Culture and disadvantage in learning Mathematics

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There is concern internationally that socio-economic class and ethnicity remain the most significant predictors of outcomes in mathematics; performance is often largely dependent on family income and level of parental education. Consequently the influence of pupils' socio-economic backgrounds remains a major challenge to those of us in the field concerned with achieving equitable education. However, the ways in which socio-economic factors play out in different parts of the world subject to different political systems and structures, remains unclear. In this paper we present an analysis of mathematics achievement in Penang to offer a localized perspective on the ways in which socio-economic status and ethnicity affect achievement.

Introduction

Those who fail or struggle to succeed at mathematics do not come from a broad cross section of society; rather they tend to be those pupils from more disadvantaged neighbourhoods (Kitchen, et al., 2007). Gaps in student outcomes, especially those associated with non-academic factors, are always a source of concern for many educators and education systems. Although the stated aim of most education systems is to elevate every citizen to a better life through education, the observable reality is that a child's academic performance is often largely dependent on family income. Differences in students' socio-economic status remain a major challenge to achieving equitable outcomes though achieving equitable outcomes is not always high up on governments' agendas. In Malaysia, socio-economic class remains the largest driver of student academic outcomes and a major challenge to achieving equitable education are the socioeconomic differences among children (Malaysian Ministry of Education, 2013).

Education in Malaysia

Malaysia follows a top-down approach in which all directives concerning education are decided by the Ministry of Education. There are three main types of primary schools in Malaysia – the *National schools* using Malay as medium of instruction and *National-type* (vernacular) schools using Chinese or Tamil as medium of instruction. National schools are government-owned and operated and student population in these schools tends to be more multiracial, while national-type schools are mostly government-aided, though some are government-owned. The student population in these schools tends to be mono-ethnic, although the national-type Chinese schools tend to attract around 10% of its population from other ethnic groups (Malays and Indians). In government-aided national-type schools, the government is responsible for funding the school, while the school buildings and assets belong to the local ethnic communities.

The mathematics curriculum

The mathematics curriculum has undergone some significant changes (both in content and in teaching approach) since the 1970s – from a traditional, absolutist approach to a more holistic, integrated curriculum. The traditional mathematics taught before the 1970s employed a behaviorist approach where drill and practice was emphasized. The *Integrated Curriculum*, which employed the constructivist teaching approach, was introduced in 1994, with an emphasis on problem solving and group work. Starting from 2011, the primary school curriculum underwent another development called the *Standard Curriculum for Primary School*. As the name suggests, pupils' achievements were measured against certain standards that they are able to acquire and do. The standards are divided into two parts: content and learning, which are delivered in modular forms. The content standards are statements about cognitive (knowledge) and affective (attitude and values) domains that are expected in learning a topic. The learning standards are statements about what a pupil is able to do in terms of concept and skills acquisition and proficiency.

Although having a national curriculum and centralized deployment of educational resources would seem to suggest that all the schools would perform somewhat similarly, the learning experience that a child experiences is characterized by a number of factors including (but not limited to) geographic location, social background factors, school types, ethnicity structures and cultures. Although the three types of school use the same national curriculum and teaching materials (but using translated versions of the textbooks), teaching and learning is very much shaped by the school culture, which in turn is characterized by ethnicity.

In this paper we report on the early stages of an ongoing project to examine the mechanisms and contributory sources of low mathematics achievement in Malaysia. Despite adopting the British education system from the colonial era, Malaysian primary schools have become increasingly organised according to the ethnicity of pupils, rather than being based upon geographical location, as is more the case in the UK. Whilst this study aims to examine the effects of locality, poverty and ethnicity on mathematics achievement by focusing on two cities – Penang in Malaysia and Nottingham in England - in this paper we focus only on data from Penang.

Government data from Malaysia shows that pupils from certain groups continue to underperform when compared to their peers and in relation to national expectations:

- Locality – children in states with more rural schools;
- Socioeconomic status – pupils from low socioeconomic background;
- Ethnicity – Malays are outperformed by minority Chinese and Indian pupils.

