Multi-positioning Mathematics Class Size: Teachers’ Views

Boris Handal
Kevin Watson
Marguerite Maher
The University of Notre Dame Australia

Abstract

This paper explores mathematics teachers’ perceptions about class size and the impact class size has on teaching and learning in secondary mathematics classrooms. It seeks to understand teachers’ views about optimal class sizes and their thoughts about the education variables that influence these views. The paper draws on questionnaire responses from 83 secondary mathematics teachers as well as interviews with 12 of these teachers. Although this current study focuses on mathematics teachers, it is nested in a much larger study across all subject areas. This present study found that class size directly impacts the attention teachers pay to individual students, the amount of investigative work undertaken and classroom management practices particularly for low achievers. However, other variables such as student ability, grade level and teacher quality make it almost impossible to determine what could be regarded as an ‘optimal’ class size. Views were also expressed about the advantages and disadvantages of smaller class sizes in terms of classroom management, class cognitive and social interaction, and teacher professional development. Implications of class size for specific student characteristics such as gender, Aboriginality, gifted and talented, socio-economic and language background issues are also intertwined in the discussion.

Introduction

Class size is a subject that excites opinion especially from parents, teachers, researchers and governments. From a ‘common sense’ perspective, parents would claim that small class size directly influences children’s learning because it increases personalised instruction (Watson, Handal, Maher & McGinty, 2013). Teachers would also advocate smaller classes arguing that smaller classes facilitate student-centred learning. In turn, researchers using metadata studies have recently asserted that although class size is an important variable in teaching and learning, its effect, compared with other educational variables is minimal (Hattie, 2009). More cautiously, governments look at class size reduction programs from the perspective of cost efficiency arguing that there are more effective ways to increase student academic performance.

This study views the concept of secondary mathematics class size flexibly. It is proposed that class size is not an absolute but a relative concept which can be examined in the broader context of student ability and socio-cultural context. Optimal class sizes cannot be established through mathematical models or by a fixed number because they are related to complex classroom variables including the teacher’s ability to deploy effective strategies (Handal, Watson & Maher, 2014).

The study reported in this paper is part of a larger research project that investigated teachers’ perceptions of class size. This paper briefly summarises the questionnaire study reported elsewhere (Handal, Watson & Maher, 2014) as context and then selects and discusses the questionnaire findings of the secondary mathematics teachers who participated in the larger study along with findings from interviews conducted with those secondary mathematics teachers who volunteered to be interviewed. Specifically, this paper seeks to answer the following questions:

- What do secondary mathematics teachers believe about the effect of class size on mathematics teaching and learning?
- What are the variables that influence secondary mathematics teacher views about the optimal class size for secondary mathematics?
- What do secondary mathematics teachers believe about the effectiveness of class size reduction interventions?
- How do smaller and smaller class sizes influence choice of teaching strategies?
- Which socioeconomic groups benefit most from class size reduction interventions?
Literature review

Throughout the past four decades the study of class size has focused on the search for a magical number – the ideal class size. Beginning with Maimonides’ (1135-1204) Talmudic rule of a maximum of 40 students in a class until the present day application of complex statistical techniques to come up with a number such as 15 (Hattie 1999), 17 (McRobbie, Finn & Harman, 1998) or 20 students (Mitchell & Mitchell, 1999; Stecher & Borhnstedt, 2000). More recent arguments claim that class size is not a monolithic concept but one which is influenced by other variables including the learner (Watson, Handal, Maher & McGinty, 2013). Davies (2003) states that researchers who generally argue in favour of small class sizes do so because they:

- allow students more individual time with the teacher;
- enable ‘better’ teaching methods to be implemented;
- reduce the incidence of non-productive class time; and
- increase learning time because there are less classroom management issues.

In 2000 Johnson explored data from the 1998 National Assessment of Education Progress (NAEP) to see if class size affected student achievement. He found there was little if any effect (Johnson 2000). Johnson (2000) classified classes of 20 or less as small and classes with 31 or more as large. Johnson (2000) correlated the academic achievement of students in grades 4, 8 and 12 with six factors: class size, race and ethnicity, educational attainment of parents, reading material in homes, participation in subsidised lunch programs and gender. He found that small classes did not increase academic performance on the NAEP reading tests. As a result of this and other findings, Johnson (2000) concluded that class size pales in comparison to many other factors including teacher quality and teaching methods.

