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IMPLEMENTING AN EDUCATIONAL TOOL FOR LAND SURVEYING TRAINING: MAKING A SIMPLE THEODOLITE MODEL BY STUDENTS

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Abstract

Visual learning by making and using simple models can enable and enhance learning. It is a proven method resulting in an easier and more effective method of transmitting skills. Students can understand theoretical concepts much easier if they can see, make and use them, or interact with them as in the real life. In this study, a student group has implemented an Educational Tool for Land Surveying Training by Making a Simple Theodolite Model. By doing this hands-on experience and then making measurements by their own instrument, it was indicated that the students can get surveying training more efficiently by having maximum motivation. The paper presents this study in detail.

Key Words: *Theodolite, surveying, educational tool.*

1. Introduction

Visual learning by making and using simple models can enable and enhance learning. It is a proven method resulting in an easier and more effective method of transmitting skills. Students can understand theoretical concepts much easier if they can see, make and use them, or interact with them as in the real life. Learning by doing uses methods that help students to open their mind [1].

The didactic activity involves a large variety of situations, environments, problems, topics, students of different levels. Particular attention has been devoted by the authors to the experimental training, taking into account the great importance of the technical aspects in the engineering area.

The realization of specific tools can be very useful for the students: indeed, they can make some private training, which is meaningful for testing their knowledge of the basic concepts. The students themselves, distributed in small groups, can carry out a complex project, at least a prototype, to be improved by other students. The theoretical importance, as well as the practical one, is evident [2].

In this paper is presented an implemented Educational Tool for Land Surveying Training.

2. About Theodolite

A theodolite is an instrument used for determining the horizontal and vertical angles between two points.

It is a key tool in surveying and engineering work, particularly on inaccessible ground. If the distance between two point in a triangle is known, and two angles are measured using the theodolite, each dimension of the triangle can be determined using the triangulation process.

The need for an advanced surveying tool first arose in the early 1500s as the kings of the European empires expressed an interest in mapping their territory and determining the extent of their kingdoms. Earlier geometric squares and graduated circles were used for the purpose of measuring angles.

To measure the height of an object that cannot be measured by ordinary means---a house, tree or a theodolite can be used.

The first true theodolite was developed and built by Joshua Habermal in 1576. Completed in Germany, the original theodolite was outfitted with a compass and a tripod in addition to the geometric squares and graduated circles. The instrument was revolutionized by Jesse Ramsden in 1791. He developed an accurate dividing engine for a making graduating angular scales. The dividing engine was capable of drawing extremely accurate graduation marks on these measurement instruments. Ramsden's Great Theodolite is now housed in London's Science Museum because of its influence on science, mathematics, and Great Britain (Figure 1).

Figure 1. Ramsden's Great Theodolite

A theodolite consists of a movable telescope mounted within two perpendicular axes; the horizontal or trunnion axis, and the vertical axis. When the telescope is pointed at a desired object, the angle of each of these axes can be measured with great precision, typically on the scale of arc seconds. Today's modern theodolites are integrated with electronically range finder (Total stations) and can be seen being used by the surveyors on highways (Figure 2).

Figure 2. Modern theodolite (Total station)

3. Designing a Simple Model Of Theodolite

In this study, a student group has implemented an Educational Tool for Land Surveying Training by Making a Simple Theodolite Model. To develop this model, these steps are implemented:

1. Firstly, a plate was made to set up the instrument. Then, horizontal protractor which had been plotted by using a printer was placed and fastened on the plate (Figure 3).

2. In the second stage, two tubular bubble plumb placed in two perpendicular directions to level the instrument (Figure 4).

3. After connecting the two arms by using a hinge, lower arm were placed and fastened with a pin on the centre of horizontal protractor so as to spin around (Figure 5).

