

Students' Recollections of Participating in Collective Argumentation When Doing Mathematics

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Student participation in Collective Argumentation (CA) has been shown to have beneficial effects in promoting student participation in the mathematics of the classroom. However, little is known about the effects of students' participation in CA on their learning of mathematics beyond that classroom. To provide insights into this issue, students, who had participated in CA classrooms in the past, were asked to respond to a questionnaire designed to elicit their perceptions of the worth of participating in CA. This paper analyses a sample of those responses in terms of the goals of schooling for young Australians.

The need for curricula to ensure that the mathematics that students do in school is rewarding for them in terms of their learning has been highlighted in the literature through curriculum documents such as *A National Statement On Mathematics For Australian Schools* (Australian Education Council, 1991) and *The Melbourne Declaration on the Goals of Schooling for Young Australians* (MCEETYA, 2008), and through the work of researchers such as Brophy (2004) and Schoenfeld (2002a). In terms of the goals for school mathematics (Australian Education Council, 1991), developing students' confidence in and positive attitudes towards mathematics are integral to developing student competence in and capacities to use mathematics. This goal orientation is affirmed, although in a more general sense, in the educational goals for young Australians (MCEETYA, 2008) that relate the development of student confidence to active participation in the learning process and to the development of critical thinking skills.

According to Brophy (2004), a student's motivation to participate in mathematics is mediated by the expectation that participation will result in successful outcomes. Such outcomes relate not only to academic achievement, but also to social outcomes such as the maintenance of self-esteem when undertaking a mathematical challenge. The research of Schoenfeld (1988, 2002b) elaborates four student belief orientations detrimental to participation in mathematics. The first relates to the process of mathematics and to the belief that using mathematics to explain, prove, discover or invent has little to do with problem solving. The second orientation relates to students' making effective use of whatever mathematical skills and understanding is possessed and to the belief that understanding in mathematics means that a student can solve a problem in five minutes or less. The third relates to students using mathematics to solve problems individually and collaboratively with peers, and to the belief that mathematics is studied passively, with students accepting solutions to problems rather than expecting that they can make sense of the solution process for themselves. The final orientation relates to students using mathematics to generate, share and test ideas, and to the belief that learning in school mathematics is "an incidental by-product to 'getting the work done'" (Schoenfeld, 1988, p. 151).

Even though these researchers conduct their studies in different teaching and learning environments, one thing that each has in common is the view that the development of student confidence in and positive dispositions towards learning takes place in social context. For Brophy (2004), student confidence and competence develop in classroom learning communities where students have opportunities to engage with the teacher and peers in collaborative activities within a supportive classroom environment. Similarly, for

Schoenfeld (2002b), students develop their sense of mathematics (positive or negative) from engaging in classroom practices that are socially constructed and socially communicated. Ways in which classroom practices are constructed and communicated can strongly influence students' views of mathematics and their development of positive attitudes towards it (Cobb, Wood, Yackel, & Perlwitz, 1992). For example, students in classrooms that employ co-operative inquiry-based practices are less likely to develop a belief orientation that mathematics is studied passively than students in classrooms that solely employ teacher demonstration and individual practice (Middleton & Spanias, 1999).

One pedagogical paradigm that sees knowledge as being co-constructed and that positions the learner in a mediated process of entering the practices, values and ways of knowing of a broader community is that provided by Collective Argumentation (Brown & Renshaw, 2000). Informed by sociocultural principles of learning and development (Vygotsky, 1987), Collective Argumentation (CA) provides a way of teaching and learning mathematics that shares congruence with the types of ways of knowing and doing privileged within broader mathematical communities. Key features of CA involve the structuring of student interactions through the use of a 'key word' format (represent, compare, explain, justify, agree, validate) and the scaffolding of student participation within a classroom culture centred on a negotiated classroom 'value charter' (e.g., openness, honesty, humility, and wise-restraint). In simple terms, CA requires students to represent a task or problem alone, compare personal representations with a small group of peers, explain and justify the various representations to each other in the small group, reach agreement within the group, and to present the group's ideas and representations to the class to test their acceptance by their peers and the teacher. It is the purpose of this paper to provide insights into whether students, who have participated in CA classrooms in the past, value this participation and would recommend participation in the practices of CA to other students of school mathematics.

Method

Participants. Twenty-four students who had participated in one Year 11, three Year 6, one Year 6/7 and three Year 4 classrooms that used the practices of Collective Argumentation (CA) to engage students in mathematics were asked to respond to a questionnaire during the year following their participation in these classrooms. These students were asked to complete a questionnaire because their individual participation in CA had been tracked during the previous year. Completed questionnaires from 19 students (10 male, 9 female) were received by return post. When completing the questionnaire most of these students were placed in classrooms that did not use CA to teach mathematics. However, the two students who had participated in the Year 6/7 classroom were still members of that class when completing the questionnaire. These 19 students displayed varied levels of achievement in school mathematics when they were in the CA classrooms.

