Ability Grouping in the Mathematics Classroom.

Report.

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Introduction.

This paper will report on the issue of ability grouping in primary and secondary schooling with a particular focus on the subject of mathematics. It will seek to synthesise the research and comments of a variety of eminent writers on the subject. It will attempt to provide a clear understanding of the critical concepts and describe the common consensus, as much as is possible. Lastly, it will aim to provide a suggested way forward in education at both the classroom and school level.

Definition of Issue.

The field of ability grouping can be defined as the study and practice of grouping students in the classroom with respect to academic ability. Students of similar abilities may be grouped together, known as homogeneous grouping, or students may be grouped together with no relation to ability, which is known as heterogeneous grouping.

Given this definition, there are many different applications of ability grouping. These might contain aspects of the permanency of grouping throughout the day; the specific academic subjects where grouping occurs; across grade grouping; selected schools grouping or whether certain groups are given an accelerated curriculum.

Ability grouping is widespread in Australian schools. (Zevenbergen, 2005, p. 607). The two most common methods of ability grouping are 'between class ability grouping' which is a school level practice and 'within class ability grouping' which is a teacher level practice. Most of the available research is based on 'between class ability grouping' and the rest of this report when mentioning ability grouping will refer to 'between class ability grouping'. Between class grouping is by far the most common type (The Balanced View: Ability Grouping Volume 6, Number 2).

'Between class grouping' refers to the grouping together of students with a similar ability (or a homogeneous group) so that they form separate classes from their dissimilar ability colleagues. 'Within class ability grouping' refers to the same practice except that the grouping occurs within a mixed ability class so that when grouping occurs, different subsets of the same class are created based on ability, but within the overall heterogeneous class.

It is thought that the grouping of students together in different ways might produce different academic and social results for the students. Of course there will also be implications for the planning and operation by teachers and schools in providing the different educational structures needed to accommodate this.

From the outset it is important to address the question of what it is that we would wish to be achieved from ability grouping in mathematics. This belies an underlying question as to why we want to teach mathematics in the first place. This is important so that we may then proceed to measure the research findings against the required outcomes.

One possible desired outcome might be the development of mathematics within society to the highest level possible. Another might focus on the student's need to understand and function in society with a proficient grasp of mathematics. Another might be the wish to develop in each individual student, or students as a whole, the concepts of mathematics to a predetermined level. Yet again, it may be that the desire is to promote mathematical understanding to the highest level possible with each individual student, or for students as a whole. Finally, it may be to develop mathematical understanding in society through encouraging a genuine love of mathematics within a socially inclusive environment and ethos.

As can be seen from the limited listing above, there are many possible rationales for teaching mathematics and the ultimate question of how we should teach mathematics, which includes the question of ability grouping, depends very much on our rationale for teaching mathematics to begin with. This report will try to be relevant to most of the abovementioned rationales.

The introduction of ability grouping occurred in the United States with the influx of new types of students to the established schools including many children of immigrant families in the 19th century. The intelligence testing done at that time seemed to suggest that there were definite links between ethnicity, social class and intelligence and so the question arose as to the best way to teach what were considered to be children of different innate intelligences. (Anne Wheelock, 1994, p.4) This was at a time in history where social Darwinism was prevalent and from this mindset it is easy to conclude that students of different innate abilities should be taught separately. Many teachers of mathematics continue to believe students have an innate ability to do mathematics although this is not linked today to any racial or social class superiority. (Lorenz 1982). As such they continue to resist mixed ability mathematics classrooms. (Zevenbergen, 2005, p. 610).

Most of the reasons for and against ability grouping have been present since at least the early 20th century and were listed in 1931 by A.H. Turney. (Slavin, 1993). There are many perceived benefits of ability grouping which are believed to contribute to greater academic success to some or all students. The main perceived benefits include the idea that students of high ability will not be held back by students of lower ability if taught together; that students of lower ability will not need to struggle to keep up with their higher ability colleagues; that it is easier and more efficient to tailor classes and curriculum's to students of similar ability so that each ability level can have their particular needs met and finally that lower ability students will generally participate in mathematics much more.

