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# Effect of Extra Classes after School to Academic Performance

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***Abstract:***
*In most East Asia and South-East Asia nations, extra classes after normal school hours, known as "tuition", has become a must for most urban and sub-urban medium-low all the way to high income families. Most parents send their children to these tuition classes with the aim of improving their academic performance, although some may have done so for other reasons such as peer pressure or convenient to have somebody to look after their kids while they are working.*
*Just how effective are those tuition classes? This is a million-dollar question for this billion-dollar industry. To look into this question, a full-factorial experiment with three independent variables, namely tuition hours per week, parents' education levels and parents' combined income, was designed and the single measurable output variable was chosen to be year-end mean test score. However, this experiment was not carried out in a normal sense but rather, passive data was collected and analyzed according to the 3-variable 2-level full-factorial experiment matrix.*

***Keywords:*** *Tuition hours, academic performance, full-factorial experiment.*

## 1. Introduction

This study was conducted in Malaysia where formal elementary education is given to children from age 7 (grade 1) to age 12 (grade 6). The school year starts in January and ends in November of the same year and academic progress is mainly assessed through a few structured written tests each year. The general society here often draw an equal sign between a child's "cleverness" and his or her academic performance in school which is almost entirely based on examination results, thus those who could learn well in the compulsory subjects and do well in singular examination sittings are deemed "cleverer".
As a result of bias and race-based political policies, which is a major education calamity faced by everybody except the favored race, the sad fact is that most awards, scholarships, opportunities for higher education and even career path are based on examination results. Consequently, high test scores have unfortunately become the overriding goal of education since it is where the students' entire future lies. The racist policies in this country and its consequences are beyond the scope of study in this paper.
Another sorrow fact is that teachers teach to the examination because their job performance is based on such outcomes and students learn to pass examinations because their futures lie in it. This is the underlying reason why parents spend a significant chunk of their income sending their children to tuition classes especially to those run by experienced teachers who know how to train students to score high in examinations. Therefore, it is safe to say that the primary goal of tuition classes is to enable its attendees to achieve a higher test score.
These paid tuition classes ranging in size from one-to-one to a few dozen students in one class. Tuition classes are often taught by either full-time professional teachers doing part-time work, other professionals who are enthusiastic in teaching children or untrained people who just like to teach.
Some of the subjects being taught at elementary level are different from year to year but generally include the following areas:

(i) Languages -- Chinese, Malay, English
(ii) Technical -- Mathematics and Science
(iii) Creative – Arts and Music
(iv) Memory Intensive – History and Geography

Many factors may contribute to a child's academic progress especially when the child is very young and the effect of fractional age difference on academic performance for children under twelve has been studied (Chow, 2007). The number of siblings and position in siblings may each be a factor of import since, in some lower income families, the elder children are required to help out in household chores and teach the younger ones. Parents' education levels may also play a role as they could become tutors themselves, more or less inclined to see their children doing well in school, or give other impacts and advises. Family income could be a significant factor too because tuition classes are not cheap especially if there are three or four schooling-age siblings in the family.

## 2. Problem Formulation

### *2.1. Problem Statement*
The primary goal of tuition classes is to enable its attendees to achieve higher test scores. How well does it accomplish this goal? What other factors may contribute to the same goal?

### *2.2. Variables*
Birth month (12 levels), sex (2 levels), tuition hours per week(5 levels), number of siblings (7 levels), position in siblings (7 levels), father's education level (3 levels), mother's education level (3 levels), parents' income (5 levels).

### *2.3. Output*
Mean test score of all subjects over several structured tests in that year.

## 3. Full-Factorial Experiment

### *3.1. Experiment Design*
In a full-factorial experiment design, the number of experiment runs is equal to the number of levels to the power of the number of factors. As listed above, there are eight factors here. For a two-level experiment, there will be two to the power of eight, which is 256 experiment runs and this is less than meaningful given the number of samples available. Hence, only three factors are chosen, namely number of tuition hours per week, parents' education levels and parent's combined income. A 3-factor 2-level full-factorial experiment was design as shown in Table 1 below.

| Factors | Low Level (-) | High Level (+) |
|---|---|---|
| ***T*** | 6 hours per week or less | >6 hours per week |
| ***E*** | Secondary or lower (≤ 2) | Tertiary or higher (>2) |
| ***I*** | MYR 6000 or less | >MYR 6000 |

*Table 1: Definition of factors and levels for the full-factorial experiment*

***T***: Number of tuition hours per week, including all subjects.
***E***: Mean of father's and mother's education levels. The numbers 1, 2 and 3 are assigned to elementary, secondary and tertiary levels of education.
***I***: Total parent's income.
Note: Average household income in Malaysia is MYR 5000 in 2012.
The output, ***S***, is the mean test score of all subjects at the end of the year.

