Road traffic engineering application in mathematics information technology

Mohd Sazali Khalida,*, Tan Lai Waib and Tutut Herawanc

Department of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia
Department of Civil and Environmental Engineering, Universiti Tun Hussein Onn Malaysia
Department of Computer System and Software Engineering, University Malaysia Pahang

Abstract

Globally mathematics is a challenging subject. However, some parties wanted mathematics to be learnt using IT in a Diploma Information Technology program in UTHM Johor for example. The objective of this paper is to prove whether mathematics IT used in a road traffic engineering case study could help the students’ understanding. Methodology used was quantitative as data on traffic flow was collected. There is a 0.58 Pearson correlation between the speed of cars with fatal accident cases and the marks from Mathematics final semester paper had improved besides the overall improvement to safer road traffic around Parit Raja vicinity.

Keywords: Case study; collaborative learning; data analysis; diploma IT mathematics; pearson correlation; quantitative method; traffic flow

1. Introduction

Mathematics is an interesting subject when most kids learnt counting using fingers. However at the end of their secondary education some of them failed at mathematics miserably. This trend happens because mathematics needs higher ordered skills consuming both cognitive and meta cognitive skills. After passing the Malaysia Certificate of Education (GCSE ‘O’ Levels), many students entered tertiary institutions such as polytechnics MOHE, private colleges, and government institute of higher learning, enrolling in semi professional courses at certificate or diploma levels. Then they applied into the four Malaysian Technical Universities Network (MTUN), i.e. Universiti Tun Hussein Onn Malaysia (UTHM) in Batu Pahat, Universiti Teknikal Malaysia (UTeM), Malacca, Universiti Malaysia Pahang (UMP), Kuantan, and Universiti Malaysia Perlis (UniMAP), Perlis. The certificate holders from polytechnics MOHE, for example, enrolled into the diploma programs while the diploma holders enrolled into the degree programs. One of the popular diploma courses in UTHM is the Diploma in Information Technology (DIT), which is a

* Corresponding author. Tel.: +6-012-7977-843; fax: +6-07-4536-337
E-mail address: hjsazali@uthm.edu.my
3-year program including a four months’ industrial attachment. This program has a subject called Mathematics Information Technology which was introduced since most first year students are IT literate. There are two papers in this subject, i.e. Mathematics IT1 and Mathematics IT2 running in two semesters in the first year. These subjects are conducted in the lecture theatre for theories and in the laboratories for a practical. The theories cover the essence of Discrete Mathematics and Calculus in Semester 1, and Basic and Inferential Statistics in Semester 2. The practical is focused on using the traffic flow data along Batu Pahat–Parit Raja–Kluang route, which is considered as one of the most fatal roads in Peninsular Malaysia. The objective of this paper is to determine how the Mathematics IT course contributes to the understanding of mathematics and statistics among the diploma students and could the students’ final report influence the relevant authorities on the safety aspects along the dangerous route. Can the students learn mathematics IT effectively? This will be discussed in this paper.

2. Related Issues

Our former premier Tun Dr. Mahathir Mohamed launched Multimedia Super Corridor in the year 2000. This paved the way for the demand in high skilled IT workers through the establishment of Malaysian smart schools in 2005 and the adoption of English as the medium of instruction for science and mathematics across the schools and tertiary institutions - in PPSMI. The models Tun Mahathir were referring to are the Indians IT workers who collaboratively and successfully took open source contracts from USA and Europe. As such smart and cluster schools were established but they can function effectively if the teachers themselves are motivated. Many ICT schools rely heavily on the attitude and perception of the teachers themselves [1]. The integration of ICT in teaching and learning processes was low although the implementation of the smart school project was already in its sixth year, evidenced by its mediocre density and low frequency of use [2]. It was found that two-thirds of the estimated 50 per cent users implemented teaching and learning ICT only once or twice a semester. Less than 20 percent implemented ICT lessons weekly. Most informants admitted they were weak in ICT skills and need collaborative learning environment to work. Attitudes are built-in characteristics of teachers who are willing to do some extra work when many others have stopped doing due to perception. Examples consulting [3,4,5,6,7,8] in applying projects within a mathematics course in a university should be thoroughly done in designing related and relevant projects.