The perceived negative effects on grouping is that it does not generally enhance students understanding of mathematics; it creates a tiered system of mathematics where students learn at different rates which then re-enforces and solidifies the abilities of the different groups; lower ability students will generally achieve worse outcomes if the higher ability students are not present in the classroom; it psychologically discourages many in the lower ability classes from performing and continuing in mathematics and that some students in the higher ability classes are pushed beyond their comfort zone so that their enjoyment of mathematics diminishes to the extent that their achievements are actually less than would be the case than if they were taught in heterogeneous classes.

Again, this is not an exhaustive list of the perceived advantages and disadvantages of ability grouping. Some would argue that one of the desires of schooling is to foster a more egalitarian society. These people would wish to discourage ability grouping on the grounds that it promotes elitism, fragments society and re-enforces perceived advantages of some groups over others.

With this in mind, Slavin makes the point that it is therefore up to the proponents of ability grouping to make their case for the benefits which they articulate. (Slavin, 1990).

Review and Analysis of Literature.

So what does the research tell us? As Slavin points out, (Slavin, 1990) while there has been much research, the interpretation of that data has been much disputed and the acceptance of the underlying structure of the research, has not always been universal. Apart from the obvious fact that students are different and it is near impossible to know how they would have developed under another form of grouping structure, all schools too are different with different quality teachers and co-ordinators with many varied methods of grouping being applied across different grades and academic subjects.

Slavin’s own research (1990) involving five comprehensive ability grouping plans in elementary schools, suggests that there is no significant difference in the achievement of students studying a basic mathematics curriculum with regard to heterogeneous or homogeneous grouping. He does find some perceivable benefit in the reading skills of students when they are grouped across different grades based on their reading ability (Joplin Plan) and he does suggest there is clear benefits to ‘within class’ grouping especially for the lower ability students and also when no more than two or three groups are formed. One reason why Slavin suggests that the number of ‘within class’ ability groups should not be larger is that it is more efficient for the teacher to target fewer groups in order to create programs for the students and to instruct them. Other research shows similar findings. (William and Bartholomew, 2004; Braddock and Slavin, 1988 cited by Anne Wheelock, 1994, p. 11).

Both supporters and detractors of ability grouping find things to agree and disagree with in Slavin's and each other's research. The supporters of ability grouping point to the fact that much of the research mentioned above does not involve an accelerated curriculum for the higher ability classes. There is evidence to suggest that when a high ability class engages with an accelerated curriculum the outcome is that the class will move rapidly ahead of the class which does not have an accelerated curriculum. Carol J. Mills and William G. Durden (1992) cite such evidence in Daurio, 1979, Fox, 1979, Kulik & Kulik 1984, 1990, Lynch, 1990, Petersen, Brounstein & Kimble, 1988 and Sisk, 1988. Such proponents of ability grouping contend that one of the main reasons of grouping high ability students together is that they can accelerate the curriculum to the advantage of those students.

The question arises however as to why we would want some students to have an accelerated curriculum. The answer may well be a commercial one in that parents of bright students would like their children to get a 'leg up' on the next level of their schooling. Thus in N.S.W., parents of students in stage 3 may wish to give their children an introduction to high school mathematics in order to pass entrance exams. Likewise parents of students in stage 5 may wish to introduce their children to stage 6 mathematics so as to obtain a higher mathematics score on their H.S.C., which will give them a higher Tertiary Entrance Score for university. This is of course, their right to wish such things and a genuinely understandable attitude. Schools, especially fee charging schools will be aware of this desire from parents and it will be a factor in deciding how they should be grouping students.

