Outcomes of Integrating Total Station and Surfer8 Software in Survey Practice Laboratory

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Abstract: At KLE Technological University, Surveying is a core 4 credit course for undergraduate civil engineering students, where a lecture-only mode of delivery is provided for 160 students in III semester. The curriculum was set to refine for up-to-date technology and to contribute for the enhancement of students acquiring industry-based skills. As a part of curriculum, the objective is to provide significant amount of hands-on training on Total Station and Surfer8 software to obtain adequate learning outcomes. This is achieved through laboratory courses like Survey Practice I in III semester and Survey Practice II in IV semester. In order to achieve these objectives, the students of semester IV were introduced with the equipment 'Total Station' which they used to carry out the open ended experiment in Survey Practice II laboratory course. This activity was implemented successfully for the first time in curriculum for the semester IV students. Total Station is a real-time system embedded with an onboard computer used for displaying and storing the data. The open ended experiment was divided into three tasks; traversing civil engineering department area, performing profile leveling using total station and mapping using the software Surfer8. This activity was scheduled for three weeks; data collection (first week), hands-on software training (second week) and report submission and assessment using rubrics (third week). The objectives of the activity were measured using three parameters. As per the assessment, the attainment of parameters data collection and documentation is 82.45% and 80.91%, whereas the attainment of the parameter analysis using software is comparatively less which is 75.67%.

Keywords: mapping, open-ended experiment, surfer8, surveying, total station

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1. Introduction

The advance in the field of technology has permeated society over the past decade and more, those advances have been especially rapid with surveying technology. During the past few decades conventional methods such as chain, compass, levels and theodolite were used for measurements in the field [1]. Whereas the latest incarnation has led to improve the conventional instruments and Total station was developed. The Total Station measures the angles and distances, also store measurements which can be retrieved to a computer for mapping and perform quantity calculations. Total Stations are also useful in obtaining accurate locations of datum points in engineering survey by means of efficient way. It is necessary to understand the basic principles of working with total station and the way it affects working practices [2]. Total Stations are more expensive compared to traditional measuring tools, such as optical theodolite and plane tables with alidades, but in return they offer considerably more accuracy and flexibility. Its rapid and precise measurement gives a reliable framework for survey work of many kinds. To obtain accurate results and avoid systematic errors, however, the Total Station must be set up correctly by the user [3]. On a Total Station the angles and distance to surveyed points are recorded digitally and in this way the Total Station locates each point measured relative to it. As the data is stored in the memory, it can be transferred to a computer with software designed to calculate the x, y and z coordinates of each point and the data can be presented in a 2-dimensional (2-D) or 3- dimensional (3-D) drawing [4][5].

Implementing mapping programme using Surfer8 software, the students were taught how total station data can be manipulated to create digital maps that show the existing terrain in different configurations and views. A particular process is involved in transforming the data into an exact mapping format which is related with the specific total station software platforms. Once the data have been retrieved from the instrument, it is usually possible to

export them from the instruments software package into a text file that can be read by standard spreadsheet applications, such as Microsoft excel or can be imported directly into a mapping software package.

The students learning outcomes after performing open ended experiment are presented below:

- Collection of traversing data using total station.
- Transfer the collected data on to a computer.
- Analyze the data using surveying software.
- Create mapping of terrain for collected data using Surfer8 software.

In [6] the authors present how to operate and manage surveying instruments such as theodolite and total station. The appropriate procedure with respect to theoretical and practical point of view is adopted to achieve more accuracy. A case study was carried out on urban planning making use of total station, geodetic GPS receivers and GPS navigators. The applied surveying techniques showed high efficiency regarding cost and effort, while saving observation time reaching to 80%. Therefore, for all the civil sites the practical application adopted proved to be valuable.

In [7] the authors discuss the use of appropriate procedure to carry out the fundamental measurements such as horizontal angle, vertical angle and slope distance. The methodology involves orienting the total station to north and making measurements. The errors were observed and double centering technique was adopted to remove errors. Make observations from both ends of a line, to eliminate curvature and refraction errors and applying atmospheric corrections to obtain correct distances from an EDM. To make students familiar with the operation of the instrument simple exercise were outlined which enable students to use instrument more efficiently.

This paper intent to discuss the pedagogical aspects of designing, teaching and assessing the open ended experiment using total station in survey practice laboratory. In this study an effort is made to maximize the use of Total station equipment and Surfer8 software. Open ended experiment is designed to enhance the knowledge and skills among students and teach how to use the modern equipment and its applications in the field. Survey practice II course content are presented and discussed in section II. Implementation and results are presented in section III. Feedback from students is also discussed.

