Cohort size, sex and socio-economic status as predictors of success in Year 12 Physics in Perth, 1987-1997

David Geelan, William Louden and Helen Wildy

A variety of factors are associated with students' achievement in secondary school physics, including cohort size – the total number of students studying Physics in the school – and socio-economic status. Earlier studies also showed boys achieving better in Physics, while more recent research has shown better results for girls. Statistical analysis of the results of 25,882 Year 12 physics students from 99 schools in the Perth metropolitan area explored three factors related to performance in the physics course. Results were also analysed in terms of the schooling sectors – state, Catholic, high fee non-Catholic (grammar school) and low fee non-Catholic (smaller Christian and other independent schools) – from which students were drawn. Cohort size and socio-economic status were found to be strongly correlated with physics success, while sex was not found to have a significant correlation with achievement.

Introduction

Several different factors might be conjectured to effect student achievement on standardised state-wide achievement tests such as the Western Australian Tertiary Entrance Examinations (TEE) in a systematic way (that is, at a level beyond student individual differences). Three such factors – cohort size (the total number of students in a school studying the subject), sex and socio-economic status – were explored in relation to the TEE results of Perth students over the eleven year period from 1987 to 1997 (inclusive). Obviously, the data are somewhat old now, however the findings remain relevant to considering factors relevant to success in secondary school physics, particularly those that are perhaps less intuitively obvious.

Altinok and Kingdon (2011) conducted a meta-analytical study of trends in International Mathematics and Science Study (TIMSS) data from forty-seven countries. They found that, in agreement with other studies on the achievement effects of class size (e.g. Wößmann & West, 2006), class size had a negligible effect on student achievement. This flies in the face of the ‘conventional wisdom’ that smaller class sizes lead to enhanced achievement. Hattie’s (2008) work supports the contention that class size is not strongly correlated with student success. Kenny and Oppedisano (2013) found evidence of enhanced mathematics achievement for students in larger classes using PISA data, however, only the results for the UK were statistically significant.

Class size data were not available for the present study, but the total number of students who studied Physics in each school – the cohort size – during the eleven years of the study was taken as a variable and compared with achievement in Physics. We are not aware of earlier studies that have explored this particular relationship. A multi-level modeling approach to Hong Kong’s PISA data by Sun, Bradley & Akers (2012), however, showed a positive correlation between school size and science achievement. While there may have been some effects due to class size in the present study – some schools average only six or less students per year, for example – we felt that the cohort size effects, particularly with larger cohorts in schools that teach multiple classes in the same course, were more likely to be influential on achievement in this study than class size alone.

While girls tend to participate in secondary school physics at a lower rate than boys, their achievement is typically at similar levels, when variables other than sex are controlled. Earlier studies such as those by DeMar (1997, citing Erickson and Erickson (1984)) and Young and Fraser (1993) showed boys achieving higher grades in Physics than girls.

Hildebrand’s (1998) study of Physics in the Victorian Certificate of Education (VCE – a similar state-wide Grade 12 assessment program, although with a larger school-based component) showed a dramatic narrowing of the gap, and in fact a reversal, with girls achieving higher grades than boys. More recently, Fischer, Schult and Hell (2013) found that female students perform better than male students, and that this effect is even more dramatic when results are controlled for basic intelligence. Given this changing picture and the potential gap between perception and reality, we felt that it was important to explore whether sex was a significant predictor of success in TEE Physics.

Finally, a persistent research finding has been the correlation between relative wealth and academic success. More than thirty years ago, Coleman et al. (1966) and Jencks et al. (1972) suggested that socio-economic status was a stronger determinant of academic achievement than school related effects. Although this has been disputed (e.g. by Bowles & Levin, 1968; Yeakey, 1983), more recent studies (e.g. Young & Fraser, 1993, and those cited in Kahlenberg, 2003) have also shown such a correlation between socio-economic status and academic achievement.
In the course of the analysis, three main factors were considered, based on previous research in the project (Wildy, Louden & Wallace, 1998): mean cohort size, sex, and socioeconomic status.