Figure 1 below depicts the 2-level coding of the three selected variables.

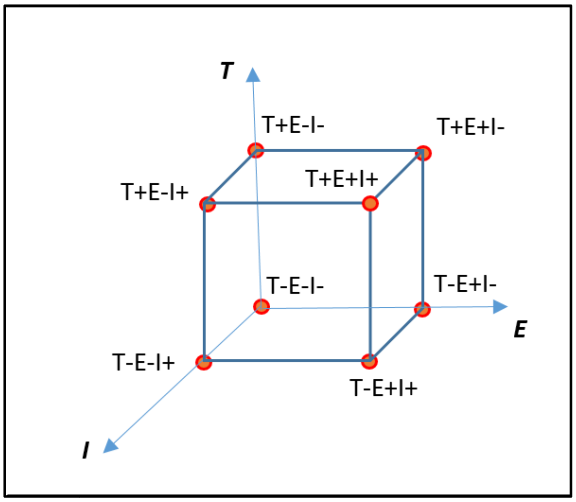



*Figure 1: Coding of the full-factorial experiment*

### *3.2. Data Source*
A friend of mine who is the principle of an elementary school in Kuala Lumpur, Malaysia, has assisted me in conducting a survey by questionnaire to all her students. Name of students are deleted once the mean test scores at the end of the year are available and correspondingly identified with other information, hence ensuring confidentiality. Due to some incomplete questionnaires, the sample size for each factor varies slightly but falls around 1000.

In this school, each age group has between 150 to 200 students divided into seven classes of different sizes. Although under different instructors, children of each class studied the same subjects and took the same tests. In this country, an elementary school serves only students who reside in the surrounding housing area. In this case, most of the students, with only a handful of exceptions, are of the same race. Therefore, the environmental and cultural differences are deemed minimal. It is assumed that the intelligence level of the children under study falls within the average range and is randomly distributed.

*3.3. Method of Analysis*

The raw data from the questionnaires (more than 12,000) was first digitized, quantified, before been keyed into spreadsheet according to age group. Four analyses were done, one for each: Lower Grades (1 and 2), Middle Grades (3 and 4), Upper Grades (5 and 6) and Overall (All Grades). The required data for the factors and output was then been extracted for further processing.

This passively-collected data (observations) was treated as results obtained from the eight experiments run according to the full-factorial experiment designed above. The effects of these independent variables as well as their interactions were then calculated. Dot plot, probability plot and some coefficients for regression analysis were also calculated for further insight.

**4. Analysis Results**

We first look at the overall analysis for all the six grades as one. The following table gives a complete picture of the effects of each factor as well as their interactions. Factor ***E*** stands out as the most important factor that positively affects the response ***S*** while the effect of ***T*** is surprisingly minimal. The second important factor is ***I***. The response ***S*** is calculated as the *mean* of the mean test score for all the students that fall into the cell with the corresponding ***T***, ***E*** and ***I*** levels.

**Grades 1 to 6**

| | Factors | | | Interactions of Factors | | | | Response |
|---|---|---|---|---|---|---|---|---|
| | T | E | I | TE | TI | EI | TEI | S |
| | - | - | - | + | + | + | - | 60.44 |
| | + | - | - | - | - | + | + | 64.37 |
| | - | + | - | - | + | - | + | 73.94 |
| | + | + | - | + | - | - | - | 69.98 |
| | - | - | + | + | - | - | + | 64.21 |
| | + | - | + | - | + | - | - | 69.43 |
| | - | + | + | - | - | + | - | 77.52 |
| | + | + | + | + | + | + | + | 75.10 |
| Σ + | 278.88 | 296.54 | 286.26 | 269.73 | 278.91 | 277.43 | 277.62 | |
| Σ - | 276.11 | 258.45 | 268.73 | 285.26 | 276.08 | 277.56 | 277.37 | |
| Effect | 0.69 | 9.52 | 4.38 | -3.88 | 0.71 | -0.03 | 0.06 | |
| Sample size | 990 | 998 | 997 | | | | | |