2. Methodology

During Surveying is a core 4 credit course which comprises of both theory and practice for undergraduate civil engineering students, where a lecture-only mode of delivery is used for 160 students in III semester. As a part of curriculum, significant amount of hands – on training is required to obtain adequate learning outcomes. Students are provided with hands – on training through laboratory courses such as Survey Practice I in III semester and Survey Practice II in IV semester. In survey practice II laboratory the students perform three demonstration experiments, eight exercise experiments and one open ended experiment. The list of demonstration, exercise, and open ended experiment is tabulated in Table I.

Table 1. List of experiments in survey practice II course

Sl. No.	Experiments
1	Measurement of horizontal angles with method of repetition and reiteration using theodolite. Measurement of vertical angles using theodolite.
2	To determine the elevation of an object using single plane method when base is accessible and inaccessible.
3	To determine the distance and difference in elevation between two inaccessible points using double plane method.
4	To determine the tachometric constants a) Using horizontal line of sight. b) Inclined line of sight.
5	To set out simple curves using linear methods perpendicular offsets from long chord.
6	To set out simple curves using linear methods by offsets from chords produced.
7	To set out simple curves using Rankine's deflection angles method.
8	To set out compound curve with angular methods with suing theodolite only
9	To set out reverse curve between two parallel line with angular methods with using theodolite only.
10	To determine height of a remote object, horizontal distance and coordinates of points using Total Station Instruments
11	Introduction to GPS
12	To collect various surveying data using Total station and transfer the data to a computer and analyze it and build models using surveying Software.
13	By using the total station find the longitudinal and cross section of the roads or canals and determine the volume of earthwork

The students perform measurements of horizontal angle, vertical angle and elevations using theodolite and Total station in demonstration experiments. The co ordinate measurements are done using Total station and setting out of curves is executed using theodolite in exercise experiments. The students were allotted with three weeks of time to conduct the demonstration experiments, eight weeks to conduct exercise experiments ant two weeks to

conduct open ended experiment. The learning outcomes of demonstration and exercise experiments serve as the pre requisites for conducting the open ended experiment.

3. Implementation and Results

The open ended experiment was divided into three tasks; the first task was to 'Traversing Civil Engineering Department area' and the second task was 'Performing profile leveling using total station'. The third task was to plot mapping using the data obtained from task one and two using the software Surfer 8. The open ended experiment was scheduled for a period three weeks. First week was utilized for data collection, second week focused on hands-on training of the software and third week had report submission and assessment of the open ended experiment. Data collection was done for two days, where eighty students performed tasks one and two each day in a team comprising of fifteen members. The hands-on tutorial was on Surfer 8 software which was used for mapping, where the students were taught to plot the layout of Civil Engineering Department, Contour map, 3D-Map, Longitudinal section & Cross section for road layout. The outcome of the mapping resulted in computation of earth work quantity.

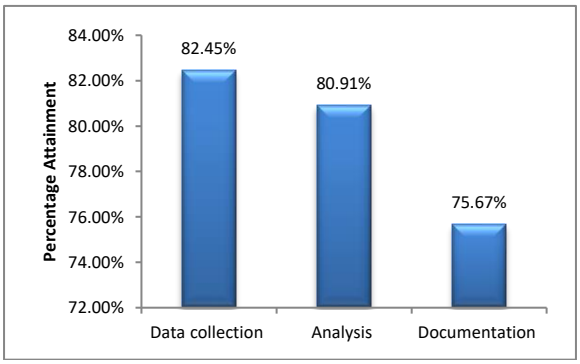

Fig. 1 Percentage Attainment of different parameters

The students have submitted the Engineering document as a team and the students were assessed for 30 marks using rubrics as shown in table II of Appendix A. The percentage attainment of the three different parameters (Data collection, Analysis and Documentation) is shown in Figure 1. The attainment of the parameters data collection and analysis is comparatively higher as most of the team collected the data with minimum error and the teams were able to analyze the data in the software. However, the attainment of the parameter documentation is lower in comparison with the other two parameters as the students have put less effort in preparing the report. The common errors in the submitted document are misalignment of the text, improper font & font size, discontinuity in the flow. There is a scope for improvement in this parameter.

