Transforming Practice: Using Collective Argumentation to bring about Teacher Change in a Year 7 Mathematics Classroom

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Providing assistance to teachers in the design of efficacious learning environments is an essential element in promoting teacher change in the teaching of mathematics. The process of teacher change, however, may be demonstrated in quite different ways by different teachers. This paper provides insights into the process of change as perceived by one teacher as she went about employing Collective Argumentation to reconstitute her pedagogy so as to better promote the learning of mathematics in her Year 7 classroom.

The recent review of Mathematics teaching in Australia (DEST, 2003) emphasised the need for schools to design pedagogies that stimulate interest, curiosity, substantive understanding, and problem solving amongst students, and that provide teachers with the means to teach mathematics confidently and competently. Designing learning environments that support a teacher's use of such pedagogies in the everyday classroom is a key challenge for the field of mathematics teaching and learning. Teacher use of productive pedagogical techniques requires that teachers learn as they teach (Sherin, 2002). That is, that teachers change the familiar routines that they have employed in the past to teach mathematics to better suit a focus on the multiple representations of conceptual understandings that students bring with them to the mathematics classroom and the connection of these representations to the conventional representations privileged by mature mathematical communities (e.g., engineers, accountants, statisticians, etc.).

The changes that teachers make to their classroom pedagogies can often bring varying degrees of efficacy to the teaching learning relationship. For example, as noted in the *Numeracy Research and Development Initiative 2001-2004* (DEST, 2005), developing understanding in the mathematics classroom may be facilitated through the use of group work, whole class discussion, and by the use of instructional materials. However, teachers may incorporate group work into the mathematics of the classroom, but filter student participation in group activities through the lens of established routines that privilege teacher authority and individual accountability (Linehan & McCarthy, 2001). Teachers may endeavour to incorporate whole class discussion in their mathematics lessons, but interpret students' contributions in terms of issues related to motivation and accept all student contributions as being 'equally' relevant to the mathematics being taught (Sfard, 2000). Still, other teachers may wish to include instructional materials, such as computer programs, into the mathematics of the classroom, but their use of such materials is mistimed, mismanaged or technically beyond their expertise (Putnam, 1992).

For the past ten years we have been interested in designing learning environments in mathematics classrooms that support teacher change efficacious of student learning. Our goal has been to reconstitute classroom pedagogy using sociocultural theory as a tool to generate new practices and to critically reflect on change as it occurred (see Renshaw, 2003). One sociocultural approach that we have used to assist in the design of learning environments is Collective Argumentation (Brown & Renshaw, 2000).

While Collective Argumentation (CA) was developed in local schools in Queensland during the past ten years, it was based partially on the pioneering work of Miller (1987),

who had defined three interactive principles necessary for coordinating competing knowledge claims. First, the 'generalisability' principle requires that students attempt to communicate their ideas, so that fellow students can participate in sifting the relevant from the irrelevant ideas. Second, the 'objectivity' principle requires that relevant ideas can be rejected only if they can be denied by reference to past experiences or logical reasoning. If ideas cannot be denied then they must remain part of the discussion whether or not they support or reject the point of view of some of the participants. Third, ideas which are contradictory to each other or that belong to mutually exclusive points of view must be resolved through group argument — the 'consistency' principle. We extended Miller's principles to include a principle of 'consensus' and a principle of 'recontextualisation'. Consensus requires that all members of the group understand the agreed approach to solving the problem. Interactively it requires that all members of the group contribute to the co-construction of arguments in support of the solution process, and can articulate the arguments in their own words. If a member of the group does not understand, there is an obligation on that student to seek clarification, and a reciprocal obligation on the other group members to assist. Finally, the 'recontextualisation' principle involves children re-presenting the co-constructed argument to the other members of the class for validation. Communicating to class members outside the group, challenges students to rephrase their ideas in terms familiar to the class, to defend their thinking from criticism, and perhaps to reassess the validity of their thinking.