*Table 2: Effects of individual factors and their interactions*

The highest response is 77.52 (mean test score at the end of the year in per cent) which corresponds to low ***T***, high ***E*** and high ***I***.The lowest response is 60.44 which corresponds to low level for all three factors. The difference of 17 percentage points here happens both at low ***T*** level.

However, the main point of factorial experiment is not to compare two cells at a time but to run all eight cells at random order and then compare four cells in which one factor is at high level to the other four cells where the same factor is at low level. This will greatly reduce the error and uncertainty in the collected data.For example, the effect of factor ***E*** shown in Table 2 of 9.52 was obtained by summing the responses of the four cells with high ***E*** level minus the sum of the responses of the four cells with low ***E*** level, then divide it by four for the mean value.

The response of these eight experiment runs are summarized graphically in the cube shown in Figure 2 below. It is surprising that the four highest responses all correspond to high ***E*** level.

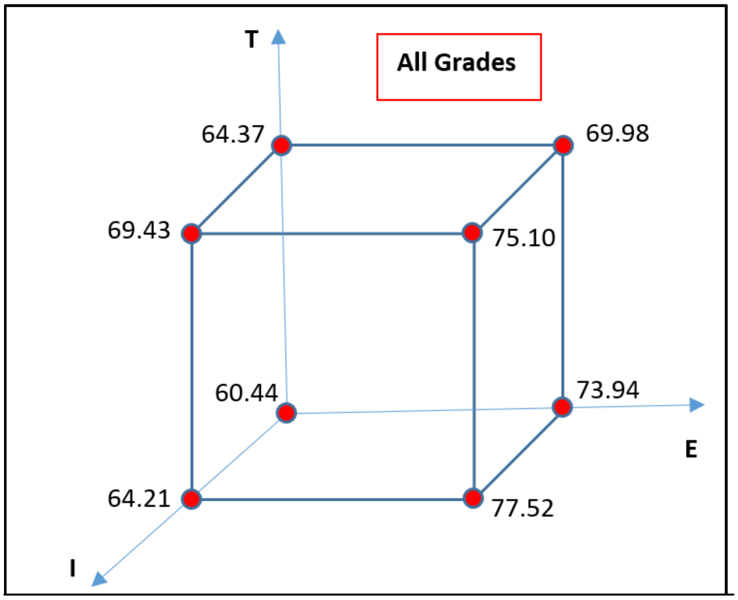



*Figure 2: Response cube for full-factorial experiment*

The dot plot below offers a visualization of the relative importance of the factors together with their interactions. It can be seen that factor ***E*** is far more significant compared to all other factors whereas factors ***I***is also somewhat significant.

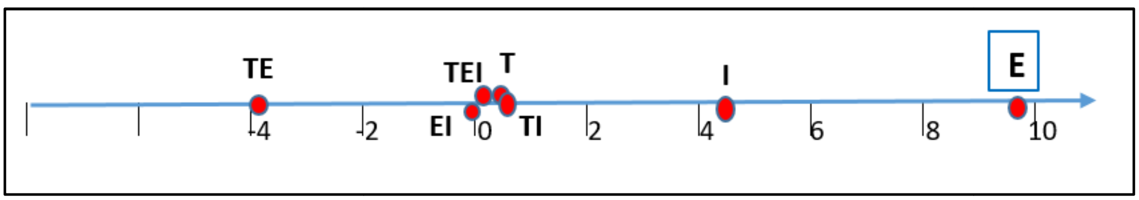



*Figure 3: Dot plot for effects and effect interactions*

It is interesting to notice that the interaction between ***T*** and ***E*** has a relatively significant negative impact on ***S*** as revealed in both the dot plot and the table above. When ***T*** and ***E*** both at high level, the average ***S*** is 72.54 whereas when both of them are at low level, the average ***S*** is 62.33. The following table shows that for high level ***E***, ***T*** actually has a negative impact on ***S***, whereas when ***E*** level is low, ***T*** should be high. In other words, if both parents have low education levels, more tuition hours per week would help their child attaining higher grades in school.