4. Discussion

For this open ended experiment students said Total station equipment is more efficient in comparison with Theodolite. Most of the students said the total station is simple to operate, and retrieving the data from total station and mapping in software is not a lengthy task. A very large number of students have agreed that they have achieved all the stated learning outcomes of this open ended experiment. The students believed that working in a team has enhanced their learning. Relating the open ended experiment to the real world scenario was experienced by most of the students. The students are now comfortable in handling and operating the total station equipment individually. Overall the students concluded that the open ended experiment has been a great learning experience and their learning's have enhanced. The questionnaire was prepared and conducted online through Google forms which consisted of eleven questions to receive the feedback from students' and the students' responses are presented in Appendix B.

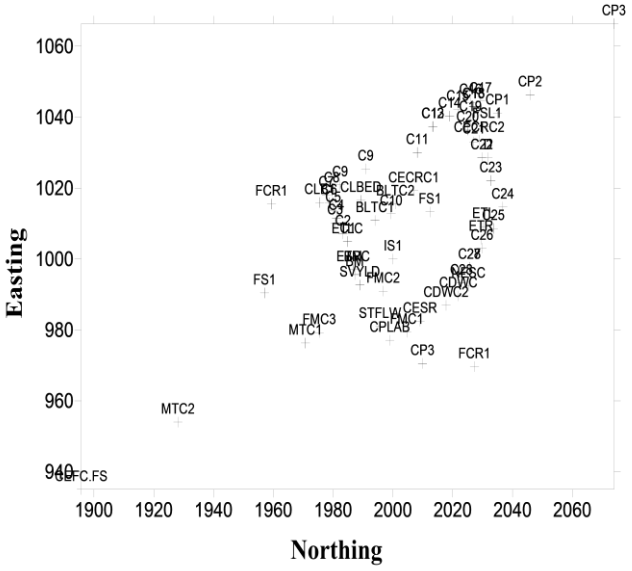

Fig. 2 Post Map of collected data

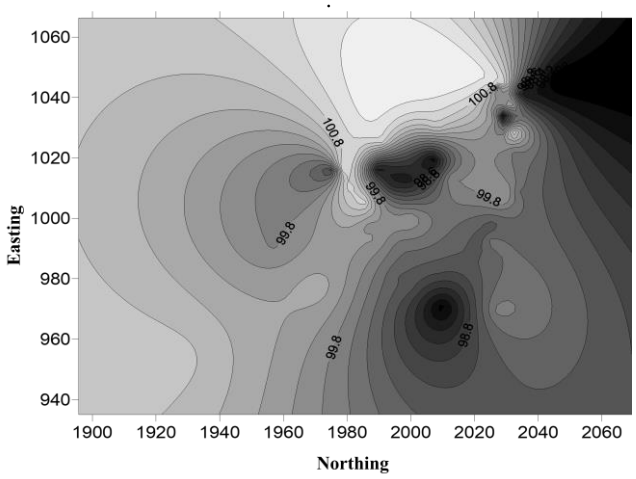

Fig. 3 Contour Map of collected data

An example showing the implementation results of the data collected in the field using Total Station and analyzing

using Surfer8 software is presented here. Before performing the traversing point codes were fixed. Fig. 2 depicts the layout of civil engineering building for assumed coordinates of benchmark such as northing equal to 1000, easting equal to 2000 and azimuth equal to 100 i.e., elevation. The contour map which describes the terrain condition whether it is hilly or valley region depending upon the counter intervals is shown in Fig. 3. Fig. 4 and Fig. 5 shows the 3D wireframe of the surface and surface layout for the data collected.