To achieve consistency in the classroom we reduced each of the above principles to a key word format — 'represent', 'compare', 'explain', 'justify', 'agree' and 'validate' — that provides teachers with a mechanism for scaffolding student participation in Collective Argumentation. Teacher participation in Collective Argumentation requires connecting student activity to the conventions of mathematics and the establishment of relationships with students that facilitate the appropriation of concepts, skills and dispositions associated with mature communities of mathematicians. In other words, teacher participation in Collective Argumentation requires change from solely using traditional pedagogical methods to transmit mathematics to using productive pedagogical techniques to promote student learning in the domain of knowing and doing mathematics.

We have just concluded a year-long intensive school-based program of research on CA with Years 4 to 7 teachers. Our findings suggest that teachers can effectively appropriate the pedagogical strategies of Collective Argumentation in the domain of mathematics if they are supported within their school communities and provided with on-going assistance from a "critical friend" who has expertise in the strategies of CA. Our study is consistent with the DEST Report (2003) that indicates that "professional learning which is primarily focussed on the situational needs of the school, where decisions are made within that school community, helps strengthen the creative and innovative capacity of the school (p.161)." In this paper we present snapshots from the account of a Year 7 teacher who deployed Collective Argumentation in her classroom to bring about change in her own practice and to facilitate student learning in the domain of mathematics.

Method

The design of the study, which arose from sociocultural methodology, was based on a "teaching experiment" (see Davydov,1988; Cobb, 2000). The "teaching experiment" is an extension of Vygotsky's experimental-developmental method that was designed to capture

the determining influence of social and cultural processes on learning and development. From this perspective, the activity of the students, the activity of the teacher/researcher, and the activity of the classroom that they co-construct, interrelate at a number of levels to create the 'life context' of the mathematics classroom. This intervention methodology is designed to interrogate the reciprocal process of intrapsychological and interpsychological change. By changing the social conditions of teaching and learning in the classroom, we also hope to change the teacher's understanding of their situated pedagogy and their insights into the learning capacities of the students in the class (see Wertsch, del Rio, & Alvarez, 1995). A "teaching experiment" in general, therefore, involves prolonged systematic inquiry into change through engagement in collaborative cycles of analysis, design, implementation, assessment and reflection. The mediator of change in our research project was a particular pedagogical tool — the habits of mind and social practices associated with Collective Argumentation. A specific aim of the study was to determine whether Collective Argumentation could be employed by a group of teachers to enrich teaching and learning in their mathematics classrooms. The design of the project required that one of the authors of this paper be intensely involved in the design, implementation and research of mathematics units of work over the course of one school term (approximately 10 weeks). In this paper we report sections of the account of a Year 7 teacher who was involved in the study.

Participants

Seven primary school teachers (5 female and 2 male) from Years 1, 2, 4, 5, and 7, and their students, volunteered to participate in the study. The teachers had from 1 to 20 years experience in the classroom. The teachers all taught at the one school located in a middle-class suburb of a major city. The school used an outcomes based mathematics syllabus and a mathematics textbook was mandated by the principal for use in each classroom. This paper focuses on a Year 7 teacher, Jackie, who had taught at this school for a number of years and who had over 10 years experience in the primary classroom. Her class was made up of 25 (12 male and 13 female) students. Jackie reported that in the last 18 months she had become discontented with a transmission approach to teaching mathematics and had been employing Collective Argumentation in her classroom to invigorate her teaching and to promote student learning in mathematics.

Data Collection

The study required each class of students and their teachers to be video/audio taped twice during the year when using Collective Argumentation to go about knowing and doing mathematics. Anecdotal records relating to teacher-student and student-student interactions were made on a regular basis and the teachers and those students who were able were asked to keep a reflective journal.

Towards the end of the study each teacher was interviewed about their perceptions of doing Collective Argumentation in their mathematics lessons. These interviews employed stimulated recall (see Meade & McMeniman, 1992) as a tool for collecting data. Teachers individually responded to a set of 10 questions (see Table 1) whilst watching a video of his/her classroom doing Collective Argumentation to learn mathematics. The video of the teacher, his/her-self, using Collective Argumentation in the classroom served as a catalyst for reflection and discussion (see Zevenbergen & Zevenbergen, 2004). The interview questions were designed to reflect the content, pedagogical, and contextual understandings

of the teachers as they went about implementing Collective Argumentation in their classrooms. Following Shulman (1987), content understandings relate to the concepts and procedures of mathematics (see question 01) and pedagogical understandings relate to the teaching and assessing of those concepts and procedures (see questions 06 and 07).