In fact much of the push for ability grouping is generated from parents. (Judith Ireson and Susan Hallam, 2001) and (Ball et al., 1994). The other push is from teachers, especially many mathematics teachers who the research shows overwhelmingly support ability grouping in mathematics and in fact support it much more than their non-mathematical colleagues. (Chen and Goldring, 1994, p. 48), (Cahan and Linchevski, 1996) and (Zevenbergen, Dole and Wright, 2004. pp. 52-53). One reason for this would be that many mathematic teachers believe the subject of mathematics to be hierarchical (Liora Linchevski and Bilha Kutscher, 1998) and that students have an innate ability to do mathematics. It would make sense then, to place students at the level of mathematics that is commensurate with their innate ability. It should also be mentioned that it is much easier for a teacher to teach mathematics to a class of similar ability than to tailor the lesson to different ability students. Another argument for ability grouping, which is based on research, is that high ability students themselves believe that their academic progress is enhanced by being grouped with like-minded higher ability students. Many students report being frustrated in having to waste time repeating simple things when grouped heterogeneously. An example of such research can be found in the interviewing of students that were enrolled in a residential summer program for talented youth. (Jan

Adams-Byers, Sara Dquiller Whitsell and Sidney M. Moon, 2004). The authors also cite similar type research showing negative attitudes from high ability students reported by (Moon, Nelson, & Piercy, 1993); (Baker, Bridger, & Evans, 1998), (Clinkenbeard, 1991; Feldhusen, 1989; Kulik & Kulik, 1987) and (Gross, 1989).

Aside from the simplification for teachers and the attitudes outlined above from higher ability students, the only benefit for ‘between class’ ability groupings that is supported by research appears to be when the curriculum is accelerated. This simplifies the issue. Returning to our initial rationale for reasons why we teach mathematics, the only rationales that might possibly be said to be supported by ‘between class’ ability grouping is that it might help develop the highest level of mathematics possible in society by advancing the mathematical understanding of the highest ability students. The assertion that ‘between class’ ability grouping does this can very much be challenged though. There is no research to suggest that higher ability students will turn away from mathematics or not fulfil their highest potential if taught in a heterogeneous group. Any benefit for an accelerated curriculum is surely temporary, that may advantage students at critical times in their academic schooling. There is no impediment to their overall development should they wish to pursue mathematics at the university level and beyond. It may be that in very minimal cases, that development is postponed for a very brief time. In fact the same research quoted above from Adams Byers et al, based on student interviews, reports that while students thought homogeneous classes benefited them more academically, a similar percentage thought that heterogeneous classes benefited them socially. It may be that in order to progress to a high level of post-graduate mathematics, it is important to foster a genuine enthusiasm for mathematics. Further research is needed in this area but it is very possible that this enthusiasm could be lost through a homogeneous structure. Three of the four countries that are ranked more highly than Australia in school level mathematics showed a tendency to be less interested in the subject overall. (National Numeracy Review Report, May 2008). Follow up studies are needed in those countries to track the participation in mathematics subsequent to that level. Less interest may dissuade these students from actually pursuing mathematics at higher levels which would remove the one remaining original rationale that ‘between class’ grouping might have supported. Certainly the research suggested by Boaler, also based on interviewing students, shows that many higher ability students have negative views on the way they are taught in homogeneous classes. Many students, especially girls, are very open to dropping down to lower levels of instruction because they feel the pace of instruction is so quick that they are not given time to think about what they are doing. (Boaler, 1997a, 1997b, 1997c). A telling finding from that particular research was that students in the highest ability mathematics classes thought that remembering was of greater importance to them academically, than learning.

In turning to ‘within class’ ability grouping, there appears to be support for this in the research and little if any support against this practice. It is a widespread practice that allows students to be targeted according to their current ability which enhances students learning outcomes, especially for the lower ability students in English and Mathematics. (Slavin, 1996 and 1987) and (The Balanced View: Ability Grouping. Volume 6, Number 2 July 2002). The reasons why ‘within class’ ability grouping may be significantly beneficial whereas ‘between class ability grouping’ is not, may be largely to do with student psychology and will be discussed later.