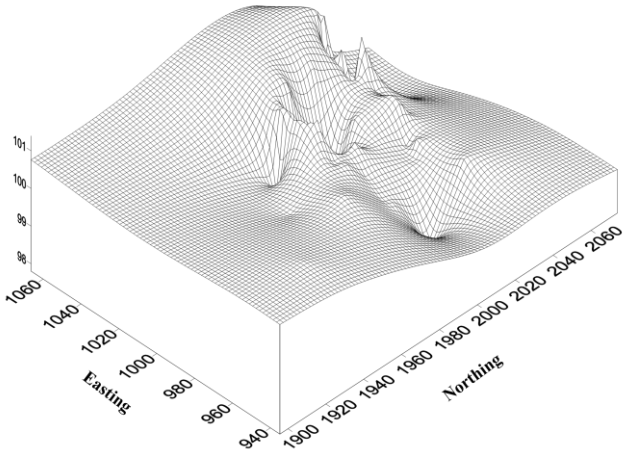

Fig. 4 3D wire frame

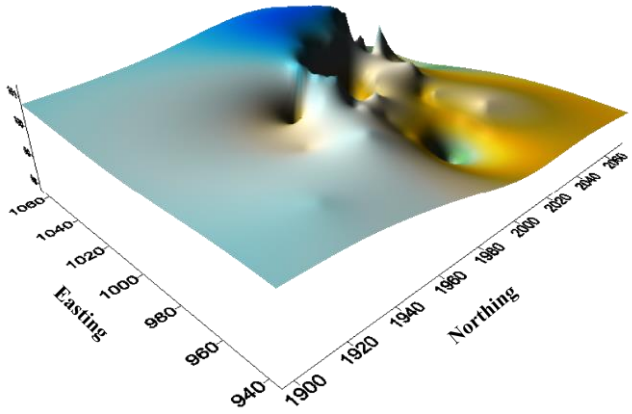

Fig. 5 Surface Layout

5. Conclusions

This paper discusses about the students gaining knowledge and skills on using the modern equipment. The paper also presents other skills which students imbibed after performing the open ended experiment such as analyzing the data collected from the field in the software and producing terrain maps of different configuration & views and calculating the quantity of earthwork as an output from the software. The software also presents a statistical data for further study. The main aim of conducting this open ended experiment is to make students perform this activity which can be related to the real world scenario. The current experiment is performed assuming the coordinates where as real – time coordinates must be considered as input in total station for more accuracy which is the future scope of this work.

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Appendix

A. Assessment Rubrics

Table 2. Rubrics For Assessment of Open – Ended Experiment

Particulars for Assessment	Exceeds Expectations	Meets Expectations	Below Expectations
Data Collection	**(12 – 15 marks)**	**(7 – 10 marks)**	**(0 – 5 marks)**
	• Collects relevant data pertaining to the given problem • Able to justify the data	• Collects relevant data pertaining to the given problem • Unable to justify the data	• Collects data with instructors help
Software Mapping	**(8 – 10 marks)**	**(4 – 7 marks)**	**(0 – 3 marks)**
	• Able to transfer the data collected to the software • Able to plot layout of civil engineering building and road works precisely	• Able to transfer the data collected to the software • Unable to plot layout of civil engineering building and road works precisely	• Able to transfer the data collected to the software with instructors help • Able to plot layout of civil engineering building and road works with instructors help
Documentation	**(5 marks)**	**(3 marks)**	**(1 mark)**
	• Able to prepare a document with minimum errors. • Includes proper sequencing of content, contains the required maps and its analysis.	• Able to prepare a document with minimum errors. Proper content sequencing. • Fails to present the appropriate analysis of the data	• Poor documentation

B. Student Feedback

1. Which equipment do you think is more efficient? 95.9% students said Total Station and 4.1% said Theodolite.
2. Were the operations of total station simple as compared to theodolite? 78.4% students said Yes and 21.6% said No
3. Is retrieving the data from total station and mapping in software a lengthy task? 54.1% said Yes and 45.9% said No.
4. Which of the following learning outcomes have you achieved by performing open ended experiment? 39.2% said collect traversing data using total station, 18.9% said Transfer the collected data on to a computer, 14.9% said Analyze the data using surveying software, 8.1% said Create mapping of terrain for collected data using software, and 62.2% said all of the above.
5. Working in a team has improved my learning, 44.6% have strongly agreed, 45.9% have agreed, 4.1% has disagreed and 5.4% has strongly disagreed.
6. The open ended task assigned in the field was effectively associated with real world problems,

25.7% have strongly agreed, 64.9% have agreed and 9.5% have disagreed.

7. Are you confident about handling and operating the total station individually? 62.2% said Yes and 37.8% said No.
8. The teacher's approach upon teaching was supportive of learning and open to students, 27% strongly agree, 52.7% agree, 13.5% disagree and 6.8% strongly disagree.
9. The faculty appeared enthusiastic and interested, 28.4% strongly agreed, 56.8% agreed, 9.5% disagree and 5.4% strongly disagree.
10. In your opinion, how do you rate learning experience of the open ended experiment? 29.7% said Excellent, 36.5% said Very Good, 27% said Good and 6.8% said Satisfactory.
11. Please provide additional comments

a) The open ended experiment has been a great learning experience. I have learnt a lot from this open ended experiment.

b) Total Station s better to use than theodolite.

c) I really achieved great knowledge from this experiment

d) Open ended experiment helped in understanding the total station.

e) Overall use of total station was very helpful & don't consume much time, I enjoyed learning survey practice.

C. Evidences