Large-scale quantitative studies such as the Student-Teacher Achievement Ratio (STAR) project (Finn & Achilles 1990; Pritchard 1999); the Student Achievement Guarantee in Education (SAGE) project (Molnar, Smith & Zahorik, 2000) and the California Class Size Reduction Program (CSRDP) (Stecher & Borhnstedt, 2000) showed that smaller classes were associated with small increases in academic performance. The small class size impact was clearly noticeable for student in the early years of schooling and those from disadvantaged socio-economic backgrounds. Following the dominance of the three major U.S. class size quantitative studies in the 1990s (STAR, SAGA and CSRP California) a methodological shift towards less positivists and more qualitative methods occurred. These qualitative studies found various small class size effects on student learning. These included positive effects on classroom management (Blatchford, Basett & Brown, 2008), teacher-student interactions (Blatchford, Baines, Kutnick & Martin 2001.), group work (Bascia, Connelly, Flessa, & Mascall, 2010), physical space, individualised learning (Blatchford, Russell, Bassett, Brown & Martin, 2007), teacher workload and satisfaction (Bascia, Connelly, Flessa & Mascall, 2010) and student engagement (Casbon, DeMeester, & Nalley, 2002).

Hattie (2009) argued that student performance is influenced more by teacher quality than class size. One of the reasons why reduced class size interventions do not report clear academic gains is because, as Evertson and Randolph, (1989) and Hattie (2006; 2009) noted, very often teachers of small classes apply pedagogies normally associated with large classes simply because they are not familiar with pedagogies that promote learning in smaller class environments. They use teaching strategies that involve group work and working on projects rather than employing pedagogies where say collaborative learning and the systems and structures needed for working effectively within the context of collaborative learning are embedded in the careful sequencing of activities that follow a specific design to promote learning. In other words, teachers ‘tinker’ with the familiar rather than searching for and using something new and different. This conclusion is supported by the assertion of Bascia and Fredua-Kwarteng (2008) that “class size does not influence student achievement directly: it is what teachers and students do in smaller classes that matter” (p. 21). As suggested by Blatchford, Russell, Bassett, Brown and Martin (2007) teachers teaching small classes should promote help-seeking behaviours and make more use of differentiated teaching, non-routine learning experiences requiring investigations, project work, discovery approaches, remedial instruction group work and collaborative learning.

Davies (2003) argued that the key issue concerning class size reductions is always cost effectiveness when compared with other policy interventions. He cites other policy interventions as teacher quality, school management, peer effects, socioeconomic status and home environments. The key issue becomes reducing class size as a cost effective strategy for improving student achievement. There is a vast literature about teacher quality and the impact on student achievement (Darling-Hammond, 2000). It was found that after the implementation of the California experience with class size reductions (Mitchell & Mitchell, 1999; Stecher &
many school districts had to employ new teachers. Some teachers employed were granted ‘emergency credentials’ with the result that teachers without full credentials rose from 1.8 percent to 12.5 percent (Davies 2003) the year after the program was implemented and rose to 14 percent in 2002. Most of the teachers with ‘emergency credentials’ were concentrated in the most disadvantaged schools.

It has been claimed that pedagogies specifically designed for teaching smaller classes, although they sometimes overlap with pedagogies employed when teaching larger classes, have distinct characteristics that differentiate them from those employed when teaching larger class. Blatchford et al. (2007) argue that for small classes to be taught effectively there should be a shift towards individualised instruction. Blatchford et al. (2007) are not referring to the traditional method of one-to-one support only, but to a more far-reaching personalised approach embedded in individual student learning plans. Small class pedagogies can include project work where students are individually monitored and provided with continuous feedback on investigative tasks designed to develop higher order thinking skills (Hattie, 2006, 2009; Ready & Lee, 2006). In addition, advantage should be taken of having fewer students in a class to provide learning experiences that facilitate increased collaboration and communication among students, provide remedial learning opportunities and foster student metacognitive skills through the development of information-exploring and help-seeking behaviours. Hattie (2009) claims that it is not the size of the class that enhances student academic performance but the quality of the teaching that takes place. Hattie (2009) notes that when teachers continue to use large class teaching strategies, even when teaching small classes, there is little evidence that learning is enhanced. Betts and Shkolnic (1999, p. 169) state that “there is no guarantee that smaller classes will automatically lead to more productive work in groups.”

Finally, the lack of class size research using Australian data in the last three decades is disappointing and unhelpful for informing policy given that class size research is heavily contextual. Consequently, the need for Australian studies is critical to understanding the relationships between class size, student achievement and other variables.

Current New South Wales Department of Education and Communities (NSW DEC) regulations prescribe a maximum class size of 30 for Years 7 to 10. The exception is that some technology-based subjects have class sizes as low as 15 students. The class limit for Years 11 to 12 is 24 students (NSW DEC 2012).