Currently there is a serious research in locating the gap between the teaching of numbers in primary schools and algebra being taught in the lower secondary schools in Israel and Europe [9] and mathematical difficulties arising from language problems in arithmetic and algebra learning among post SPM students in Malaysia [10]. It seems that no consensus has yet been reached that can make the transition of learning mathematics on ICT be a successful one. Perhaps by introducing interesting games like what [11] in England and [12,13] did in a polytechnic in Malaysia MOHE on algebraic learning could make mathematics more interesting among the students who are much more IT literate than their teachers. Now ICT are used as remedial work among freshmen [14] and this reduced teachers’ burden where they can focus on research in mathematics and sciences. This is a serious issue considering the amount of ICT investment made by the government. Can we introduce important social issues to create more interest to remedy the students’ general weakness in mathematics? To do this we created road traffic engineering case study in a subject called Mathematics IT to study why the route from Batu Pahat to Kluang is dangerous and what should the relevant authorities do to save the students’ lives who had come from all over Malaysia to study here.

3. Methodology

The approach of conducting studies based on the real data is known as a case study. Dealing with the real case this can test the students’ knowledge learned in the lecture theatre and also improve their cognitive and human soft skills. The following data collection was done by two batches of students 2008/09 and 2009/10 intakes taking Mathematics IT 2 in semester 2 only. The sample was 75 where the female students dominated the males.

Students were divided into groups consisting of a maximum of five members per group and they were asked to collaborate with their team members. Among the observation tasks which were delegated among the group members were on-site collection of traffic flow data for all types of vehicles, collection of road accident statistics from the Batu Pahat and Parit Raja Police Departments, frequency of ambulance trips due to emergency cases of the Batu Pahat General Hospital, and details on construction works carried out on the Federal Route 50 from the Batu Pahat Public Works Department.
Students were expected to present an official letter obtained from the Faculty. The identification letter will ease in the process of obtaining data. The processes of data collection from related agencies created the sense of responsibility and commitment as well as improved communication skill among the participating students as expected from a collaborative learning environment.

Table 1 gives the frequency of the Batu Pahat General Hospital ambulance trip due to all types of emergency cases including road accident casualties in the months of February to May, 2007. On average, there was almost one ambulance trip per day. This data guided the work of observation by new students cohort 2008/09 and 2009/2010.

Table 1. Ambulance Trip Frequency of the Batu Pahat General Hospital in the Months of Feb To May 2007

| Item | Feb | Mar | Apr | May |
|------|-----|-----|-----|-----|
| Frequency | 20  | 25  | 24  | 30  |

In order to understand the road accidents situation better, traffic observations were made within the 10 km radius from UTHM main campus along the Federal Route 50. The approximate speed of each vehicle was recorded at three observation stations, i.e. under the overpasses at Station No. 1: Sri Gading, Station No. 2: Parit Jelutong, and Station No. 3: Parit Raja town centre. There were more than one group of observers (comprise of students) stationed at each station so as to cross-validate each group observations. Photos were taken to describe the traffic situations during observation (Fig. 4). Every week, each group was expected to present their findings and report any pressing issue to the course facilitator.

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Through interviews with the police and hospital personnel, it was found that the critical hours were between 06:30 to 08:30, 16:30 to 18:30, and 21:00 to 00:00 hours. The hours between 06:30 to 08:30 were the time when road users travelled to work or schools. Meanwhile, the time between 16:30 to 18:30 was the time when road users were returning home. Due to student learning time constraint, the observations were carried out only between 07:00 to 10:00 hour. The method used to approximate the speed of vehicles was to measure the time needed for a vehicle to travel through a predetermined distance, i.e. a 100 m distance. The speeds were then classified into four classes, i.e. slow: < 50 km/hour, moderate: 51 km/hour to 70 km/hour, fast: 71 km/hour to 90 km/hour and dangerously fast: > 90 km/hour. Table 2 shows the observation which was made from February 1 to 28 2009 on the traffic flow corresponding to the vehicle speed. It should be noted that the data collected may be exposed to human errors during the time of measurement.
Table 2. Frequency of Vehicles Corresponding to Speed Observed on Wednesdays In February 2009