Thus, having agreed with Slavin that the onus is on the ‘between class’ ability grouping side to make their case, the absence of any real benefit for ‘between class’ grouping could be said to have settled the issue. That is, that between class ability grouping is something that should not be pursued as it does not create any real advantage.

The report may be stopped here except for the fact that there is very much evidence to suggest that between class grouping for mathematics is actually detrimental to many students development and so should be actively discouraged at the school level.

In fact Maureen Hallinan, comes out strongly against ability grouping. She strongly criticises Slavin, describing some of his findings ‘astonishing’ and going against the accepted research findings of the last couple of decades. (Hallinan, 1990). This research she claims, finds that not only is there very little increased achievement in higher ability classes (non accelerated) but there is much evidence to show that lower and middle ability classes fair much worse than they would if taught in heterogeneous classes.

The best research that the author of this report could find that seems to present verifiable scientific data on ability grouping, comes out heavily against ‘between class’ ability grouping.

One such valued research was reported by Liora Linchevski and Bilha Kutscher in 1998 who describe a secondary school which had four starting year 7 classes of heterogeneous ability. These would normally be grouped by the school into different classes based on ability. The testing of the students ability was conducted as usual but only two classes were split by ability into higher, intermediate and lower ability classes while the other two classes were taught mathematics in heterogeneous classes. Thus there were five classes in all. All students remained in the same class for two years and at the end of the eighth grade all of the students took two mathematics tests. The first test was specific for the original ability grading they were assessed at, and the other test was a common one that all students sat.

Table 1

Achievements (Means in Percentages) in Mathematics at the End of 8th Grade

	Same-ability groups			Mixed-ability groups		
Tests	High	Intermediate	Low	High	Intermediate	Low
Differential test						
Mean	85	64	55	82	80*	78*
Standard Deviation	7.8	5.6	6.2	7.5	4.3	5.1
Number of Students	33	27	14	35	26	15
Common Test						
Mean	88	41	____@	85	65*	54
Standard Deviation	8.1	5.1	____	6.9	6.1	3.9
Number of Students	33	27	14	35	26	15

@ Because many of these students did not complete the test, we could not do a t-test, but because the mean would have been exceedingly low, we assume that it would be significantly different from 54, the score of the low-ability students in the mixed-ability group.

- $p < .05$ (significant t-test value between same-ability mean and the mixed-ability mean).

The results were quite astounding. As can be seen by the accompanying illustration (Table 1) there was only a very small recorded benefit to students taught in the homogeneous higher ability classes compared to their high ability colleagues taught in a heterogeneous class. The mean score for the first test was 85 percent compared to their same ability colleagues in the heterogeneous glass who scored a mean of 82 percent. When the results were further analysed, it was found that the small advantage could be shown to be the result for more marks being awarded for 'setting out' and using correct mathematical notation. The teacher of the heterogeneous classes admitted that time was not spent on such things as a priority. Applying the t-test to the data by comparing the means of both groups to the variance of each group (square of the deviation) yields a value of $P < .05$ and this is not considered to be significant.

Thus, it can be concluded, there was not any real benefit to the higher ability class that were taught homogeneously. In comparison, the intermediate and lower ability students showed a very marked difference in the results. These results favour mixed ability classes and the differences were found to be significant. The common test results gave exactly the same findings but presented an even clearer picture favouring mixed ability classes. Many students in the lower ability class that were taught homogeneously, handed in blank papers and clearly performed very badly. The lower ability students taught in heterogeneous classes however fared much better and their mean score was a respectable 54 percent. This group even clearly outscored the intermediate class that were taught in a homogeneous structure who only had a mean of 41 percent. This is clear evidence that grouping students homogeneously is detrimental to the intermediate and lower ability students. In general it suggests that there are no significant benefits to homogeneous grouping but certainly adverse effects for the lower placed students.