Background

The large research project, which contextualises this paper, was carried out in the State of New South Wales (NSW), Australia, throughout 2013 among early childhood, primary and secondary public school teachers. The questionnaire for the larger study was designed to capture teacher opinions, perceptions and beliefs about class size interventions. The questionnaire asked for participant demographic and teaching background as well as information about the student population such as student achievement, ability, gender, socio-economic and ethnic backgrounds at each selected school. A stratified random sample of approximately one-third of all NSW DEC schools was the sample for this original study. A total of 1,119 questionnaires were returned from 321 of the 808 schools across the ten NSW DEC regions. This represents a response rate of 40%. (Handal, Watson & Maher, 2014). The main findings for the larger study are outlined below.

It was shown that public school teacher perceptions of class size are related to their personal variables such as gender, teaching qualifications, teaching methods as well as to exogenous factors such as school type (early-childhood, primary or secondary) and geographical region. While some patterns emerge for each variable it was not possible to determine a general profile for the whole cohort indicating that the direction and magnitude of teacher perceptions about an optimal class size is contextualised. However, the findings did show that teacher age, their experience and school socio-economic (SES) status did not significantly change their perceptions. In general, perceptions of small class size appear to be relevant for students with language background other than English (LBOTE), with low school achievement and for those from low socio-economic background. There was a large endorsement for smaller classes across the K-12 range but particularly for the early years of schooling.

Most teachers in the larger study indicated they changed teaching strategies when teaching a smaller class. The reported strategies included individualised instruction and the development of higher order thinking skills. However, such claims could not be verified because the research design did not include classroom observations. Teachers who said they did not change their teaching strategies when teaching smaller classes prioritised quality teaching ahead of class size as more important when trying to enhance student learning. It is possible that teachers who reported broadening their teaching strategies when teaching small classes were just ‘tweaking’ strategies they would use with larger classes rather than looking for strategies more suited to small classes.
The questionnaire open-ended responses were analysed thematically and were also reported elsewhere in more detail (Handal, Watson & Maher, 2014). For each analysis comparisons across categories and themes occurred until no further generalisations were possible following Bowen’s (2008) methodology. In general, teachers said they changed the way they taught small classes through personalised instruction. Teachers also reported that small classes were advantageous because they:

- helped accommodate individual student differences;
- facilitated student-centred learning;
- increased the capacity to use technology;
- provided more physical space;
- facilitated group work;
- helped build personal rapport with students;
- facilitated classroom management; and
- reduced competition for available resources.

In general, the following thematic areas were identified as influencing teacher perspectives, views and beliefs about class size:

- teaching quality and student ability;
- student competitiveness, cognitive interaction, socialisation and attendance;
- giftedness, gender, language and ethnics background;
- resources and physical space;
- professional development; and
- understanding of small class pedagogies.

These six themes were further explored in the interview study reported below.

**Questionnaire findings specific to mathematics teachers**

From the 1,119 respondents for the larger study 83 were secondary trained mathematics teachers. Some of these teachers were trained to teach a subject in addition to mathematics. In the survey, nearly 50% of these secondary mathematics teachers had a Bachelor's degree with a Diploma of Education. Twenty four percent had a Bachelor of Education and 16% had a Masters of Education. Almost a third had been teaching for more than 30 years. Thirteen percent had taught for between 26 and 30 years, 11% had been teaching for between 20 and 25 years and 10% had taught for between 11 and 15 years.

The class size preferences for these teachers are shown in Table 1. The optimal class size range selected by the greatest percentage of teachers was 16 to 20 students corresponding to the whole sample’s distribution.

<table>
<thead>
<tr>
<th>Number of students</th>
<th>Percent for secondary mathematics teachers (N = 83)</th>
<th>Percent for the whole sample (N = 1,119)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6-10</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>11-15</td>
<td>18</td>
<td>16</td>
</tr>
<tr>
<td>16-20</td>
<td>40</td>
<td>52</td>
</tr>
<tr>
<td>21-25</td>
<td>28</td>
<td>26</td>
</tr>
<tr>
<td>26-30</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

Similarly, to the question “indicate how you feel about the impact of class size on student performance”, on a scale from 1 (unimportant) to 10 (important) the secondary mathematics teachers scored class size at an average of 9.10 while the rest of the sample scored a higher average of 9.37, both figures showing how highly both groups rate class size as a factor that influences student performance. It is noteworthy that there was significant statistical difference between the two groups ($t = 2.032$, $df = 1103$, $\alpha = 0.42$).
They were also asked to indicate if small class sizes were more effective in increasing student outcomes for ten specified groups of students using a scale ‘Yes’ (3 points), ‘Unsure’ (2 points) and ‘No’ (1 point). The items were prefaced with the statement “In my opinion small class sizes are more effective for …” Table 2 shows the average scores for mathematics teachers (N = 83) compared with the average score for the whole sample (N = 1119) for the ten specified groups. Both mathematics teachers and the total sample placed the groups in a similar order with low achievers placed first and gifted and talented students placed last.