In the UK pupils seen as seriously underperforming in mathematics tend to be those who live in social housing, and Afro-Caribbean pupils, who are regularly outperformed by minority Chinese and Indian pupils (see Gates and Guo, 2013). Naturally, geographical and political systems and therefore the mechanisms of influence will differ between Malaysia and the UK. In this project, we are investigating effects of locality, poverty and ethnicity on mathematical attainment. The aim is to offer a more localized perspective to try to understand the ways in which socio-economic status effects students' mathematical achievement and how this is influenced by ethnicity.

The Context of Penang

The island state of Penang is situated in the northern peninsular of Malaysia, consisting of an island (Pulau Pinang) and Seberang Perai (SP) on the mainland. Its population of 1.6 million consists of 42% Chinese, 40% Malays, 10% Indians and 8% non-Malaysians and others. Its population is thus highly diverse in ethnicity, culture, language, and religion. Traditionally, the Chinese, who work mostly in the business industry, are located in the urban parts of the state while the mostly agrarian Malays and estate worker Indians are mostly in the rural parts. The more economically developed part of the state consists of 50% Chinese, 33% Malays and 8% Indians. The less developed part on the mainland consists of 32% Chinese, 50% Malays and 11% Indians. Others make up the rest.

The school system is highly ethnically segregated. There is a total of 259 primary schools and 127 secondary schools in Penang. We were unable to obtain data on one Malay and one Chinese school. 149 of the primary schools are "*national schools*" (whose pupils are mostly ethnic Malays), 80 are "*Chinese national-type schools"*, and 28 are "*Tamil national-type schools*". These three types of schools are generally ethnicity-based, and the teachers tend to be of the same ethnicity (except for language teachers). The national schools consist of 94% local Malays, 3% Indians, 1% Chinese and 2% other races. The Chinese national-type schools consist of 88% Chinese, 9% Malays, 2% Indians and 1% others, while the Tamil national-type schools are 100% Indians. Out of the 271 primary schools, 143 (53%) are urban schools and 128 (47%) are rural schools. In order to simplify language, we hereinafter refer to these school types as Malay, Chinese or Tamil to represent the majority ethnicity in each.

Methodology

Our aim is to explore the effects of locality, ethnicity and poverty on pupil achievements in mathematics, and to provide some analytical map of the mathematics achievement in the state. The choice of Penang was to exacerbate ethnic and social divergence given the aforementioned social and political structures and the segregation within the primary schools. Whilst Malaysia is a diverse ethnic mix, Penang has particular characteristics of being significantly culturally Chinese within a tri-cultural community. We are examining whether there were, for example, differences in levels of achievement between Malay, Chinese or Tamil schools, and whether the social mix and geographical location played any role. Of course in order to undertake any detailed and robust parametric statistical analysis of such effects, we need to have sustainable assumptions that there actually are effects to identify, otherwise we may find we attribute causation to otherwise random or error effects.

Data was obtained from the Penang State Education Department. At the end of Year Six (age 11 – 12), all pupils sit for the Primary School Achievement Test (UPSR), the performance in which will decide which secondary school they go to the following year. The UPSR is an examination designed as an internal national qualification to mark the completion of primary school. The subjects tested in UPSR include Bahasa Malaysia, English language, Mathematics, and Science for students in national schools. Students at national-type primary schools also sit for Chinese or Tamil language. We also obtained the number of pupils in each school in receipt of government financial assistance. For each school we were able to obtain demographic data (size, type and location of school), achievement data (number of pupils sitting the

UPSR and achieving each grade) and the number receiving government financial assistance. Analysis of data was undertaken at a school and not a pupil level since we were only able to obtain the data in this aggregated form. Data contained information on name, location and ethnicity of school, total number of pupils, number of pupils receiving financial assistance, number of pupils who obtained each of the grades A to E in Mathematics (grades A-C are considered passes and D-E are failures).

The use of data

This is the first time such data has all been gathered together in one place and subjected to analysis. In this study we are examining a bounded geographical area, however within that boundary, we can see considerable heterogeneity. It is our contention that we gain little from attempting to utilize seemingly "hard" parametric statistics, because the data do not meet the underlying assumptions for such a statistical analysis. It would help us little – and indeed be a positivist distraction - were we to try to calculate means, variations and other test statistics and look for significance (Gorard, 2010). Consider poverty and achievement in **Figure 1**.