Materials. The paper and pencil questionnaire comprised 13 questions. The first 4 questions elicited students' recollections of Collective Argumentation (CA) and the nature of salient characteristics of the pedagogy associated with its implementation. The next 6 questions elicited students' perceptions of differences between student participation in CA and the ways of learning mathematics that they were presently experiencing, and aspects of CA that they may have found useful or a hindrance to their learning of mathematics. The next 2 questions elicited students' opinions of CA and their opinions as to whether it should be experienced in other classrooms within the school system. The final question provided respondents an opportunity to record their personal impressions about CA as they

now thought of it and to record any other comments that they wished to make about CA. Responses to question 1 and question 11 (see Table 1) comprise the data pool for this paper. The responses to these questions were chosen for analysis because they provide insights into what these students perceived CA to be and because they provided students with an opportunity to make judgments about its personal and general worth.

Table 1
Questions Chosen for Analysis

| Question no. | Question posed to students |
|--------------|--|
| 1 | What do you remember about Collective Argumentation? |
| 11 | Should Collective Argumentation be trialled in other classrooms? Give reasons for your answer. |

Analytic method. The analysis of students’ responses was conducted on two levels. The first level simply noted responses to each question. The second level interrogated students’ responses in terms of practices implicitly indicated in the 2nd educational goal for young Australians, namely, “All young Australians become successful learners, confident and creative individuals, and active and informed citizens” (MCEETYA, 2008, p. 8). In particular, the analysis focused on the “Successful learners” dimension of this goal and on the identifier “develop their capacity to play an active role in their own learning” (MCEETYA, 2008, p. 8). This goal dimension and identifier resonates goal 2 of *A National Statement On Mathematics For Australian Schools* (Australian Education Council, 1991), namely, that “Students should develop positive attitudes towards their involvement in mathematics” (Australian Education Council, p. 1991, p. 11). As such, the text relating to this goal statement was subjected to a content analysis. The content analysis focused on words contained within the text of the goal statement that expressed the development of a preferred action or condition by students. For example, in referring to the goal of developing positive attitudes towards their involvement in mathematics, the text states that “making effective use of whatever mathematical skills and understanding is possessed” (Australian Education Council, 1991, p. 11) is an important aspect of learning mathematics. Within the content analysis, this statement was taken as indicating a preferred mathematical practice that students’ should be guided toward appropriating when doing school mathematics. This content analysis resulted in 3 practices being identified for goal 2 (see Table 2). Student responses were analysed in terms of these practices.

Table 2
Practices Identified Within Goal 2 of A National Statement On Mathematics

| Goal Statement | Students should develop positive attitudes towards their involvement in mathematics. | | |
|----------------------|--|--|-----------------------------------|
| Practices identified | Making effective use of whatever mathematical skills and understanding is possessed. | Experiencing the excitement and pleasure that mathematical investigations can bring. | Applying mathematics to problems. |

Analysis and Discussion

In relation to the question, “*What do you remember about Collective Argumentation?*” student responses ranged in text size from no response (1 student) or the use of a question mark (1 student) to 70 words (see Table 3).

Table 3

Responses to the Question: What Do You Remember About Collective Argumentation?

| Sex | Year | Student | Response |
|-----|------|---------|--|
| M | 11 | TR.1 | It gave everyone an opportunity to give their opinion and allowed everyone to learn from everyone else's thought process. |
| M | 11 | TR.2 | It's the method of learning that is used to build a good answer using the knowledge of other peers. |
| M | 6 | SR.1 | It is when you are given a problem you solve it then get into a group and share your ideas. |
| F | 6 | SR.2 | Think – by yourself work it out! Pair – pair up and compare answers; Share – share with the class your final answer. |
| F | 6 | SR.3 | Collective argumentation is think/pair/share. I remember making posters and presenting them to the class in a group of a minimum of 2 and maximum of 5. What we used to do in the pair stage is we worked with a partner and with the answers that we had each come up with, what we would discuss, and negotiate which answer was right. This was the process with the share stage. |
| M | 6 | JG.1 | I don't know what it means. |
| M | 6 | JG.2 | That we did a lot of it. |
| F | 6 | JF.1 | Working on butcher's paper, working with others, MTV make thinking visible, think pair share. |
| F | 6 | JF.2 | I remember that it is think, pair, share. |
| F | 6 | JF.3 | We didn't do much with this. |
| F | 6/7 | JOC.1 | That I learnt a lot and it has helped me to work well in groups. |
| M | 6/7 | JOC.2 | You would receive a question from Mrs G, try to find out the answer then get into groups and discuss the answer. After that we presented our work to the class. |
| F | 4 | AM.1 | Standing in front of the class and giving our ideas in a group to the class. People in the class may agree or disagree with our ideas. |
| F | 4 | AM.2 | You have to do a maths investigation. |
| M | 4 | AM.3 | Word and number problems, volume. |
| M | 4 | CL.1 | We did our own work then we said it in the group then we shared all the ideas with the class. |
| M | 4 | CL.2 | - |
| F | 4 | TF.1 | Mr F would give us a group and we would have roles of a manager, speaker and more, then he gave us a problem and we showed the class how to fix the problem. |
| M | 4 | TF.2 | ? |