Table 2: Class size effectiveness means for type of student

<table>
<thead>
<tr>
<th>Type of Student</th>
<th>Whole Sample (N=1119)</th>
<th>Maths Teachers (N=83)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low achievers</td>
<td>2.96 (0.26)</td>
<td>2.98 (0.22)</td>
</tr>
<tr>
<td>Language other than English (LBOTE)</td>
<td>2.91 (0.34)</td>
<td>2.80 (0.44)</td>
</tr>
<tr>
<td>Low SES</td>
<td>2.89 (0.38)</td>
<td>2.88 (0.40)</td>
</tr>
<tr>
<td>All students</td>
<td>2.89 (0.40)</td>
<td>2.79 (0.52)</td>
</tr>
<tr>
<td>Ethnic</td>
<td>2.84 (0.44)</td>
<td>2.77 (0.48)</td>
</tr>
<tr>
<td>Indigenous</td>
<td>2.83 (0.46)</td>
<td>2.78 (0.47)</td>
</tr>
<tr>
<td>Boys</td>
<td>2.80 (0.52)</td>
<td>2.76 (0.58)</td>
</tr>
<tr>
<td>Girls</td>
<td>2.68 (0.61)</td>
<td>2.56 (0.66)</td>
</tr>
<tr>
<td>Rural and remote students</td>
<td>2.64 (0.62)</td>
<td>2.58 (0.63)</td>
</tr>
<tr>
<td>Gifted and talented Students (GAT)</td>
<td>2.61 (0.71)</td>
<td>2.36 (0.83)</td>
</tr>
</tbody>
</table>

Note: Standard deviations are given in brackets.

Interviews findings for mathematics teachers

The interviews reported in this paper sought to examine teachers’ views about optimal class sizes and their thoughts about the student, school, classroom and other contextual variables that influence their views. The interviews were a follow-up of the questionnaire responses and sought to explore the six themes identified above. Hence, the purpose of the semi-structured interview questions was to explore in more depth mathematics teacher responses to the open-ended section of the questionnaire. Interviews were conducted by telephone. Only twelve of the 83 secondary mathematics teachers who participated in the questionnaire volunteered to be interviewed.

The following questions were used to direct conversations between the researcher and participants and to elicit more detailed elaborations of the views expressed in the open-ended section of the questionnaire:

- Please describe the student population in your school.
- What is your ideal class size for a mathematics classroom and why?
- How do large and small class sizes differ in the teaching strategies employed?
- Which social-economic groups will benefit most from class size reduction interventions?
- How should class size reduction program be implemented to maximise success?
- When you taught a smaller class did you change the way you taught? How?

One-third of the 12 teachers interviewed were female with five of the ten NSW regions represented. The interviewed teachers held a diverse range of educational qualifications with the majority having taught for more than twenty years although teachers with less teaching experience were also among those interviewed.

Table 3: Socio-demographic descriptors of the teachers interviewed

<table>
<thead>
<tr>
<th>Gender</th>
<th>Region</th>
<th>Qualifications</th>
<th>Teaching Experience (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>Location</td>
<td>Qualification</td>
<td>Age Range</td>
</tr>
<tr>
<td>--------</td>
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<td>-----------</td>
</tr>
<tr>
<td>Female</td>
<td>Hunter/Central Coast</td>
<td>Bachelor in any discipline plus DipEd</td>
<td>26-30</td>
</tr>
<tr>
<td>Female</td>
<td>Hunter/Central Coast</td>
<td>BEd</td>
<td>30 plus</td>
</tr>
<tr>
<td>Male</td>
<td>North Coast</td>
<td>Masters of Education</td>
<td>30 plus</td>
</tr>
<tr>
<td>Female</td>
<td>North Coast</td>
<td>BEd</td>
<td>16-20</td>
</tr>
<tr>
<td>Male</td>
<td>Hunter/Central Coast</td>
<td>Masters of Education</td>
<td>21-25</td>
</tr>
<tr>
<td>Male</td>
<td>Northern Sydney</td>
<td>Bachelor in any discipline plus DipEd</td>
<td>30 plus</td>
</tr>
<tr>
<td>Male</td>
<td>North Coast</td>
<td>BEd</td>
<td>26-30</td>
</tr>
<tr>
<td>Female</td>
<td>Western NSW</td>
<td>Bachelor in any discipline plus DipEd</td>
<td>0-5</td>
</tr>
<tr>
<td>Male</td>
<td>Western Sydney</td>
<td>Bachelor in any discipline plus DipEd</td>
<td>30 plus</td>
</tr>
<tr>
<td>Male</td>
<td>North Coast</td>
<td>Diploma in Teaching</td>
<td>30 plus</td>
</tr>
<tr>
<td>Male</td>
<td>North Coast</td>
<td>Bachelor in any discipline plus DipEd</td>
<td>21-25</td>
</tr>
<tr>
<td>Male</td>
<td>Hunter/Central Coast</td>
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<td>30 plus</td>
</tr>
</tbody>
</table>

