Temporal geospatial analysis of secondary school students’ examination performance

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Abstract. Malaysia’s Ministry of Education has improved the organization of the data to have the geographical information system (GIS) school database. However, no further analysis is done using geospatial analysis tool. Mapping has emerged as a communication tool and becomes effective way to publish the digital and statistical data such as school performance results. The objective of this study is to analyse secondary school student performance of science and mathematics scores of the Sijil Pelajaran Malaysia Examination result in the year 2010 to 2014 for the Kelantan’s state schools with the aid of GIS software and geospatial analysis. The school performance according to school grade point average (GPA) from Grade A to Grade G were interpolated and mapped and query analysis using geospatial tools able to be done. This study will be beneficial to the education sector to analyse student performance not only in Kelantan but to the whole Malaysia and this will be a good method to publish in map towards better planning and decision making to prepare young Malaysians for the challenges of education system and performance.

1. Introduction
Education plays an important role in human capital development and is associated with prosperity and individual opportunity for a better life [1]. In order to achieve better student performance, the authority related to education sector realizes that high students’ quality are needed to lead the country in the future. Unfortunately, quality is not easy to measure and define because of the complicated process increases due to different opinion of the interested parties with respect to individual quality attributes [2]. For example, the leader of the economic world, USA realizes that the importance of quality jobs depend directly on the ability of the education system that emphasizes producing of an excellent student in science and mathematics to join the industries. In addition, teaching and learning styles of mathematics and science should be improvised and become a priority to the education policy making agenda [3]. For that reason, this study focuses on the science and mathematics subjects to analyze secondary school performance with the aid of geospatial techniques. In mapping perspective, Malaysia Ministry of Education has improved the organization of the data to have the geospatial school database format. However, no further studied was done and the student performance results were not properly presented in graphical manners. The map has acted as a communication tool is not useful when the data are not published in the right way using the appropriate analysis data tool. To date, the portal of Ministry Malaysia Education is less efficient in presenting school performance information.

Sijil Pelajaran Malaysia (SPM) is a national examination organized by the Malaysian Examinations Board for student taken normally when their age is at 17 years old. SPM is a compulsory certificate for student to further the study to the next step level. Students would have a choice whether they want to continue the study to university, matriculation, overseas university, polytechnic, college or continue to take the STPM examination depend on the examination result they have. The analysis of school performance is not new and the researcher efforts to determine associations between school
performance and catchment area was done by [4]. The study utilizing statistical techniques of Geographically Weighted Regression (GWR) to determine the spatial variation of the Mathematics school performance [5] was done.

The aim of this study is to find the potential used of geospatial techniques for school student examination performance in science and mathematics score in the year 2010 to 2014. The objectives of this study are to analyse school student performance of science and mathematics subject score for the SPM examination result using geospatial techniques and to produce GPA scoring map for these subjects from the year 2010 to 2014.

2. Methods and Materials

2.1. Area of study

The Kelantan state was chosen as a study area. The data involved GIS layers such as the boundary of Kelantan state and territories, school data (shape format) which provided by the Cartography Section of the Malaysia Survey and Mapping Department (JUPEM) and the SPM examination result (excel and .doc format) derived from the Department of Kelantan Education. All the GIS layer data use the Kertau Rectified Skew Orthomorphic (RSO) coordinate system. Only two SPM’s subjects’ performance which is the Science and Mathematics Grade Point Average (GPA) score were used for further analysis in this study. Figure 1 shows the study area of Kelantan includes the territory of Tumpat, Kota Bharu, Pasir Mas, Bachok, Pasir Puteh, Tanah Merah, Machang, Jeli, Kuala Krai and Gua Musang with the schools location point.

