are encapsulated in such virtues as persistence, determination, and challenge and are necessary for managing student affect in the Mathematics classroom (Cobb, Yackel & Wood, 1989). What the teacher and students are doing in Jackie’s classroom, therefore, is moving beyond a traditional approach to teaching and learning Mathematics to construct a creative and critical classroom context for the

teaching and learning of Mathematics, a classroom context advocated by reform documents such as the Ministerial Review of Teacher Education in Australia (TEMAG, 2015).

The development of this classroom context is further evidenced in Jackie's perceptions of the constraints of Collective Argumentation. As suggested in the above analysis these constraints are expressed in the form of tensions that exist for Jackie in each of the analytic categories. In terms of location, Jackie alludes to the tension between the context of her classroom and the school in which it operates. References to feeling uncomfortable about the time devoted to Mathematics lessons expresses a concern raised by many teachers interested in constructing an inquiry type context in their Mathematics lessons in a school context that privileges a traditional school timetable (Leatham, 2006). Relationships in Jackie's classroom require the teacher to support students to engage in classroom talk, to assume autonomy in the learning process, to actively participate in their own learning and, where reasonable, challenge students' and the teacher's ideas. Constructing such student centred relationships in a Mathematics classroom can be uncomfortable for teachers who are used to the division of labour that exists in many traditional classrooms (Sullivan, 2011).

In terms of content, it is clear that Jackie is concerned with teaching Mathematics to students in a manner that facilitates students' construction of understanding through engagement in meaningful and interesting tasks. This can be somewhat difficult at times for teachers operating in school systems that are rated by their students' performances on standardised, external testing regimes (Leatham, 2006). Pedagogy, for Jackie, appears to be framed by the values/norms of adult communities of mathematical practice, such as determination and persistence. Such norms are necessary to implementing the type of teaching appropriate for the development of inquiry type approaches to teaching Mathematics (Sullivan, 2011). However, such pedagogy is often represented by teachers as being not suitable when dealing with disengaged students (Sullivan, 2011). It is not surprising then to see that what is valued in the context of Jackie's mathematics classroom goes beyond the 'knowing', that is, the conceptual and procedural knowledge of Mathematics to embrace competencies related to the 'agency' and 'accountability' of 'doing' Mathematics, norms of participation that frame the kinds of 'agency' and 'accountability' necessary to engaging in the learning of Mathematic and that are accessible to most students. However, as such competencies are intimately related to the structure of the tasks presented to students (Gresalfi, Martin, Hand, & Greeno, 2009), it is not surprising that competencies of this nature are not privileged in many conventional classrooms, another potential source of tension for Jackie when moderating assessment practices with other teachers.

## Conclusion

In this paper we have explored a Year 7 teacher's writings relating to implementing a sociocultural approach to engaging students in the learning of the Mathematics classroom. As used by Jackie, Collective Argumentation has the potential to focus the teacher on collaborating with students when constructing a classroom context facilitative of students coming to know and do Mathematics. As suggested in this paper the affordances of using such an approach to construct classroom contexts facilitative of student engagement in Mathematics are many. However, before the construction of such contexts can spread beyond Jackie's classroom, issues related to the constraints of approaches such as Collective Argumentation need to be dealt with at the national, state and local levels of schooling.

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