| Observation station | Speed Category | Feb 4 | Feb 11 | Feb 18 | Feb 25 |
|---------------------|----------------|------|-------|-------|-------|
| No. 1               | Slow           | 106  | 79    | 56    | 89    |
|                     | Moderate       | 56   | 8     | 29    | 40    |
|                     | Fast           | 50   | 10    | 2     | 5     |
|                     | Very fast      | 16   | 12    | 4     | 5     |
|                     | Total          | 228  | 109   | 91    | 139   |
| No. 2               | Slow           | 94   | 70    | 78    | 73    |
|                     | Moderate       | 86   | 17    | 21    | 50    |
|                     | Fast           | 25   | 9     | 8     | 4     |
|                     | Very fast      | 15   | 11    | 2     | 1     |
|                     | Total          | 220  | 107   | 109   | 128   |
| No. 3               | Slow           | 48   | 80    | 108   | 29    |
|                     | Moderate       | 109  | 5     | 87    | 29    |
|                     | Fast           | 20   | 10    | 5     | 20    |
|                     | Very fast      | 24   | 9     | 1     | 25    |
|                     | Total          | 201  | 104   | 201   | 156   |

Table 2 shows that on February 25, 2009, as much as 16% of the road users were driving dangerously in the bustling town of Parit Raja. The threshold speed value used to determine the dangerous speed is 90 km/hour.

Descriptive statistics was applied on road traffic observations carried out on Wednesdays for four consecutive weeks. The students were exposed to how the mean, median and standard deviation of a sample were obtained, and research techniques, beforehand. Computer programs such as the Excel spreadsheet and the Statistical Package for the Social Sciences (SPSS Version 9.0) were employed in the analysis.

The hypotheses of this research project are:

H0: There is no correlation between the numbers of road accident fatality with driving speed; and
H1: There is a correlation between the numbers of road accident fatality with driving speed.

4. Results and Discussions

4.1 Vehicle Speed - Road Fatality Correlation

The Pearson's correlation was used to determine the relationship between vehicle speed and road fatality. Table 3 shows one set of data which was used to determine the correlation.

Table 3. Vehicle Speed and Number of Fatalities Between February 2008 and June 2009

| Period     | Vehicle speed | Number of fatalities |
|------------|---------------|----------------------|
|            | High          | Medium | Low    |                  |
| Feb 2008   | 24            | 60     | 48     | 10                |
| Mar 2008   | 21            | 89     | 50     | 16                |
| Apr 2008   | 30            | 124    | 64     | 20                |
Based on Table 3, the correlation was 0.582, which shows that the number of fatalities does depend on the speed of vehicles. Thus null hypothesis was rejected. Higher vehicle speed does lead to larger number of casualties.

4.2 Causes and Accident-Prone Spots Along Federal Route 50

Apart from the vehicle speed, information such as the age of drivers and the origin of the vehicles (type of road users) also were also obtained and recorded. These will provide information to determine whether age and familiarity of an area do play any role in contributing to the number of accident cases.

A public university (UTHM), a college (Kolej Kemahiran Tinggi MARA), a teacher's college institute (Institut Perguruan Tun Hussein Onn), a nursing college (Kolej Jururawat Masyarakat Batu Pahat), and more than five primary and secondary schools are situated along Federal Route 50. Population of students is estimated to be more than 10,000 and there are a number of traffic accidents that involve students. A correlation analysis was carried out to determine whether there exists any relationship between the age of road accident victims and the number of road casualty. The correlation was 0.23. This shows that there is a fairly weak correlation between the number of road accident with the age of victim along Federal Route 50.