Bowen’s (2008) model of thematic analysis and saturation and the six issues emerging from the open-ended questionnaire comments were used to organise the discussion which follows.

**Teaching quality and student ability**

Overall, there was no agreement among interviewees about what constituted an optimal class size in secondary mathematics. One teacher said: “more important than class size is teacher quality” and class size “also has a lot to do with the teacher.” As one teacher said:

> You could have a boys’ class, or a small Aboriginal class, it’s, if you don’t have the personality to, you know, handle students, or you’re not that good at classroom management.

Some teachers related class size to student ability although it was acknowledged that small classes benefited all students:

> But I think it’s a, it (small class) has a big bearing on kids’ results, gifted and talented kids, the slower kids, Aboriginal kids, all kids really.

Classes with low achievers were more likely to qualify for smaller sizes for reasons of classroom management:

> With lower ability students, I think the fewer students you have in the class, the better it is for them … I find that they are less self-disciplined and more easily distracted. So, if you’ve got smaller numbers, there are fewer distractions. They don’t have the skills too, for peer tutoring, they can’t help each other. They’re not even independent workers. They need a lot of teacher attention. So, the more students you have the less attention the teacher can give each student.

Such expectations seem to materialise through individualised instructions: “… the quality of support you can give students, the personal help you can provide is ‘improved’. A workable strategy that teachers reported for low ability students was hiring teachers’ aides.

Class size is also a function of whether the class is a junior (Year 7-10) or a senior (Years 11-12) class although there is a consensus that such a relationship is generally mediated by student ability:

> Class size matters when students are not very good, not very able students, and they need a teacher’s help, and that’s where, I think, class size matters.
It depends on the level of the students, the more capable students do better in a larger class, the less capable students are better in a smaller class, because of the fact that they need a little bit more one-on-one time.

In the top classes we used to have thirty four to thirty five kids. In the bottom classes, we have about fourteen, fifteen students, because the lower ability kids are difficult to manage.

Student competitiveness, cognitive interaction, socialisation and attendance

For low ability junior classes teachers said the optimal size of the class should be as low as 12 students but for higher ability students the number increased to 33. For senior students who were spread across four secondary mathematics courses, namely, General Mathematics, Mathematics, Mathematics Extension 1 and Mathematics Extension 2 (from lowest ability to the highest ability), classes reflected the official cap of no more than 24 students. Higher ability courses like Mathematics Extension 2 tended to have very small numbers simply because there were few students with high mathematics ability while General Mathematics students tend to be grouped in larger classes reflecting greater numbers of students with lower mathematics ability.

Some teachers said very small classes of able students can be counter-productive as far as student achievement is concerned because the competitive dynamic is less.

You can have a lot of [very capable] students, and the students will still perform well. In fact, they like competing against each other in a healthy way. So the more you have, I think it’s good.

And so what you find is, you know, the small, if you’ve got ten, fifteen students, the gap between the top student and the bottom student isn’t as great as when you’ve got thirty students. And, you know, sometimes the kid who comes, who got a mark of say, forty per cent, it’s handy to have another student in the same class who got a mark of seventy or eighty per cent, because then they realise that, it’s not that the test was too hard, or that the work hadn’t been taught. It’s that they’re not doing the work.

The cognitive interactions that occur in higher level mathematics classes can provide useful information when trying to identify the ‘optimal minimum’ class size.

I’ve worked in central schools where, for example, you have two or three students in the extension classes. When you get down to that sort of number, you don’t get a class dynamic.

And in the senior classes, I believe … the minimum size, for effectiveness, depends on the level. So, for our Extension students I believe the minimum’s about six, six or seven, so they can bounce ideas off each other.

Socialisation and peer-pressure are also factors that need to be considered when thinking about optimal class size.

It takes a very strong-willed kid to stay in a class where they’ve actually got no friends in the class. So, the smaller the class, the less likely they are to actually have a friend in the class.