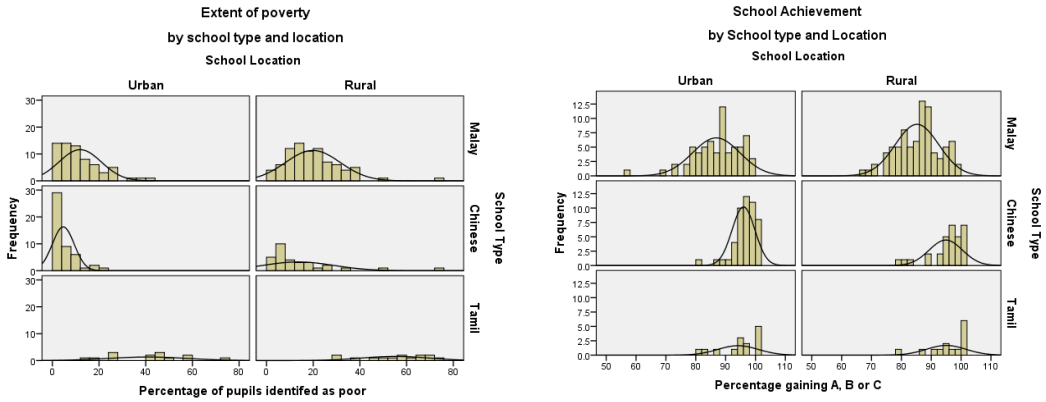


Figure 1 – Poverty and Mathematics achievement in Penang 2012 (Histogram)

It would seem difficult not to conclude on the basis of this data representation that underlying data appears to contravene normality assumptions, making most parametric analysis impossible. Also patterns of poverty and achievement within each ethnic school group appears to be quite different as we can see more clearly in the box plots in **Figure 2**, which also illustrate the existence and position of school outliers.

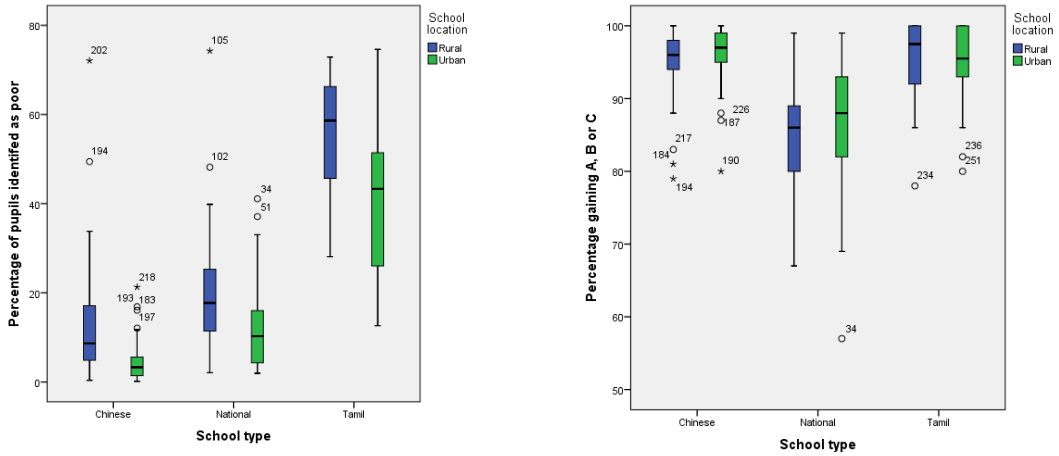
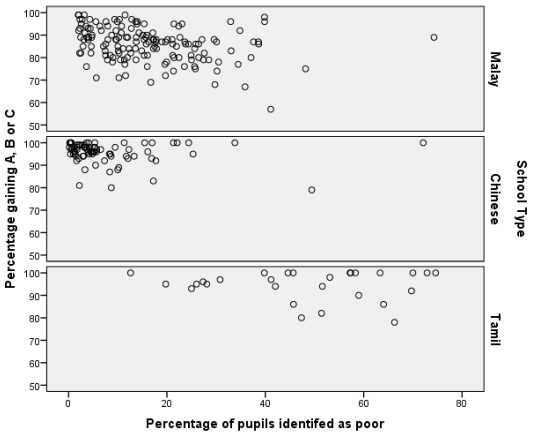


Figure 2 – Poverty and Mathematics achievement in Penang 2012 (Box plots)

Again assumptions of normality are not substantiated here, but we do not need to calculate significance levels in order to see something about the distributions of levels of poverty and mathematics achievement. This is not surprising, as both variables are politically constructed rather than representing some natural phenomenon.