Table1
Questions Presented to Teachers

No.	*Question*
01	How important is the teacher's knowledge when doing Collective Argumentation?
02	What are the good points of Collective Argumentation for your own teaching?
03	What are the difficult points of Collective Argumentation for your own teaching?
04	What student behaviour problems has Collective Argumentation provided for you?
05	What three values would you advocate teacher's use when doing Collective Argumentation?
06	How does doing Collective Argumentation help with an outcomes based approach to teaching and learning?
07	What assessment strategies do you use when doing Collective Argumentation?
08	What part of the Collective Argumentation key word format did you find useful?
09	What part of the Collective Argumentation key word format did you not find useful?
10	How could Collective Argumentation be improved?

However, as could be expected, the majority of interview questions (questions 02, 03, 04, 05, 08, 09, 10) were directed at the context in which teachers went about teaching mathematics in their classrooms, namely, Collective Argumentation. According to Sherin (2002), the effective teaching of school mathematics is as much influenced by the context (the idiosyncratic representation of ideas, engagement in group work, participation in whole-class discussions, etc.) in which teachers scaffold student learning as it is by the teachers' own understandings of mathematics and how to teach it. Jackie's responses to questions 02 and 03 are the focus of this paper. Jackie's stimulated recall responses to questions about the affordances and constraints of Collective Argumentation were chosen for analysis because they capture the nature of Jackie's learning in the act of her teaching.

Analysis and Discussion

In summarising the affordances of using Collective Argumentation to teach mathematics in her Year 7 classroom, Jackie (see Table 2) focuses on the transformation brought about in the nature of the participation of those 'boys' reluctant to engage with schoolwork. Collective Argumentation is described by Jackie as making a 'huge difference', transforming these students from being 'boys' whose engagement with the mathematics of the classroom is such that they finish up hating the teacher, the subject and themselves, to being students who are 'switched on' and able to communicate to others through the language of the subject. For Jackie, the transformation in these students' desire to talk about mathematics is the 'first' that she has experienced in her teaching career and unique to Collective Argumentation — 'way more than they would ever get in any other sort of method of teaching'.

Table 2
Perceived Affordances of Collective Argumentation

Speaker	*Text*
Researcher	I know you have mentioned some of these already but would you summarise for me — What are the good points of Collective Argumentation for your own teaching?
Jackie	I have found for the first time in my life that boys are switched on in my room. Really interacting with what they are doing. I found, particularly last year, that boys who had no interest in school work in the past and would only participate if it was a teacher talk lesson or they were working out of their books, they're not, you know, they have finished the page of work, but they haven't really thought about what they have done, or they haven't thought about their learning they only, they don't care if they get it (the task response) wrong. They (boys) will happily hand in a page of work and get it all marked wrong and then happily toss in back in their desk. And you can get them (boys) to do it, five, ten times and they'll eventually might get it right, but they'll find ways, you know, you'll spend two weeks getting them to finish something correctly, and all that energy wasted and they'll hate you by the end of it and hate themselves and hate the subject. I can't believe how different this (Collective Argumentation) has made them. It (doing Collective Argumentation) is a huge difference. They just do it (the task). They do it (the task), they listen, they're involved, they're talking and even the children who have an inability to concentrate, say your A.D.D. (Attention Deficit Disorder) child, are switched on by it (Collective Argumentation) because it's less structure for them and they love the talking. Their (the boys') interest and motivation to talk about maths now is something that never happened previously. Social interaction is way more than they (the boys) would ever get in any other sort of method of teaching, and the style that takes place means that suddenly the language that goes with maths becomes precise. It has to become precise because they (boys) can't communicate with one another if they don't have that. Then having the audience means, once again, that the language has to be precise. Their communication skill, on the discussion of that particular topic, has to develop a common understanding through the presentation, which I find very powerful.