Meanwhile, Table 4 shows the type of road users and vehicles involved in the road accidents with the time of incidents and the causes reported. It is assumed that all the vehicles bearing registration plate beginning with the letter ‘J’ belong to the locals while plates other than ‘J’ are categorized as outsiders.

| Type of road user | Mode of transport | Time      | Cause of accidents                                      |
|------------------|------------------|-----------|---------------------------------------------------------|
| Locals           | Motorcycles      | Morning   | Light visibility                                        |
| Students         | Motorcycles      | Morning   | Infrastructure                                           |
|                  |                  |           | Infrastructure, driving habit, and poor navigation of Parit Raja |
| Outsiders        | Cars             | Afternoon | traffic condition and direction                         |

The road accidents data obtained from the Batu Pahat police traffic division also provide information on the locations of the accidents. The Federal Route 50 from Kluang to Batu Pahat is divided into 39 sections, with Section no. 1 located in Batu Pahat, Sections no. 23 and 24 in the vicinity of UTHM campus, and Section no. 39 in Kluang. The number of accidents are computed for three main locations, which are the Batu Pahat, Parit Raja (including Sri Gading), and Kluang. For the last three years i.e. 2007 to 2009, Fig. 2 shows that the town of Batu Pahat is more prone to accidents compared to Parit Raja town and Kluang. Higher traffic flow in Batu Pahat might have contributed to the higher incidents of road accidents.
The number of fatalities due to road accidents, expressed in terms of percentage relative to the total number of road accidents at each location is shown in Figure 3 for the three respective years.

Figure 3 shows in 2009, although Kluang area has lower number of recorded road accidents than both Parit Raja and Batu Pahat, the road accidents are relatively more fatal. This may be because of a much drastic and higher speed taken by motorists once they had passed the town of Parit Raja and they were travelling towards Air Hitam, Plus Highway and Kluang.

From the academic point of view, the benefits obtained by the students were firstly, their average grade score in Test 1 and final semester paper for the subject Mathematics IT2 had improved tremendously by one grade i.e., from low grade ‘C’ towards a medium grade ‘B’. Few students from each cohort got grade ‘A’. Secondly, their soft skills in expressing their opinions improved and most importantly, their arguments shown in their weekly presentations where they used their statistical understandings were quite impressive as they could relate to data capture along the Federal 50 highway. This resulted in an overall positive consequence from a successful collaborative learning environment depicted in Mathematics IT 2 subject.

5. Conclusion

This paper has discussed the importance of Mathematics IT course introduced to first-year students of Fakulti Sains Komputer dan Teknologi Maklumat, UTHM. As part of its syllabus, practical was incorporated to complement theories. One of the case studies was studying road accident statistics in Parit Raja, Johor to determine the causes. Throughout their data collection it was observed that many students were very keen in participating in team discussion followed by more focused questions and this led them to numerous visits to important government offices.
and departments in Batu Pahat and Kluang. Their nagging for data and interviews with the government departments related to road accidents along Federal Route 50 since year 2008 could somehow trigger many heads of villages and decision makers such as the Sri Gading Member of Parliament on solving the fatal issue. Fig. 4 concludes the upgrade works which are being done to improve the existing road within the vicinity of UTHM in year 2010 - 2011.

Figure 4. The main access road to UTHM and Kolej Kemahiran Tinggi MARA are being upgraded on 22 August 2011

From the findings of this Mathematics in Information Technology’s project, it is concluded that the number of road users and their speed along Federal Route 50 are closely related while the age of the road users is not directly correlated to road accidents. The results agree with the findings by [3,4]. Moreover, the course has helped students to appreciate the collaborative learning processes as recommended in [12,13]. The contribution of this paper was by introducing an local issue of high number of road accidents, it has created more interest within the students to learn and improve their mathematics understandings as spelt out in the aim and objectives of Diploma Mathematics IT course here.

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Note:
Diploma Mathematics IT subjects were transferred to Centre for Diploma Study (CDS) in 2010. This was the time all diploma courses were completely managed by CDS, UTHM.