Influence of ethnicity and poverty

We might however look at rank correlation coefficients for any indication of possible strength of association. All three types of school show a low correlation between mathematics achievement and percentage of students on financial assistance:
Malay (n=148) = -0.336; Chinese (n=79) = -0.152; Tamil (n=28) = +0.063. Whilst the correlation was not significant (at p = 5%) for Chinese and Tamil National-type schools, it was significantly negative for (Malay) National schools. This indicated that there may indeed be evidence of greater levels of association within the Malay schools than Chinese or Tamil, with Tamil schools having virtually no association between levels of poverty and mathematics achievement – which fits **Figures 1** and **2** since if there were we might expect to see the two box plots as horizontal reflections of each other**.** We did run a Kruskal-Wallis test to examine whether the level of mathematical achievement across the three ethnic groups represented different underlying distributions. A p value of <0.000, suggests the distribution of mathematics achievement across the three groups was different. The Malay National schools ranged from 70% – 100% passes with scores symmetrically distributed within that range. Both the National-type Chinese and Tamil schools ranged from 80 – 100% with only two such schools scoring below 80% and **Figure 2** shows the skew toward the higher pass rates. This is more notable when we consider that 10% of Malay schools had more than 30% of pupils on financial assistance, but 80% of Tamil schools and only 5% of Chinese has similar levels of poverty. For the three types of schools there appears to be three different mechanisms at work for the effect of levels of poverty on achievement.



In the **Malay National schools**, there is a weak negative association between levels of poverty and achievement.

In the **Chinese National schools**, levels of poverty are low and levels of achievement very high, leading to little discrimination.

In the **Tamil National schools,** levels of poverty are spread between 13% and 75%, yet this has virtually no effect on the high levels of achievement.

Figure 3: Scatterplot of poverty and achievement by school type

There is a tendency that schools with a high percentage of pupils receiving financial assistance are located in rural areas – this is perhaps not surprising. Of the Malay national schools, 83 (55%) were located in rural parts of the state (hence termed "rural schools") while 66 schools (45%) were in urban areas. Of the national-type Chinese schools, 31 (39%) were located in rural parts of the state while 49 (61%) were in urban areas. Half of the national-type Tamil schools (14) were located in rural

parts of the state, while the other half (14) were in urban areas. Generally, there does not appear to be a pattern of effects between the location of the schools and their mathematics achievement, as can be observed in **Figure 2** apart possibly from the Tamil schools where even schools in rural areas with high level of pupils in poverty still achieve high pass rates.

Discussion and Future Research

Our analysis in this early phase of the research has been deliberately low-key because of our contention that for such localised school data detailed statistical analysis is inappropriate and unjustified. What we have demonstrated is how we might use more non-parametric exploratory approaches to data representation and analysis in order to examine some possible underlying mechanisms in educational systems.

The first finding is the similarity between overall results in rural and urban schools. Some rural schools with high levels of poverty are obtaining high levels of passes – particularly in the Tamil communities. And this poses questions for the next stage of research.

Whilst our data provided us with only school level variables, we are unable to identify any pupil level effects. Nor do we know anything of the familial levels of poverty in each of the three types of school. All types of schools appear to have a heterogeneous spread of poverty levels, with only Chinese Urban schools appearing to be quite homogeneous with low levels of poverty. As of yet we have no data on school choice mechanisms, and this is a further avenue of future research.

What is also worthy of further research, and is something we are now examining through qualitative approaches, are those schools seen as outliers in **Figures 2** and **3**. For example, one rural Malay National school has a high percentage of pupils receiving financial assistance and obtained 98.5% passes, while another with a sizeable number of pupils on financial assistance obtained the lowest pass rate (57%). Of the three national-type Chinese schools with a high proportion of pupils receiving financial assistance, two obtained 100% passes while the other obtained 79% passes and is the lowest performing national-type Chinese school. For the national-type Tamil schools, most of the schools which obtained 100% passes had a high proportion of pupils receiving financial assistance. Two of these are cases for further research as one has the highest percentage of pupils receiving financial assistance but obtained 100% passes, and the other has a sizeable number of pupils receiving financial assistance but performed the least well (78% passes).

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