According to Jackie, Collective Argumentation is improving student attitudes towards the knowing and doing of mathematics in her classroom. However, Collective Argumentation is a pedagogical tool or method, like 'reciprocal teaching', that a teacher may access to engage students in a teaching learning relationship. It is well known that student enjoyment of mathematics is correlated with achievement, particularly with

teachers' perceptions of student achievement (see for example, Brew, Pearn, Bishop, & Leder, 1995). As such, it can be implied that it is not Collective Argumentation as simply a decontextualised technique that is transforming student participation in Jackie's classroom, but Jackie's personal and situated deployment of Collective Argumentation with her students to teach and to learn. To teach mathematics, yes, but also to learn from her teaching of mathematics. Jackie's perceived transformation in student participation implies, therefore, a transformation in her own teaching practice from being a teacher of school mathematics to being a participant (needless to say an experienced participant) in the mathematics of the classroom. This transformation in Jackie's teaching practice is further evidenced in her perceptions of the constraints of Collective Argumentation (see Table 3).

Table 3
Perceived Constraints of Collective Argumentation

Speaker	*Text*
Researcher	What are the difficult points of Collective Argumentation for your own teaching?
Jackie	The ability to get every child involved in the group and having one or two children that no one wants to work with, that's a difficulty. Whereas if they have to do every task on their own that child would complete their work like every other child in the room. Yes it is a negative, but I don't think you are teaching them any life skills by doing that (letting the students work by themselves), they are going to have to work with people to get a job or whatever else. So yes, it is a negative, but it is a healthy negative because at least we are exposing it (not being able to work with others), we are working with it and we are getting that child (the excluded child) to see how they could possibly change, how the rest of the children in the group could possibly change, so we are learning to work with one another, which of course is a social skill which is how societies function. And because they (the children) verbalize, if they stand up and do a presentation and they have had no idea what they are doing, they (the children) can then verbalize to me what they don't know. The only other way I would find out is by going around to each child when they had a problem, which doesn't really show me the full picture. I guess you could argue that an exam would, but you can't give them a written test everyday.

Jackie perceives the noticing of peer exclusion as being a constraint of Collective Argumentation. For Jackie, this is a constraint that has not had a major influence on her teaching before and is something that the teacher and all the children in the classroom need to address. As such, the requirement of Collective Argumentation that the children collaborate with each other is described by Jackie as a 'healthy negative' - a healthy negative that has the potential to take student learning from the 'personal' to the 'social'. However, working in the social domain of the classroom holds other challenges for Jackie. Student verbalisations of what they 'don't know' is also perceived as being difficult for her own teaching. No longer can Jackie rely on the written test to tell her what her students don't know, now she is looking for the students to give her the 'full picture' by talking

about their mathematics.

Working collaboratively and talking about the mathematics of the classroom are two powerful tools that teachers can use to engage students in the 'deep' learning of mathematics (see for example, Lampert, 1990). For Jackie, her classroom practice is changing from masking the exclusion of some students through the predominate use of individual seat work, to seeing exclusion from group participation as being a challenge that the teacher and all students must address if the learning of mathematics, as described in curriculum documents (see for example, *A National Statement on Mathematics for Australian Schools,* Australian Education Council, 1991), is to be for everyone.

Conclusion

In this paper we have explored teacher change from a Year 7 teacher's perspective, and related it to the use of Collective Argumentation to facilitate the teaching and learning of mathematics. Collective Argumentation focuses the teacher and students on collaborating with each other when coming to know and do mathematics in the classroom. In our analysis of a Year 7 teacher's responses to questions related to the affordance and constraints of using Collective Argumentation, we suggest that the teacher and students in this classroom were beginning to adopt ways of knowing and doing mathematics that were consistent with curriculum initiatives, namely, that ideas need to be meaningful (personally understood) and communicable (able to be explained and represented for others to appreciate).

Teacher responses, as reported in the above extracts, testify that change in the mathematics classroom cannot exist in a vacuum or be insulated from the histories of the participants. For Jackie, bringing about change in her pedagogical techniques required her to negotiate with the pedagogy of her past, maintaining those techniques that worked, for example, "going around to each child when they had a problem" and dispensing with those techniques that didn't work, for example, "spending two weeks getting them to finish something correctly". This negotiation, this learning during the act of teaching, enabled Jackie to view students, who in the past she had classified as being difficult to teach, in a new light — a light that made visible previously hidden levels of student interest, involvement, and communicative skill.