| | | S | Effect |
|---|---|---|---|
| ***E-*** | ***T+*** | 133.8 | 4.58 |
| | ***T-*** | 124.65 | |
| ***E+*** | ***T+*** | 145.08 | -3.19 |
| | ***T-*** | 151.46 | |

*Table 3: Effects of interactions between T and E*

The probability plot shown below provides the same information presented in a different way.

| i | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Eff ID | TE | EI | TEI | T | TI | I | E |
| Effect | -3.88 | 0.03 | 0.06 | 0.69 | 0.71 | 4.38 | 9.52 |
| P | 7.1 | 21.4 | 35.7 | 50 | 64.3 | 78.6 | 92.9 |

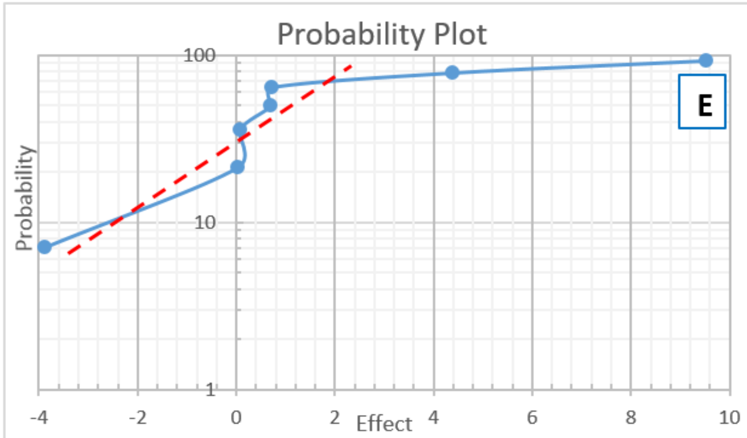



*Figure 4: Probability plot for effects and effect interactions*

As supplementary information, the product moment coefficient of correlation($r$), the coefficient of determination ($r^2$) and the regression coefficient ($b$) are tabulated as follows. The statistic indicator $r$ gives an indication of the strength of the linear relationship between two sets of interval-scaled or ration-scaled variables, whereas $r^2$ provides the proportion of the total variation in the dependent variable that is explained by the variation in the independent variable. The slope of the regression line, $b$, indicates the average change in ***S*** per unit change in ***T***, ***E*** or ***I***, and is just an estimate of the linear relationship between the two variables in the population.

| | | T | E | I |
|---|---|---|---|---|
| Product moment coef. of corelation | r | 0.19 | 0.25 | 0.19 |
| Coefficient of determination | $r^2$ | 0.04 | 0.06 | 0.03 |
| Regression coefficient | b | 2.64 | 10.68 | 3.59 |

*Table 4: Some statistic indicators relating the factors to the response*

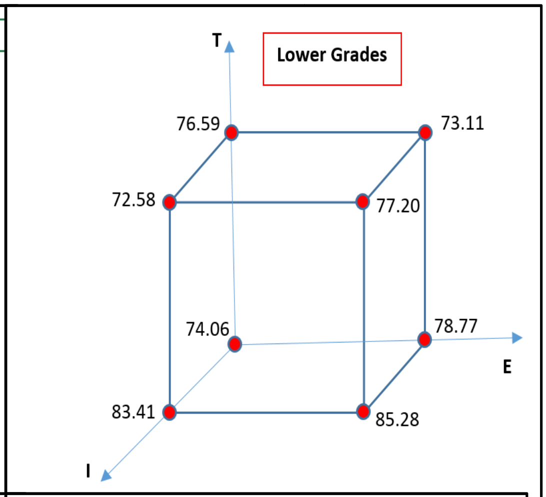
The first row shows that the linear relationship between ***T***, ***E*** and ***I*** each to ***S*** is not strong even though the strongest is seen to be ***E***. From the second row, one can see that the most significant factor, namely ***E***, only explains 6% of the variation in ***S***. In the last row, although the numbers themselves do not carry much meaning in the analysis technique adopted here, however, ***E*** again stands out as the most noteworthy.