Due to response length, some responses (e.g., see Table 3 student SR.3) contained multiple utterances that could be related to multiple indicators of preferred mathematical practices (see Table 2). For the purpose of this paper the analysis focuses on representative examples of student responses. Student Identifiers such as SR.3 indicate the classroom that the student was in (e.g., SR) and the student (e.g., number 3).

When recollecting their participation in Collective Argumentation (CA), the majority of student responses (see Table 3) were related to using mathematics in solving problems

individually and collaboratively. Specifically, students recollected participating at the individual level to (a) form an opinion (e.g., TR.1), (b) solve a problem (e.g., TR.2), (c) think by yourself (e.g., SR.2), (d) find out the answer (e.g., SR.3), and to (e) do our own work (e.g., CL.1). However, recollections expanded beyond the individual to encompass working at the collaborative and whole-class levels where students (a) learnt from everyone else (e.g., JOC.2), (b) used the knowledge of peers (e.g., AM.1), (d) compared answers and shared with the class (e.g., SR.2), (e) discussed and negotiated (e.g., SR.3), (f) made thinking visible (e.g., JF.1), (g) worked with others (e.g., JOC.1), (h) presented work to the class (e.g., JOC.2), (h) agreed or disagreed with a group's ideas (e.g., AM.1), and (i) showed the class how to fix a problem solution (e.g., TF.1).

The responses represented in Table 3 illustrate that when recalling participation in CA, students are recollecting their capacity to play an active role in their own learning, not only at the individual level, but also at the group and whole-class levels of participation. Specifically they are recollecting using their own and peers mathematical skills and understanding to solve problems. Not only are these sentiments, implied in these recollections, necessary to implementing the *Goals of Schooling for Young Australians* (MCEETYA, 2008), they are also important indicators of the appropriation by students of mathematical practices necessary for the development of positive attitudes towards involvement in mathematics (Australian Education Council, 1991).

Of interest in the analysis are the responses by students that do not imply such an appropriation. Beside the one student who did not offer a response to this question, one student stated that “I don't know what (Collective Argumentation) means” and another responded with the question mark symbol (?). These responses may be due to the fact that some teachers did not refer to the name ‘Collective Argumentation’ when doing mathematics with their students. This is implied in the responses of the 5 students (SR.2, SR.3, JF.1, JF.2, TF.1) who associated CA with ‘thinking/learning’ strategies such as ‘Think/Pair/Share’ (Lyman, 1987), ‘Making Thinking Visible’ (Flower, Wallace, Norris, & Burnett, 1993), and cooperative learning techniques such as ‘Group Member Roles’ (Cohen, 1994). This association of CA with learning strategies and pedagogical techniques implies that these students recollect CA, not as being a pedagogical technique, but as being a part of the culture of knowing and doing in their classroom and that the teachers of these students are adapting CA to suit the needs of their various local communities of teachers and learners. Whether CA should be trialled within other communities of teachers and learners was the focus of another question asked of these students.

In relation to the question, “*Should Collective Argumentation be trialled in other classrooms?*”, student responses (see Table 4) ranged in text size from no response (3 students) or the use of a question mark (1 student) to 44 words. Once again only exemplars of student responses are identified in the analysis.

Table 4

Responses to the Question: Should Collective Argumentation be Trialled in Other Classrooms? Give Reasons for Your Answer

| Sex | Year | Student | Response |
|-----|------|---------|---|
| M | 11 | TR.1 | Yes because it is good help, people understand other people's thought processes. |
| M | 11 | TR.2 | Yes, it allows a look into the ways that other, especially people with higher grades, people think. |