In terms of the larger study referred to in this paper, our findings suggest that teachers can employ the pedagogical strategies of Collective Argumentation in the domains of mathematics if they are supported within their school communities and provided with on-going assistance. However, the level of efficacy of such appropriation for bringing about lasting change in pedagogical techniques varies. Preliminary analysis of video-tapes of teachers using Collective Argumentation suggests that transforming teacher practice in the mathematics classroom requires the teacher to learn how to balance the complex interaction between content knowledge, pedagogical techniques, and contextual understandings with the institutional requirements of schooling. How teachers may be assisted to address this balance is the focus of our future research.

References

Australian Education Council (1991). *A National Statement on Mathematics for Australian Schools*. Melbourne: Curriculum Corporation.

Brown, R. A.J. & Renshaw, P.D. (1999) Speaking with authority in episodes of mathematical discourse. In J. Trunan and K. M. Trunan (Eds.) *Making the difference: Proceedings of the twenty-second annual conference of the mathematics research group of Australasia.* Adelaide:MERGA. pp.113-119.

Brown, R.A.J. & Renshaw, P.D. (2000) Collective argumentation: A sociocultural approach to reframing classroom teaching and learning. In H Cowie, and Diny van der Aalsvort, (Eds.), *Social Interaction in Learning and Instruction The meaning of discourse for the construction of knowledge.* Pergamon Press. pp 52-66.

Cobb, P. (2000) Conducting teaching experiments in collaboration with teachers. In A. Kelly & R. Lesh (Eds.) *Handbook of Research Design in Mathematics and Science Education*. Mahwah, N.J.: Lawrence Erlbaum.

Davydov, V.V. (1988) Problems of developmental teaching (Part1). *Soviet Education, 30*(8), 6-97. European Union Directorate-General for Education and Culture (2001) Learn, learn, learn. Le Magazine, 14, 3-4

Department of Education, Science and Training (2003). *Australia's Teachers: Australia's Future. Advancing Innovation, Science, Technology and Mathematics*. Main Report. Committee for the Review of Teaching and Teacher Education. October.

Department of Education, Science and Training (2005). *Numeracy Research and Development Initiative 2001-2004: An Overview of the Numeracy Projects.* Canberra: DEST.

Lampert, M. (1990). When the problem is not the question and the solution is not the answer: Mathematical knowing and teaching. *American Educational Research Journal, 27*(1), 29-63.

Linehan, C., & McCarthy, J. (2001). Reviewing the "community of practice" metaphor: An analysis of control relations in a primary classroom. *Mind, Culture, and Activity, 8*(2), 129-147.

Meade, P., & Mc Meniman, M. (1992). Stimulated recall" — An effective methodology for examining successful teaching in science. *Australian Educational Researcher, 19*(3), 1-18.

Miller, M. (1987) Argumentation and cognition. In M. Hickmann (Ed.), *Social and Functional Approaches to Language and Thought* (pp. 225-249). London: Academic Press.

Putnam, R. T., (1992). Teaching the "hows" of mathematics for everyday life: A case study of a fifth-grade teacher. *Elementary School Journal, 93*, 163-177.

Renshaw, P. (2003) Community and learning: Contradictions dilemmas and prospects. *Discourse: Studies in the Cultural Politics of Education, 24*(3), 355-370

Sfard, A. (2000). On reform movement and the limits of mathematical discourse. *Mathematical Thinking and Learning, 2*(3), 157-189.

Sherin, M. G., (2002). When teaching becomes learning. *Cognition and Instruction, 20*(2), 119-150.

Shulman, L. S., (1987). Knowledge and teaching: Foundations of a new reform. *Harvard Educational Review, 57*(1), 1-22.

Wertsch, J. V., del Rio, P., & Alvarez, A. (1995). Sociocultural studies: History, action, and mediation. In J. V. Wertsch, P. del Rio, & A. Alvarez (Eds.), *Sociocultural Studies of Mind* (pp. 1-34). New York: Cambridge University press.

Zevenbergen, R., & Zevenbergen, K. (2004). Numeracy practices in contemporary work: Changing approaches. In I. Putt, R. Faragher, and M. McLean (Eds.), *Mathematics Education for the Third Millennium: Towards 2010.* Proceedings of the 27th Annual Conference of the Mathematics Education Research Group of Australasia. Townsville: MERGA.