Now, let's examine the analysis for the three groups: Lower Grades (1 and 2), Middle Grades (3 and 4) and Upper Grades (5 and 6). Figure 5 shows the effect tables for the three factors and their interactions together with the corresponding response cubes for these three groups.

The effect tables show that the effect of ***T*** increases from -5.51 in lower grades to +1.89 in middle grades to +5.50 in upper grades. This result says more tuition hours is helpful to upper grades students and harmful (in terms of test scores) to lower grades students! One possible explanation for this is upper grades students are more matured to understand the importance of formal structured education and tuition classes do indeed help them to revive what they have learnt in school classes. As for lower grades students who are only in their first and second year of schooling, more classes after school hours deprive them of playing time which they still value greatly.

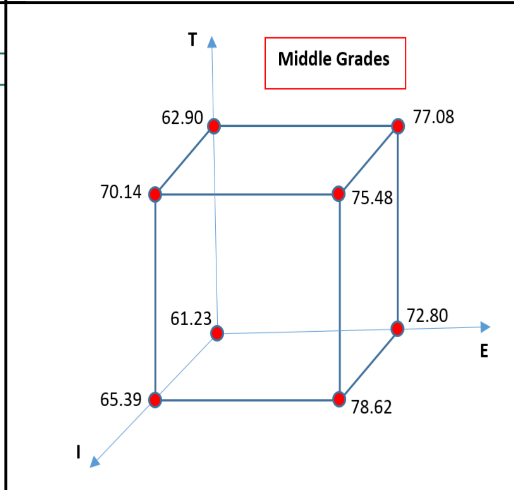
**Effect Table : Lower Grades (Age 7 and 8)**

| | Factors | | | Interactions of Factors | | | | Response |
|---|---|---|---|---|---|---|---|---|
| | T | E | I | TE | TI | EI | TEI | S |
| | - | - | - | + | + | + | - | 74.06 |
| | + | - | - | - | - | + | + | 76.59 |
| | - | + | - | - | + | - | + | 78.77 |
| | + | + | - | + | - | - | - | 73.11 |
| | - | - | + | + | - | - | + | 83.41 |
| | + | - | + | - | + | - | - | 72.58 |
| | - | + | + | - | - | + | - | 85.28 |
| | + | + | + | + | + | + | + | 77.20 |
| Σ + | 299.48 | 314.36 | 318.47 | 307.78 | 302.61 | 313.13 | 315.97 | |
| Σ - | 321.52 | 306.64 | 302.53 | 313.22 | 318.39 | 307.87 | 305.03 | |
| Effect | -5.51 | 1.93 | 3.99 | -1.36 | -3.95 | 1.32 | 2.74 | |




**Effect Table : Middle Grade (Age 9 and 10)**

| | Factors | | | Interactions of Factors | | | | Response |
|---|---|---|---|---|---|---|---|---|
| | T | E | I | TE | TI | EI | TEI | S |
| | - | - | - | + | + | + | - | 61.23 |
| | + | - | - | - | - | + | + | 62.90 |
| | - | + | - | - | + | - | + | 72.80 |
| | + | + | - | + | - | - | - | 77.08 |
| | - | - | + | + | - | - | + | 65.39 |
| | + | - | + | - | + | - | - | 70.14 |
| | - | + | + | - | - | + | - | 78.62 |
| | + | + | + | + | + | + | + | 75.48 |
| Σ + | 285.60 | 303.98 | 289.63 | 279.18 | 279.65 | 278.23 | 276.57 | |
| Σ - | 278.04 | 259.66 | 274.01 | 284.46 | 283.99 | 285.41 | 287.07 | |
| Effect | 1.89 | 11.08 | 3.91 | -1.32 | -1.08 | -1.79 | -2.63 | |