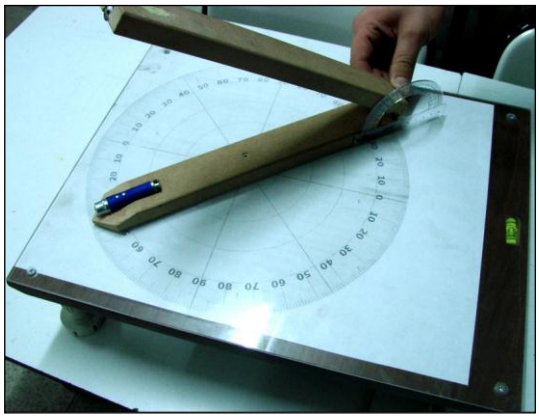


Figure 3. Horizontal protractor plate

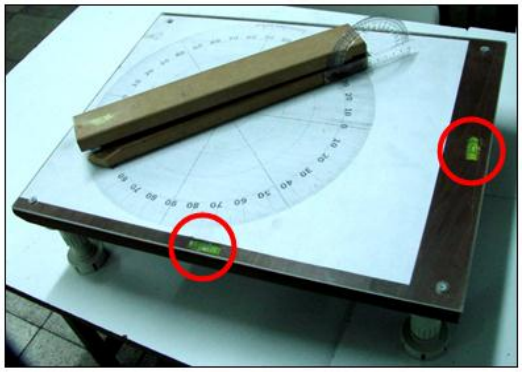


Figure 4. Tubular bubble plumbs

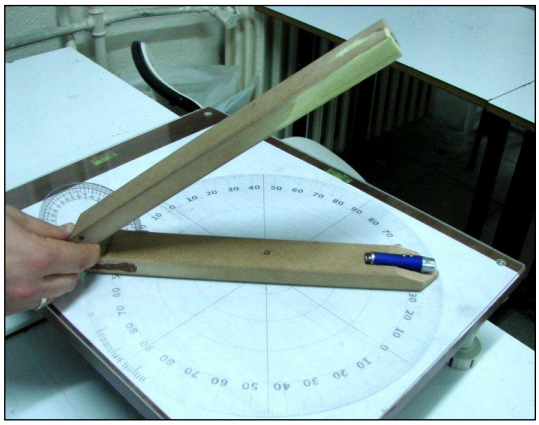


Figure 5. Lower arm fastened with a pin on the centre

4. Vertical protractor was sensitively glued on the lower arm by centering to the exact corner of the elbow (Figure 6).

5. Two laser pointers were tipped end of the arms to target desired directions for doing angle measurement (Figure 7).

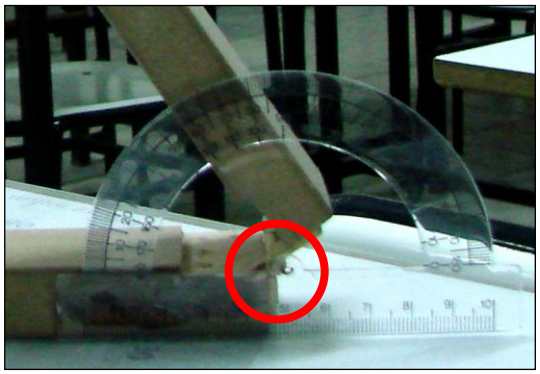


Figure 6. Vertical protractor was sensitively glued on the lower arm.