In a really large class, some of the kids are disinclined to seek assistance. There’s a little bit more peer pressure because the kid next to them mightn’t think they’re smart. I think in a smaller class, the kids are more likely to feel, to feel like they’re a real part of the class, rather than just one of a group of kids.

Also, very small classes can be a problem when absenteeism and truancy are common.

So we will have, a student will come to school maybe once a week, or twice a week. And then they will miss all that work. So then they come in, and they don’t have a clue what’s happening in the class. Then you need to go back, and reteach the things they’ve missed. You have to do this because there are only a few kids in the class and that kid is a large part of the class. If the class was bigger you could ask them to see you another time.
Giftedness, gender, language and ethnic background

In large classes, where teachers tend to teach to the ‘middle of the class’, not only might low ability students tend to miss out but the needs of brighter or more gifted students may also not be met. “They sort of get bored, get left to just deal with stuff on their own as they drift in and out of attention. They do all right, so just tend to muddle along on their own.”

When considering class size as a strategy to meet the different needs of boys and girls there were voices arguing that girls “are easier to control” and “With boys, you need less of them [in a classroom], because they’re hard to control” although three teachers said:

Generally, boys behave worse than girls. But I, in my current year 9 class, I just seem to have a large group of girls that truant a lot – have a lot of behavioural issues.

The girls are now exhibiting behavioural management issues as well, and they’re hard to handle, but I still think that the problem with boys is greater than the problem with girls. I find that that girls, as well as boys, need that one-to-one support.

Similarly, some teachers recommend caution when making broad generalisations across student demographics. For example, students from non-English backgrounds (NESB) often “benefit greatly when they’re surrounded by English speaking students.” The teacher added that:

I probably wouldn’t exclude them. I, honestly, my philosophy for teaching, I don’t like segregating, at all. I don’t like boys’ classes, or girl classes, or Aboriginal classes, or non-English speaking classes. I think it’s better if the students are mixed, even ability. In this school I think it is better to have larger classes that have a genuine mix of different groups of students.

Students from Aboriginal backgrounds tend to be in the lower classes “because a lot of time their literacy and numeracy are quite low” and because they “usually find it quite hard to cope with the work.” Another teacher commented: “The biggest problem with Aboriginal students is attendance … and I don’t think that class size is really the main issue when it comes to the range of disadvantages that Aboriginal students experience.” Two teachers commented:

I’ve come from a regional teaching background where Aboriginal kids are often regarded as casual students. So, for me, smaller classes benefit these students regardless.

I had a year 9 class, where I had an Aboriginal boy who just did not comprehend anything I was trying to teach him. He just could not get it. He needed some, he needed ten, fifteen minutes with me, and it would just be impossible to do that with a large class, to be able to give him that time. So, yeah, and I treat all the students equally, whether they are Aboriginal, or whatever, it doesn’t really matter. It’s not just because they are Aboriginal. On the other hand I have Aboriginal students who understand mathematics very well.

Resources and physical space

Class size has implications for physical space, resources, marking and the number of staff. “When you’ve only got that many kids (small class), your marking is a lot less” and “it doesn’t take as long to do the marking, or as long to do parent teacher interview, and things like that [i.e., writing reports].” The same interviewee said:

If we’re going to have to tolerate larger class sizes, then we need to have the resources to cope with them. I think it’s unsatisfactory that students are sharing textbooks, because we don’t have the resources, or they don’t have access to computers, unless they’re sharing.

In a similar way, more comfortable physical spaces are not facilitated by large classes:
One of the problems we have is that rooms are built for a class of thirty, so if you get a class of thirty three, or thirty four, you suddenly find that you don’t have enough desks, and there’s not enough space to add more.

Finally, a number of teachers talked about the financial implications of hiring more staff and the need for more classrooms if class sizes are reduced:

The biggest problem we have is, if we decrease class sizes, is that we will have even less trained maths teachers than we do now.

I don’t think for a moment that [class size reduction] that’s ever going to happen, because the sheer cost of doing it, we don’t have enough maths teachers to cover classes now and we’re not going to have enough maths teachers in the future. So, if we turn around and have [junior] classes of twenty, that would require us to have a lot of more, employ a lot more maths teachers. Not possible.

**Professional development**

When teachers were asked if they would value the opportunity to learn about small class pedagogies, the majority of teachers interviewed did not provide a clear response. There seemed to be little recognition that pedagogy would be different for different class sizes. Instead, they answered the question in terms of classroom management.

Beginning teachers need management skills and management processes can vary depending upon the size of the class. I would be trying to provide less experienced teachers with a range of classroom management strategies.