**Response Table -- Upper Grade (Age 11 and 12)**

| | Factors | | | Interactions of Factors | | | | Response |
|---|---|---|---|---|---|---|---|---|
| | T | E | I | TE | TI | EI | TEI | S |
| | - | - | - | + | + | + | - | 49.52 |
| | + | - | - | - | - | + | + | 61.92 |
| | - | + | - | - | + | - | + | 68.41 |
| | + | + | - | + | - | - | - | 59.10 |
| | - | - | + | + | - | - | + | 56.61 |
| | + | - | + | - | + | - | - | 66.66 |
| | - | + | + | - | - | + | - | 65.00 |
| | + | + | + | + | + | + | + | 73.86 |
| Σ + | 261.54 | 266.37 | 262.13 | 239.09 | 258.45 | 250.30 | 260.80 | |
| Σ - | 239.54 | 234.71 | 238.95 | 261.99 | 242.63 | 250.78 | 240.28 | |
| Effect | 5.50 | 7.92 | 5.80 | -5.72 | 3.96 | -0.12 | 5.13 | |

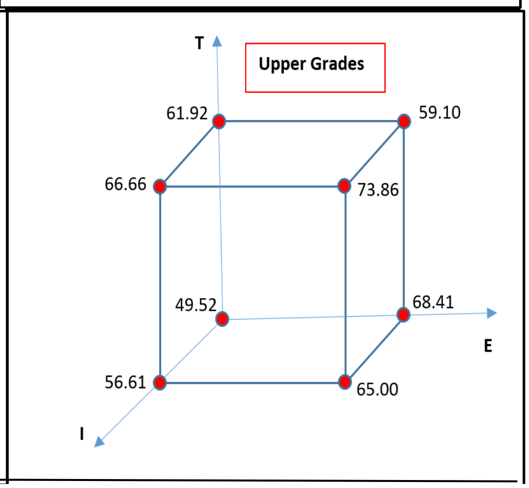



*Figure 5: Effects of individual factors and their interactions for three different groups*

The tables also demonstrate that, except for lower grades ***T***, all factors have positive effect on ***S*** and for middle and upper grades, ***E*** is the most significant factor by far while ***I*** is the second significant factor. It is interesting to note that the lowest mean test scores ***S*** is associated with the cell with low level of ***T***, ***E*** and ***I*** for all three groups (except for lower grades with a marginal difference). This points to a disadvantage of the students who come from family with both parents having low level of education, earning low income and could not afford to pay for tuition classes after school.

Table 5 below shows the same statistics indicators as before, but this time broken down into the three age groups. The first row, *r*, indicates that the relationships between ***E-S*** and ***I-S*** are weak to medium in strength while ***T-S*** is negligible. The $r^2$ values reveal that ***T*** contributes a mere 0%, 3% and 1% to the variation in ***S*** for lower, medium and upper graders, respectively.

| Lower | T | E | I |
|---|---|---|---|
| r | 0.06 | 0.22 | 0.22 |
| $r^2$ | 0.00 | 0.05 | 0.05 |

| Middle | T | E | I |
|---|---|---|---|
| r | 0.16 | 0.31 | 0.30 |
| $r^2$ | 0.03 | 0.10 | 0.09 |

| Upper | T | E | I |
|---|---|---|---|
| r | 0.08 | 0.31 | 0.29 |
| $r^2$ | 0.01 | 0.09 | 0.09 |

r : Product Moment Coefficient of Corelation

$r^2$ : Coefficient of Determination

*Table 5: Some statistic indicators for three different groups*

Shown in Figure 6 are dot plots for effects of individual factors and their interactions for the three different groups. It is a graphic visualization of the relative importance of the factors. The further away the factor is from zero, the more significant it is. To the right side of zero represents positive effect and left side indicates negative effect. Again, it is obvious that ***E*** is the most significant factor for middle and upper graders and the effect of ***T*** increases from lower to middle to upper grades.