This view is supported by many other researches such as that cited by Anne Wheelock. She reports that a Muirlands Middle School in LaJolla California decided to move from a homogeneous class instruction to heterogeneous classes. At the end of the 6th grade after standardised testing, the lowest ability students had moved from the bottom to the middle deciles whereas the top achievers had not suffered from heterogeneous class instruction. (Anne Wheelock, 1994, p. 69).

Another quality research project, that appears to clearly demonstrate the adverse effects of student achievement for the lower placed mathematical students uses the Regression Discontinuity Design (Cook & Campbell 1979). This design uses a pre-test and a post-test for students after ability grouping has occurred. It looks specifically at students at the cut off level between classes. That is the best of the lowest and the lowest of best. It uses a regression line and looks for discontinuity at the grouping cut off point. If there is a clear advantage or disadvantage to being grouped in the higher or lower class this should be shown in the post-test results of the students who were around the original cut off mark and therefore of a similar ability.

One study using this design was conducted by Cahan and Linchevski in 12 junior high schools and it found in all schools, that after same ability grouping, the difference in variation was greater than would have been expected from initial placement. It was further found that this grouping practice had an accumulating effect in all of the schools and entrenched the initial placing.

It seems students close to the cut off point have their success determined by an arbitrary selection into one group or the other. (Liora Linchevski and Bilha Kutscher). These results may then confirm a teacher's original thoughts regarding students having innate abilities to do mathematics. (National Numeracy Review Report, May 2008).

It is very concerning that an initial assessment of a student which is often subjective, will have a long lasting effect on that student's academic outcome. Once a placement is made for ability grouped classes, it is very difficult for students to move up to the higher ability classes. (Zevenbergen, Dole and Wright, 2004. pp. 52-53) and (John Goodlad, 1984). This is even more pronounced when the higher ability class have an accelerated curriculum.

Initial student placements could conceivably be incorrect. (Judith Ireson and Susan Hallam, 2001). It is also possible that many students will develop their mathematical abilities at a later age or perhaps when initially tested, may have had some outside factor influencing their results. As mentioned earlier, some students may be involved in an accelerated curriculum that will help their chances of being grouped in a higher ability class even over students who may have a higher mathematical ability but had not been exposed to an accelerated curriculum. Thus an accelerated curriculum and entrenched ability grouping philosophy may actually prevent many highly talented students from achieving their full potential.

There have been many reasons put forward as to why students in lower ability classes do not live up to their full potential. Some findings have shown that these classes are often taught by lower experienced teachers that are more likely to leave and who provide lower instruction to students. (Liora Linchevski and Bilha Kutscher, 1998), (Anne Wheelock, 1994 p. 12 citing Lorraine McDonnell), (Dreeben & Gamoran, 1986; Gamoran, 1986, 1987; Gamoran & Mare, 1989; Oakes, 1985, 1989; Sorensen & Halinan, 1986; Veldman & Sanford, 1984 all cited in Secada, 1992) and (Davenport 1993). Other research shows that teachers may not expect their students to achieve and these expectations are felt acutely by the students. (Boaler, Wiliam and Brown, 2000).

The author of this report was previously in agreement with ability grouping. After spending some time in the classroom and observing students being grouped into higher and lower ability classes for mathematics, on reflection I would say that the attitude of the higher ability kids when going into the classroom was much more enthusiastic and energetic than the lower ability students who were marched into the library as part of the 'dumb' class. These are harsh words but the research by Zevenbergen (2005) reporting on an Australian study of 96 interviews of year 9 and 10 students, suggest that the lower ability students define themselves in this way, or at the very least believe that is how they are perceived by their teachers. They believe they get the worst teachers and find it hard to see the point of even participating. This attitude contrasts very unfavourably with the students placed in the higher ability classes.