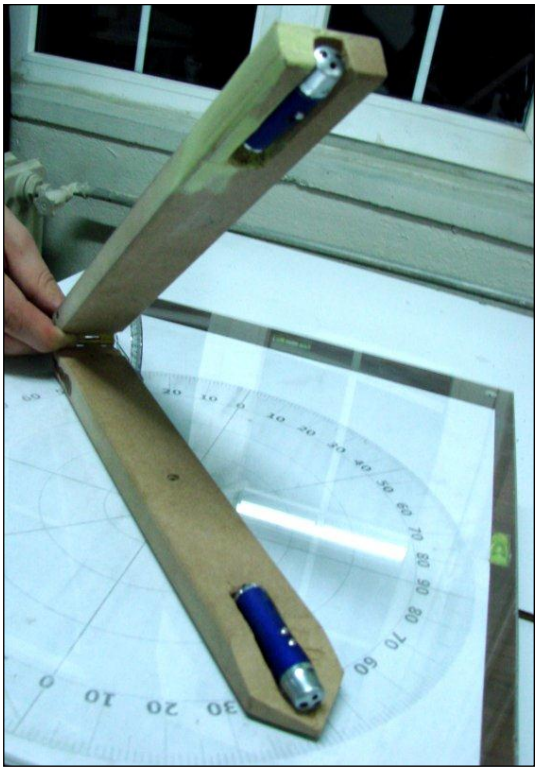


Figure 7. Two laser pointers were tipped end of the arms

6. To level the instrument by using tubular plumb rules, four adjustable leg were placed the corners of underside of plate (Figure 8).

7. Also, to center the instrument on the desired measuring point, an adjustable height plump bob was placed center of the underside of plate (Figure 9).

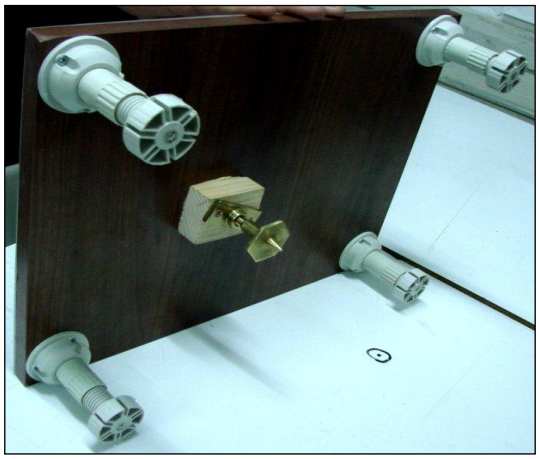
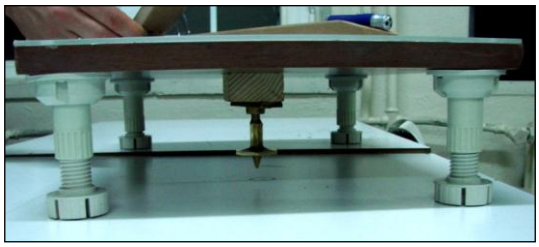


Figure 8. Four adjustable leg were placed.



Figur 9. Adjustable height plump bob

3. Making Observation with the designed model

After making this simple instrument described above, the students performed some angle measurements to test it. Altough these handmade theodolites should not be used with precision is crucial as in engineering or survey, they could roughly make the measurements. Steps of the setting up this simple theodolite and making observations are as below:

1. Theodolite is set over the survey point. To do this, the legs are moved to center the instrument on this point using the plumb bob.

2. The length of the legs is adjusted to level the tubular bubble plumb without disturbing the centering.

3. To observe any angle, either horizontal or vertical, made by two objects with the position occupied by the instrument all that is required is to bring one object into target with the top laser pointer, read the direction angle value made by the horizontal or vertical protractors, and swing the top laser pointer to the second object. Then, subtraction of two direction value which is read from vertical protractors gives the vertical angle. And subtraction of two direction value which read from horizontal protractors gives the horizontal angle.

4. After these observations, by using this measurements together triangulation principles, if a distance is known between two points, the distance and height of another third point which was out of reach can be calculated.

4. Conclusion

In this study, a student group has implemented an Educational Tool for Land Surveying Training by Making a Simple Theodolite Model. Altough this handmade theodolites should not be used with precision is crucial as in engineering or survey, by doing this hands-on experience and then making roughly measurements by their own instrument, it was indicated that the students can get surveying training more efficiently by having maximum motivation.

5. References

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