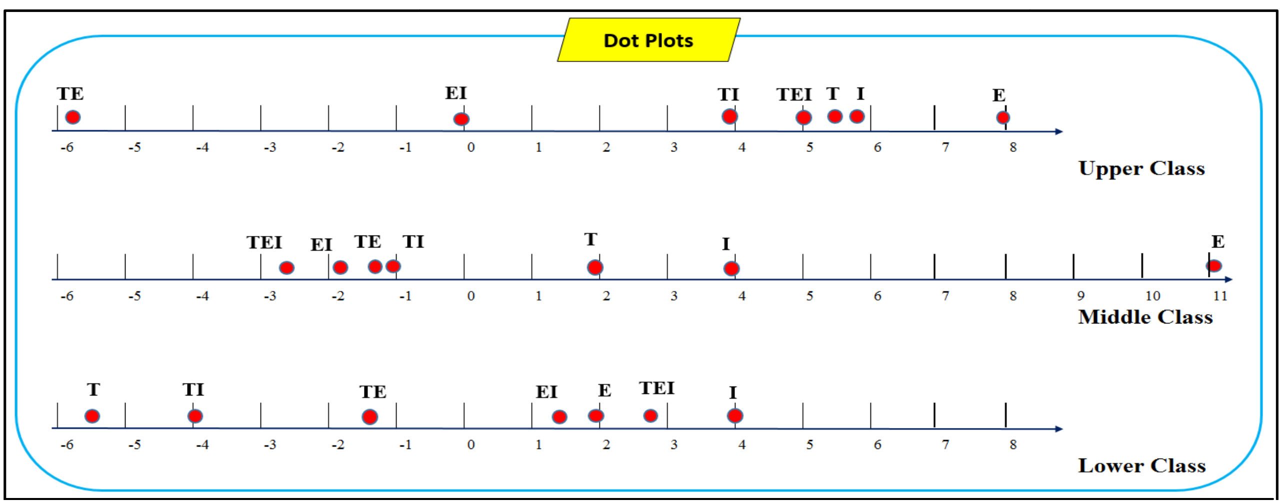



*Figure 6: Dot plots for effects of individual factors and their interactions for the three groups* gr different groups

**5. Conclusion**

Parents' education level (***E***)is the most significant factor that positively affects the mean tests score (***S***) while the effect of tuition hours(***T***) is surprisingly minimal. Family income (***I***) is somewhat significant whereas the interaction between ***T*** and ***E*** has a negative impact on ***S***.The linear relationship between ***T***, ***E*** and ***I*** each to ***S*** is quite weakand the strongest among them is found to be ***E***.

The calculated effect of ***T*** that changes from negative to positive to higher positive for lower, medium to upper grades reveals that more tuition hours after school is beneficial only to upper graders but has a detrimental effect to lower grades students.In fact, ***T*** contributes no more than 3% of the variations in ***S***.

Students from families with low level of ***T***, ***E*** and ***I*** obtained the lowest ***S*** for all grades. This demonstrates a disadvantage faced by some students who come from families with both parents having low level of education, earning low income and, for some reasons, not attending tuition classes after school.

**6. Discussion**

Mathematics education is currently swirled in controversy over whether a cognitive or a practice approach should be followed (Stevenson, Hofer & Rabdel, 1999). Some proponents of the cognitive approach argue against memorization and practice in teaching mathematics. They emphasize a constructivist approach to mathematical problem solving. Others assume that speed and automaticity are fundamental to effective mathematics achievement and emphasize that such skills can be acquired only through practice. In recent years, the constructivist approach has become increasingly popular. In this approach, effective instruction focuses on involving children in solving a problem or developing a concept, and in exploring the efficiency of alternative solutions(Santrock, 2001). We are obviously talking about elementary and secondary levels mathematics education here since teaching mathematics at tertiary level and beyond is of a different dimension.

There is no right or wrong in choosing a teaching method, be it sciences or mathematics or arts. Apart from the teacher's individual capabilities and preferences, the more suitable approach in teaching mathematics is largely depends on the education system. As mentioned earlier, in many Asian countries including Malaysia, students are assessed mainly through structured tests and examinations and many of these tests consist of multiple choice questions. Therefore, getting the correct answer is of utmost import in order to do well in these tests and examinations. Hence, I opine that, the "practice approach" is more suitable for examination-based education system. Since the syllabus remains unchanged year after year and there are not much variations on the examination questions on those fixed topics, a tremendous amount of practice in solving examination questions does indeed help the student to excel in terms of test scores. The logic is simple. If one practices a certain thing day after day over a year, that person is highly likely to achieve speed and accuracy in doing that thing. I believe this is what tuition classes aim to do.

Most tuition classes consist of three parts:

- (i) Explanation – The tuition teacher explains the theory again to reinforce what the student learnt in regular school classes.
- (ii) Practice – A large amount of examination-style questions including many past-year examination questions with solution are supplied to the students with the believe that the student would acquire speed and accuracy through practice.
- (iii) Tips –Advises on some techniques on how to score high, or even some forecast examination questions are given to students.