**Cohort Size**

There is a well-known debate about the perceived advantages of small class size (e.g. Boyd-Zaharias, 1999; Deutsch, 2003; Johnson, 2002; Reynolds, Reagin & Reinshuttle, 2001). Our study deals with cohort rather than class size. Here we refer to the total number of students in a school presenting for Physics in Year 12. We found that larger cohort size was strongly correlated with high achievement in TEE Physics.

Mean cohort sizes were calculated for each school, by dividing the total number of students who completed the course at the school by the number of years in which students from that school presented results. For 72 of the 99 schools in the study this was the whole eleven years. One school presented students in only three years, two schools four years, two schools five years, and a further twelve schools for between six and ten years. The smallest mean cohort size was six students per year, and the largest was seventy-one, with the mean of cohort sizes equal to 24.5 and the standard deviation 14.2.

No data were available about the number and size of individual class groups in each school, so the measure relates to the average total number of students taking Physics in the school each year. In general, the cohort sizes were quite stable across the period studied, except in the very small schools, which often fluctuated more dramatically in percentage terms, simply because of the smaller groups. The Pearson correlation coefficient across the entire study between mean school cohort size and Physics score was found to be +.545, significant at the 0.01 level.

When this is divided by sectors, the results are as shown in Table One.

<table>
<thead>
<tr>
<th>SECTOR</th>
<th>MEAN COHORT SIZE</th>
<th>PHYSICS SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government, n=54</td>
<td>+.641**</td>
<td></td>
</tr>
<tr>
<td>Catholic, n=23</td>
<td>+.446**</td>
<td></td>
</tr>
<tr>
<td>High fee non-Catholic, n=13</td>
<td>-.083</td>
<td></td>
</tr>
<tr>
<td>Low fee non-Catholic, n=9</td>
<td>+.212</td>
<td></td>
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</tbody>
</table>

**Table 1: Mean cohort size vs Physics achievement, school level, by sector.**

**Sex**

The mean physics score for the entire student group (n=25,682) was 67.32 marks (out of 100). The mean for all male students was 67.37 and the mean for all females 67.22.

In each sector, except the low fee non-Catholic group, the mean female scores were slightly below the group mean and the male scores slightly above, but this difference was generally very small (less than 1 mark out of 100) and not statistically significant.

The issue of single-sex versus mixed-sex classrooms is difficult to disentangle from that of socio-economic status in this instance, since the single-sex grammar schools also tend to be the most affluent, highly resourced and selective schools.
The overall point-biserial correlation between sex and achievement in Physics was .006, and is not statistically significant, even with a sample of this size. Divided by sector, these results are as shown in Table Two.

### Discussion

The results for cohort size – the average total number of Year 12 physics students taking the subject in a school each year – are intriguing, and were perhaps the most surprising of the study. The correlation was strong and positive (larger cohorts correlates to higher scores) in the government and Catholic sectors. It was negative but negligible in the high fee non-Catholic (grammar school) sector and positive but not significant in the low fee non-Catholic sector. In general, across all students, the results suggest that a student in a school where there are more students taking Physics is more likely to succeed in Physics than students in schools with smaller cohorts. This may to some extent be a selection effect, in that students (and parents) who want to succeed in Physics, select schools with a reputation for good physics programs.

The strong correlation between the number of students taking Physics in a school and the success rates may be related to factors in addition to selection effects. For example, schools with larger cohorts might develop greater levels of collegiality, support and resource sharing between multiple physics teachers. Similarly, schools with larger cohorts might develop more specialisation among teachers. For instance, in a school with seventy Year 12 physics students, a teacher may have responsibility for two Year 12 physics classes and two Year 11 physics classes, that is, be responsible only for teaching senior Physics. In contrast, in a school with only ten Year 12 Physics students, the Physics teacher’s workload would be built around teaching courses other than Physics, such as mathematics and junior high science.

This finding may also reflect the fact that some schools with large cohorts have the capacity to retain teachers with strong Physics backgrounds and high profiles in professional associations (Wildy & Wallace, 1995).