| | | | |
|---|-----|-------|---|
| M | 6 | SR.1 | Yes because it teaches kids to work with others, listen to others' ideas and accept that they are right or wrong. |
| F | 6 | SR.2 | Yes because it extends people's knowledge in other ways to get an answer and to understand why you got an answer wrong. |
| F | 6 | SR.3 | Yes, because it gives students the opportunity to communicate with their classmates and gives them a chance to explain why they think their answer is right and allows them to give support towards others and explain to them why their answer may be incorrect. |
| M | 6 | JG.1 | Don't know what it means. |
| M | 6 | JG.2 | Not in other classes because there is no need for them because you do stuff in groups or by yourself. |
| F | 6 | JF.1 | Yes because you get other people's opinions and they can explain their answers and how they got their answers. |
| F | 6 | JF.2 | No I don't think so because most people wasted their time. |
| F | 6 | JF.3 | - |
| F | 6/7 | JOC.1 | Yes because all students learnt other ways of learning maths. |
| M | 6/7 | JOC.2 | Yes but only in older grades because I think it is a good way to be learning maths and a fun way. |
| F | 4 | AM.1 | Yes because I thought it was fun. |
| F | 4 | AM.2 | Yes because it helps you to learn different maths problems. |
| M | 4 | AM.3 | Yes because it helps you to understand maths more and it doesn't matter if you get the answer wrong because the class corrects you and challenge you. |
| M | 4 | CL.1 | - |
| M | 4 | CL.2 | - |
| F | 4 | TF.1 | In Collective Argumentation everyone gets a part to be the boss so I think it should be done more. |
| M | 4 | TF.2 | ? |

The majority of student responses represented in Table 4 are in favour of trialling Collective Argumentation (CA) in other classrooms. Reasons given range from the personal to the social. On the personal level CA was recommended to others because it (a) was fun (e.g., AM.1), (b) helps you to learn/understand (e.g., TR.1), (c) allows risk taking (e.g., AM.3), (d) is challenging (e.g., SR.2), and because it (d) provides a sense of personal agency (e.g., TF.1). On the social level, CA was perceived as being able to help people to (a) understand others' ways of thinking (e.g., TR.2), (b) work with others (e.g., SR.1), (c) accept and understand errors (e.g., SR.3), (d) extend ways of solving problems and learning mathematics (e.g., SR.2), (e) communicate with peers and support their learning (e.g., JF.1), and to (f) explain and justify problem solutions (e.g., AM.3).

The responses represented in Table 4 illustrate that when recommending CA to others, students emphasised its potential to assist students in other classrooms to play an active role in their own learning, not only at the personal level, but also at the group and whole-class levels of participation. Specifically they highlighted the potential of CA to assist students to make effective use of whatever skills and understanding is possessed in the classroom to learn mathematics. At the personal level, some responses went further and

provided a sense of the excitement and pleasure that participation in CA can bring to mathematical investigations, important sentiments necessary for implementing the *Goals of Schooling for Young Australians* (MCEETYA, 2008).

Of the students who did not respond to this question, or who responded with a question mark, it can only be surmised that participation in CA, like participation in any other approach to teaching and learning mathematics is not valued by everyone. This sentiment is made explicit in the statement of one student who did not recommend that other classrooms trial CA because “most people wasted their time” and in the statement of another who equated CA to doing “stuff in groups or by yourself”. However the majority of student responses to this question imply that doing CA in other classrooms should be trialled because it is “a good way to be learning maths” (e.g. JOC.2).

Conclusion

The above analysis of students’ responses to questions designed to elicit their recollections of participating in Collective Argumentation (CA) and their views as to whether CA should be trialled in other classrooms provides some evidence that for the majority of these 19 students their involvement in CA was a worthwhile experience. Participation in CA can be considered to be a worthwhile experience for these students in terms both of their learning of mathematics in accord with the goals set down in *The Melbourne Declaration on the Goals of Schooling for Young Australians* (MCEETYA, 2008), and in terms of their personal needs which they associated with learning in the domain.

Specifically benefits associated with participation in CA relate to assisting students to (a) make effective use of whatever mathematical skills and understanding are available in a learning situation, (b) use mathematics flexibly and openly in both individual and collaborative problem solving situations, (c) appreciate the benefits to their learning of doing mathematics with others, (d) express themselves clearly and mathematically, (e) explore new approaches to solving old problems, and to (f) use mathematics to explore new notions of what it means to know and do mathematics.

In terms of developing student confidence and positive attitudes towards participating in school mathematics this paper provides some evidence of the efficacy of employing co-operative inquiry-based practices such as those associated with CA for promoting active student participation in their own learning. However, the evidence provided here is but a snapshot of student perceptions of participating in such practices. Overall, most students’ responses to the complete questionnaire consistently made reference to engagement in practices such as discussing, sharing, and validating ideas as being positive to their learning of school mathematics. A key question for further research, therefore, one to which this paper makes a contribution relates not to whether certain approaches to the teaching and learning of mathematics are ‘good’ or ‘bad’, but to whether they could be better attuned to promoting student confidence and positive participation in their own learning.

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