Learning happens best when there is mutual respect between teacher and student and it appears that the psychological mindset created by ability grouping works against this. Zevenbergen suggests this with her concept of a student's 'habitus' which is a self created image a student will make for themselves that strongly affects their learning. Brighter students who are grouped in higher classes will have a much better attitude to mathematics. (Burkes, 1994).

My experience with observing elementary 'between class' grouping for mathematics also supports much research which suggests that lower ability classes are exposed to more rote learning and less open ended questioning to engage the students in higher cognitive thoughts. (Gary, 1995 and Veves 1989 both cited by Masalah Pendidikan Jilid J7. P 109), (Gamoran 1993) and (The Balanced View: Ability Grouping. Volume 6, Number 2 July 2002). This may be one reason why students in lower ability classes reported maths as being boring and irrelevant to their lives.

Implications and Conclusions.

The ultimate question of teaching students is a social one. (Jill Cheeseman, cited from the Tasmanian Government Education website). There will continue to be a push by parents for ability grouping for the reasons covered earlier, but the research clearly shows that there is no lasting benefit, but in fact has significant adverse effects on the lower and intermediate ability students.

Believing that a main reason for this adverse effect rests in the psychological position created by 'between class' ability grouping, the author would recommended heterogeneous grouping making use of the within class ability grouping method. The author sees merit in the suggestion put forward on the Tasmanian Government website (From Learning, Teaching and Assessment Guide) where teachers should introduce mathematical topics to a class as a whole and if needed split the class into 'within class' groups to target different abilities. The groups should be fluid in that the members of the groups will change depending on the student ability to grasp the different mathematical concepts introduced. One week a student might be in a lower ability 'within class' group for say a geometry lesson and in a higher ability 'within class' group the next week for graphing. Teachers can also introduce topics in such a way to engage with different students. References may be made to a mathematical concept in sports or the arts or transport or farming etc. Each student will react to such a varied presentation differently, and will sometimes be more engaged and successful than at other times.

This will require more work from individual teachers in thinking about how to base their mathematics classes and how to plan three or four different units of work for the different ’within class’ grouping abilities. It should though, be a more diverse and inclusive way to teach mathematics and help the teacher engage with the class. (Carol Ann Tomlinson, 2005). In the end, it should help to make the teacher better at his or her profession which gives a more rounded education to the students.

There is much advantage in having a diverse and interesting classroom which will engage with all students and produce a more rounded education. Howard Gardner’s multidimensional approach to intelligence would also support such diversity. Young people experience continual cognitive growth at all ages and thus should be continually engaged and challenged at school. (Anne Wheelock 1994, p. 10) and (Colleen Politano and Anne Davies. 1994.).

Such an approach will prevent teachers from simply engaging with the mathematics textbook at a certain predetermined level and instead encourage teachers to engage, recognise and effectively develop student’s own particular mathematical experiences and strengths to the benefit of all in the classroom. (Boaler, Wiliam and Brown, 2000). A diverse classroom that is continually grouped and regrouped is certainly more challenging for the teacher but it also gives the teacher the opportunity to draw on different student perceptions to create a co-operative approach to learning.

If there are some students who will need remedial attention with mathematics then there are different ‘before’ and ‘during’ school programs that may be of benefit to target such needs but will largely keep such students within a heterogeneous classroom environment. (Anne Wheelock, 1994, p. 28).

In conclusion, to return to the original rationales for teaching mathematics, the author believes that the main way to achieve all stated rationales is by fostering a genuine love and enthusiasm for mathematics in the classroom which leads to greater mathematical achievement for all students.

According to the available research, this enthusiasm is best served in the heterogeneous classroom using ’within class grouping’ by a teacher who believes all students can succeed at mathematics and each brings their own important experiences to the classroom. This structure shows no significant disadvantages and avoids those disadvantages that the abovementioned research suggest occurs with ’between class’ grouping

As such, at the school level, heterogeneous class structures should be favoured and at the classroom level inclusive and tailored ‘within class’ groupings appear to be the best way forward.

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