Over the whole student group, there was a very small negative correlation between physics success and sex, with boys scoring slightly higher than girls. However, the correlation was close to zero and was not statistically significant. The findings for the Catholic and HFNC sectors were statistically significant, probably due to the very large size of the samples, but at a very low level of correlation. It is interesting to note, however, that almost three times as many boys as girls completed the Year 12 Physics course. We note data suggesting that girls who complete Year 12 Physics may be more academically able than the boys. The mean ASAT score for female students was 69.14 and the mean ASAT score for male students was 67.34 (out of 100). Given that the boys and the girls showed almost identical final TEE Physics scores, we might suggest that the girls were to some extent under-achieving in Physics, compared to their ability.

Our analysis of socio-economic status (SES) indicates that the more affluent students are, the more likely they are to achieve success in Physics.

When the data were analysed by correlating individual students’ scores and socio-economic status (approximated using the Index of Urban Advantage and the school postcode), the correlation was positive and statistically significant for the students in the entire school level, the observed correlation is much stronger: $r = .505$ for the entire group (significant at 0.01 level), simply because similar students are grouped together. Within particular sectors, the correlation at school level between SES and achievement is as shown in Table Four.
study, and also for the government, Catholic and HFNC school sectors. The correlation was negative, of negligible size and not statistically significant for the LFNC sector.

When these data were aggregated by schools (that is, mean school score versus SES), the effect was even more marked because the students were more tightly grouped in terms of their similarities. The correlations for the study as a whole and for the government sector were large, positive (i.e., more affluent students were more successful) and statistically significant. Correlations for the Catholic and HFNC sectors were positive and smaller, but not statistically significant at a 0.01 level of significance. The range of socio-economic status represented by the HFNC sector was sufficiently narrow that this result is unsurprising for that sector.

The result for the low fee non-Catholic sector was a strong negative correlation, which is surprising in terms of the results in the other sectors, however this sector was very small (nine schools in total), and one particular school, which was in a very affluent suburb, had experienced very small and fluctuating cohort sizes in Physics over the period of the study, and very poor Physics scores. If this school was removed from the data set, the correlation was close to zero.

Achievement in schools with smaller cohorts was much more variable. In particular, more students in schools with small cohorts achieved very low scores in Physics (10-30%) than occurred in schools with larger cohorts.

**CONCLUSION**

This paper is one in a series from our long term study of the construction and perpetuation of advantage in society. We are interested in the notion that those who are already socially and economically advantaged often receive schooling that helps to maintain and expand that advantage, whereas those who are already disadvantaged may not receive benefits from their schooling that will allow them to change their circumstances. This statistical piece of the study does not allow strong causal claims to be made about why there is a correlation between socio-economic status and success in Physics, because it looks only at outcomes.

The factors that lead to success and failure in Physics may be correlated with home resources and support for learning, parents’ educational level and ability to support students’ learning or a large number of other factors, rather than to what happens to them at school. However, the finding that science education is not serving as a means of overcoming students’ disadvantages, and may even be perpetuating them, is worthy of further research attention.

It was heartening to see that sex was not a significant predictor of success in Physics, and that male and female students were achieving at very comparable levels. During the period covered by this study, there were still almost three times as many boys as girls taking Physics, however, and there is continued scope for encouraging motivated girls to choose to study Physics.

Cohort size is in some ways the most interesting finding of this study. It was impossible to determine actual class sizes from the data available, but anecdotally and from other parts of the study, it seems as though class sizes around thirty are not a significant impediment to success in Physics.

None of these three factors determines students’ success (or otherwise) in Physics – there are numerous other factors in play, relating to the student, teacher, parents and school context. There is value, however, in being aware of factors that have implications for building students’ access to Physics, and subsequent related professional careers.

Repeating this study with newer data – since the relationship between sex and achievement in Physics in particular seems to be a ‘moveable feast’ – and in more Australian states and internationally, has the potential to inform efforts to invite and engage more students to study and succeed in Physics.

**REFERENCES**


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