With an education system that emphasizes more on test scores rather than understanding and other soft skills, parts (ii) and (iii) above are central theme for tuition classes.

I do not intend to play down the constructivist approach to mathematics and science problem solving. In fact, when I teach engineering and mathematics at tertiary level, I always emphasize on understanding the meaning of the equations and why we take the steps that we do. However, I am teaching in American University Program which is a couple of worlds different from the Malaysian elementary education system.

When I was a high school student in Malaysia back in the 1980s, we have to perform laboratory works for physics, biology and chemistry on a weekly basis. However, I came to know that the laboratory work for these subjects has been reduced alarmingly in recent years. I understand that, in many western countries, many science teachers help their students to construct their knowledge of science with an emphasis on discovery and hands-on laboratory investigation. Constructivist teaching emphasizes that children have to build their own scientific knowledge and understanding. At each step-in science learning, they need to interpret new knowledge in the context of what they already understand. Some critics argue that such constructionist approaches give too much attention to inquiry skills and not enough to discipline-specific information (American Association for the Advancement of Science, 1993). Again, I personally believe that the best approach in teaching science and mathematics depends on the country's overall education system which dictate the expectation of a student. I also believe tuition classes are less capable or less suitable of constructivist teaching.

As for memory-intensive subjects such as history and geography, I suppose tuition classes could provide some helps due to the fact that people generally could remember more if repeatedly been told the same thing over and over again. Remember, we are talking about elementary level education in which the reason of action of some historical characters or the technical details of global warming are not involved.

I am not sure of the validity of this statement but I do believe that arts and music are subjects that require inherent capabilities, at least to some extent. I do not think Elbert Einstein could play the piano well nor paint a masterpiece no matter how many hours you spend teaching him just that even though he was a genius in science and mathematics. Therefore, as far as I know, there is no tuition classes offered for these subjects. Children who show interests in these fields would attend special classes for a different purpose.

Talking about languages, few people would dispute that, in order to be good at any, one has to practice the following four things: read a lot, write often, listen frequently and speak regularly. It is difficult to imagine one could master a language without doing these four things. Tuition classes, to a certain degree, could provide extra opportunities for the youngsters to practice these outsides of school time.

The predominant goal of education should be gaining knowledge, learning skills and attaining wisdom rather than passing examination alone. Thus, it is necessary and crucial for the authority to transform our education system moving away from over-emphasis on examination result, thus influencing parents to do like-wise. Educators of young souls should be duly trained and confidently empowered to assess the academic achievement of students using their professional judgement and appropriate techniques rather than rely solely on structured examination. Of course, this is easier said than done due to various reasons ranging from government policy to teachers' quality.

## 7. Further Research

I do understand that the data gathered here is highly localized and less than sufficient in terms of number due to the lack of budget and infrastructure support. Nevertheless,I am confident that, based on the collected data, the analysis done is correct and the conclusion drawn is valid. With considerable monetary and manpower support, perhaps with authority backing as well, similar research along this line with an expanded scope should be an interesting and rewarding project.

**APPENDIX**

Formula for regression coefficient

$$b = \frac{n(\sum XY) - (\sum X)(\sum Y)}{n(\sum X^2) - (\sum X)^2}$$

Formula for Product Moment Coefficient of Correlation

$$r = \frac{n(\sum XY) - (\sum X)(\sum Y)}{\sqrt{[n(\sum X^2) - (\sum X)^2][n(\sum Y^2) - (\sum Y)^2]}}$$

Formula for Coefficient of Determination

$$r^2 = \frac{Total\ variation - Unexplained\ variation}{Total\ variation} = \frac{\sum(Y-\overline{Y})^2 - \sum(Y-Y')^2}{\sum(Y-\overline{Y})^2}$$

## 8. Acknowledgement

I would like to express my sincere appreciation to Miss YinPeng Shak, the principle of the elementary school in Kuala Lumpur where this data was obtained and her deputy, Miss GeatNoay Chia, who assisted me in data collection.I am also grateful to the teachers in all 42 classes who helped me to distribute, explain and collect the questionnaires.

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