One teacher said; “No professional development is needed for teaching smaller classes.” She went on to say; Younger teachers could probably do with some training, but I don’t know what that would involve.”

**Small class pedagogies**

When asked what type of pedagogy would be more suitable for smaller classes compared with larger classes, teachers spoke about specific teaching strategies but did not articulate them within a small-class pedagogy. Even then teachers indicated that most strategies could be used for both small and large classes.

Responses ranged from: “I’m a bit old fashioned in my teaching, I still use a blackboard” to “I’d try and set up self-directed learning. I’d try to get them to use computers more.” In response to this question teachers seemed to ‘stretch their minds’ to answer it. One teacher said; “I’d look at the possibly of integrating with other key learning areas (KLAs), to see what they’re doing and perhaps match our programs a bit.” Most responses were in terms of strategies such as ‘taking them (students) out in the playground for measurement” and “providing more remediation.” Other responses included:

- setting up a maths lab;
- providing students with more choice;
- grouping more able students with less able students;
- spending more time with individual students;
- run more short topic tests to see how they are going; and
- do more examples on the blackboard.

**Discussion and conclusion**

Mathematics teachers believed that class size did influence student performance in their classes. Mathematics teachers believed class size was important and highly influential in increasing student learning outcomes. However, they also thought teacher quality and student ability were far more important. A major influence of smaller classes was that classroom management issues were reduced particularly for low achieving junior mathematics classes when class sizes were smaller.
Mathematics teachers also thought that the maturity of students (junior versus senior), their ability (high achievers versus low achievers) demographics (LBOTE and Aboriginality) and the distribution of different students within a class (LBOTE students working with native English speakers) influenced their view of ‘optimal’ class size. They thought a small class did not always maximise student achievement. This recognition increases the evidence that mathematics teachers do view the class size debate as complex and that there is no universal class size that is thought to maximise student performance. Further, the fact that mathematics teachers scored lower than their counterparts in appraising the impact of class size on student performance (Table 1) might be due to the fact that only the secondary mathematics curriculum, along with its English counterpart, offers differentiated classes by ability level. As transpires from the interviews, mathematics teachers might be linking optimal class sizes to learning aptitudes, feeling comfortable with large classes for high ability students and small classes for low ability students.

The effectiveness of class size interventions was thought to be greatest for lower ability classes as well as for classes where there was a high number of LBOTE and low SES students. However, this was not the case with classes devoted to gifted and talented students. In gifted and talented classes it was thought that larger classes promoted greater student achievement. It would seem that mathematics teachers did recognise a differentiated effectiveness for class size reduction interventions. This is consistent with the findings of Blatchford and Martin (1998) who suggested that class size reductions have negative effects on classroom socialisation. They found that British classes with less than 20 students tended to be less socially adjusted and more aggressive. In larger classes students tended to interact more with each other and develop greater independence from teacher direction which, in turn, lead to improved learning outcomes.

Amidst the various findings of this study, the finding that emerged with the greatest volume of evidence was the influence of smaller classes on teaching strategies. The study showed convincingly that mathematics teachers thought smaller classes afforded opportunities to employ a greater variety of teaching strategies. However, the evidence seemed to restrict changes in classroom practice to teaching strategies rather than to broader and more substantial pedagogical shifts. This is consistent with other studies (Davies 2003; Blatchford, Russell, Bassett, Brown & Martin, 2007; Betts & Shkolnic, 1999). When mathematics teachers did refer to pedagogies they would employ in small classes they articulated pedagogies that would normally be used in larger classes (Evertson & Randolph, 1989; Hattie, 2006; 2009). In other words, the mathematics teachers interviewed did not distinguish between pedagogies that were commonly used in large classes and those they would use in small classes. The reality is, not only didn’t the mathematics teachers interviewed plan to used pedagogies more suited to smaller classes, they did not know about such pedagogies.

This study also found that mathematics teachers thought students from low socioeconomic backgrounds would benefit most from smaller classes. Further interrogation of this view suggested that this finding could be extrapolated more broadly to disadvantaged groups. This finding and its extrapolation are consistent with previous studies (Watson, Handal, Maher & McGinty, 2013).

Overall, this study shows that the mathematics teachers who provided the data for this study consciously acknowledge that class size is a complex construct. They also recognise, at least in the context of secondary mathematics education, that no one single value for optimal class size can be singled out in an attempt to maximise student learning outcomes. This study has shown that optimal class size is a function of educational variables such as student ability, teacher quality, class dynamics, physical facilities and other demographics. This study also found that the mathematics teachers interviewed did not differentiate between pedagogies used when teaching large classes and small classes. Rather, they differentiated classroom practice between the two in terms of teaching strategies.