Figure 1. Study area of Kelantan and the location of schools

Table 1 shows the subject Grade System that has been used by the Malaysia Ministry of Education since 2009. The grade value is used as a reference for the analysis of Mathematics and Science subjects.
Table 1. SPM Grades System

| Grades | Grade Value | Interpretations       |
|--------|-------------|-----------------------|
| A+     | 0           | Super Distinction     |
| A      | 1           | High Distinction      |
| A-     | 2           | Distinction           |
| B+     | 3           | Super Credit          |
| B      | 4           | High Credit           |
| C+     | 5           | Upper Credit          |
| C      | 6           | Credit                |
| D      | 7           | Upper Pass            |
| E      | 8           | Pass                  |
| G      | 9           | Fail                  |

There are three category data in this study, first is the Science and Mathematics which are in word and excel format, second is the school point location in the ArcGIS format of shape and third is the softcopy base map data. The attribute data contains the name of school and the Grade Point Average (GPA) data. The GPA range value divided into 1 to 9 according to SPM system Grade. The relational database concept was used to relate and join excel and shape format. This study utilizing the inverse distance weighted (IDW) as an interpolation method to map the trend surface of Grade Point Average (GPA) of Science and Mathematics as a variable of this project. The IDW method is based on the supposition that the neighbouring point contributes more interpolation than the farther one. The IDW method states that impact of known data point is inversely proportion to the distance from unknown to know data point [6].

3. Result and discussion

3.1. Geospatial science and mathematics scoring performance pattern distribution analysis

The IDW interpolation method is used to derive spatial distribution patterns of SPM school performance for the years 2010 to 2014 from the GPA score data. Figure 2 and Figure 3 show the results for the spatial distribution of the Science and Mathematics GPA score for the year 2010 to 2014 in Kelantan state. The result indicated interesting trends of GPA for the Kelantan schools. The IDW interpolation map of GPA for the Mathematics score consist of nine (9) GPA values as proposed by the Malaysia Ministry of Education grade system (Table 1) known as a GPA value of 0 – 2 for the grades of A+ to A-, 2-4 for the grades of A- to B, 4-6 for the grades of B to C and 6-8 for the grades of C to G.

Overall, the result indicated that a high number of students achieved the super and high distinction for the grade value 0-2 consist of A+, A, A- for both subject in year 2010 to 2014 in the Kota Bharu territory. The Kota Bharu is the capital state of Kelantan which has the 48 out of 144 selected schools comprising boarding school, excellent regular school and also some of satisfactory regular school. However, in the year 2014 the results of GPA show declining trend when the GPA color for top score performance is reduced obviously for Science subject. Furthermore, the spatial distribution map also indicated that many territories in the Kelantan state have achieved top score and also super credit (B+) and high credit (B) for student performance as shown by the Pasir Mas, Pasir Puteh, Bachok, Tanah Merah, Machang and Tumpat. From the generated spatial distribution map the Jeli territory has resulted the highest GPA score as compared to the others territory for the science and mathematics SPM examination results. This is because the Jeli territory has the lowest number of schools located only five (5) primary schools with one school of science category school, thus make the result dominated by high performance color category (Figures 2 and 3). The Gua Musang territory presented the lowest GPA performance result with upper credit (C+), credit (C), upper pass (D) and pass (E) for both SPM subjects.
Figure 2. The trend of Grade Point Average for Mathematics Score in the years 2010 to 2014
Figure 3. The trend of Grade Point Average for Science Score in the years 2010 to 2014.
Meanwhile, for the SPM 2014 GPA result, [7] stated that the result shows decline in several attainment, but it still on acceptable GPA and not significantly different from the previous three (3) years prior to 2013. The results can be considered as satisfactory results for candidates who sat for SPM 2014.

4. Conclusion
The used of GIS in education analysis particularly on Science and Mathematics score from the years of 2010 to 2014 is successfully done to achieve the objective of this study. The use of the IDW tool of interpolation is a highly potential approach to produce spatial distribution patterns of school’s performance trend. Regarding the student performance result, the result indicated that in the overall, the Kelantan has good school performance of the SPM examination from 2010 to 2015 for every territory except for the Gua Musang with average to low performance result. This study able to provide effective ways of interpreting school performance results statistically and graphically not only to education management policy makers, but also benefited to school teachers as well as parents.

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