**Implications**

Historically, the vast majority of early research on class size (1970s to 1990s) used numbers. The main findings were that the greatest increase in learning, as a result of being in a small class, occurred in the early years of schooling and when students were from a disadvantaged background. In our study, teachers were also able to identify students’ ability, and language and Aboriginal background as potential factors determining an appropriate class size.

For decades, the media, teachers and members of the general public as well as researchers read and interpret research to try and confirm their ‘common sense’ expectation that small class sizes would automatically improve academic performance. More recent studies have used mixed methods which included interviews and
observations that enabled researchers to understand why and how class size reductions influenced student achievement. During the 1990s and 2000s researchers began to strongly voice their opinion that class size reductions should not be expected to improve student academic performance arguing that the relationships between class size reductions and student improvement was relatively weak. Consequently, they re-examined, re-thought and re-interpreted evaluations of previous studies.

As this study with mathematics teachers corroborates, research on class size needs to be related to other variables. Class size reductions alone cannot improve academic performance hence explaining mixed findings in past quantitative studies. It is therefore encouraging the finding that interviewed teachers held a strong belief that class size was important and influential while acknowledging that other factors were even more important. It provides evidence that class size is a discrete construct but one that intertwines with many other instructional, curricular and organisational issues influencing teaching and learning. Qualitative research such as interview studies is making more apparent that the quest for a single-figure optimal class size, even with sophisticated statistical methods, can become a futile exercise.

The implication is that professional learning is essential if mathematics teachers are to modify their pedagogy to increase student performance when teaching smaller classes. Mathematics teachers need to know about small class pedagogies in order to include them in their repertoire. If teachers do not change their teaching practices to accommodate teaching smaller classes there is no increase in student achievement. As the literature discussed in this paper informs, it is not the size of the class that increases student academic performance. Rather, it is the teaching practice or pedagogy that a reduction in class size facilitates the improvement in student performance.

In isolation, class size is a small factor in increasing student academic performance. Class size reduction achieves its ‘effect size’ as an enabler of increased student achievement only when the desired pedagogies are implemented effectively. While our interviewees unanimously recognised that small classes provide an opportunity for a more student-centred approach to teaching, they were not able to sufficiently characterise pedagogies for small classes.

Given the ideas discussed on this paper on the relationship between pedagogies and class size lead us to a question to ponder: Can changing the way we teach increase student achievement without the huge expense of employing more teachers, providing more classrooms and schools as well of the additional management costs?

References


## Appendix: Questionnaire

### Section A

1. **Gender:**
   - Female □
   - Male □

2. **What is your age group?** *(Tick only one box)*
   - 18-21 □
   - 22-25 □
   - 26-30 □
   - 31-40 □
   - 41-50 □
   - 51-60 □
   - 61 or over □

3. **Highest completed educational qualifications:** *(Tick only one box)*
   - BEd □
   - Masters in Education □
   - Teaching diploma (2 or 3 years) □
   - Doctoral Degree □
   - DipEd + Bachelors in any discipline □
   - Other. Please specify: _________________________
   - Masters in Teaching □

4. **Years of teaching experience:** *(Tick only one box)*
   - 0-5 □
   - 6-10 □
   - 11-15 □
   - 16-20 □
   - 21-25 □
   - 26-30 □
   - 30+ □

5. **Are you a teacher trained in?** *(Tick only one box)*
   - □ Primary
   - □ Secondary
   - □ Other. Please specify _________________________

6. **If trained in secondary methods please indicate the key learning areas (KLA’s) in which you have been trained?** *(Tick more than one box if applicable)*
   - Creative Arts □
   - English □
   - HSIE □
   - Languages □
   - Mathematics □
   - PDHPE □
   - Science □
   - Technology (TAS) □

7. **What is your ideal class size for effective teaching and learning?** *(Tick only one box)*
   - 1-5 students □
   - 6-10 students □
   - 11-15 students □
   - 16-20 students □
   - 21-25 students □
   - 26-30 students □
   - 31-35 students □
   - 36+ students □

8. **In my opinion small class sizes are more effective for students in:** *(Tick more than one box if applicable)*
   - Early Stage 1 □
   - Stage 1 □
   - Stage 2 □
   - Stage 3 □
   - Stage 4 □
   - Stage 5 □
   - Stage 6 □

9. **Choose one box below to indicate how you feel about the impact of class size on student performance**
   - Important □□□□□□□□□□ unimportant
Section B

1. In my opinion small class sizes are more effective for:  (Tick one box for each row)

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2. When you taught a smaller class did you change the way you taught?

- □ Yes  □ No

Please give reasons for your answer.

________________________________________________________________________________________
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