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THE EFFECT OF USING SIMPLE EQUIPMENT ON THE ACQUISITION OF PLAN MAP CONCEPTS IN THE VOCATIONAL SCHOOLS

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ABSTRACT. The purpose of this study was to investigate the effectiveness of using simple equipment on teaching plan map concepts as a main topic in a surveying course of vocational education. Six groups of students, enrolled in the surveying course, were randomly selected and pre-tested to examine their experience on plan map concepts. Three groups received traditional methods of teaching and used theodolite in plan map-making, while the other three used simple equipment as an extra fieldwork activity. At the end of the semester, all participants were post-tested. A significant difference was found between experimental and control groups on post-test scores. Also, there was a significant difference between the two groups with respect to students' high-level understanding of plan map concepts. The use of the simple equipment was strongly recommended in science and vocational schools to overcome some main problems.

KEYWORDS. Teaching Plan Map Concepts, Vocational Education.

The most notable characteristics of vocational schools in Iran are to prepare skillful technicians to involve in the industrial development of the country. In this connection, the surveying course was offered to eleventh grade students in the vocational schools. The course introduces planimetry, altimetry, topographies, and other kinds of surveying, four hours a week during a semester. However, the planimetry is the main part of the course, which is called "plan map" with the following main objectives:

1. The student knows common terms used in the plan map construction and interpretation.
2. The student demonstrates skills in finding azimuth, scales, and other necessary variables in making plan map.
3. The student uses the theodolite device correctly.
4. The student properly measures leveling.
5. The students construct and make a proper plan map in a given area.

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BACKGROUND

In the past few decades many science program, has been available to represent science as a direct or laboratory – based experience rather than to present science as only a body of knowledge (Hudes & Moriber, 1969). "When students have direct experiences with materials & events, each comes from that experience with his / her own interpretations." (Marker & Methven, 1991). In the other words students construct their own concepts from their experience, that is why, it is a well established fact that theory is more understood and appreciated by the students when subjected to experimental techniques (simpler the better), and visual presentation is preferred to abstract lectures and mere statement of facts.

The main part of course namely plan map was commonly offered in two components, with lecture typically once per week and practical work two times a week. The practical or fieldwork needs a complex device called theodolite. The theodolite is expensive and the schools can have just a few of them. As a result, learning experiences in practical work may have minimal impact on helping students construct understanding of plan maps' concepts, content, or relationships.

As a result, practical work is now emphasized in school science. Hodson (1996), identified three justifications of practical work for learning of science:

1. To help students learn science
2. To help students learn about science and to
3. Enable students to do science.

Also, Woohnough and Allsop (1985) have argued that practical work can be viewed as providing experiences, exercises, and investigations.

Laboratory-based experiments are not necessarily needed for practical work. Out school activities can provide opportunities to learn and to do science as well. In this regard, Griffin (1998) pointed out the importance of informal settings of learning processes, and showed how carefully planned museum-based experience could provide a vehicle to achieve some goals of practical work in school science. Lock (1998), realized that "the limited available empirical research findings suggest that field work may be more effective than equivalent teaching carried out in laboratory." He further concluded "field work can make significant contributions to all three [objectives of practical work in science]." It is inevitable that science, vocational education, and practical work should be changed over time and be geared toward fieldwork. The work can be done in the schoolyard or in the wider environment.

It is known that textbooks are used as an alternative to practical work (Lock, 1997). Even though practical work can include the design of experiments, and when the work goes according to the textbook, it may add little to conceptual mastery.

Laboratory and fieldwork need not reasons for emphasizing the use of complex and expensive equipment. One area of Japanese superiority on test achievement and comprehension in school science can be seen on their teachers' emphases in "the experiment done with everyday simple equipments and materials" (Walberg, 1991).

Kirschner and Huisman (1998), in designing non-traditional practices to replace traditional practices suggest that, "the use of simulations is advocated when: (1) the 'real' laboratories are unavailable, too intricate; (2) the experiment to be carried out is dangerous for the experimenter or to the object of experimentation; (3) the techniques which need to be used are too complex for the typical student; and (4) there are severe time constraints."

Based on local reports and experiences in vocational schools, most of the students who take the surveying course, fail at the end of semester, and their achievement in the course is not adequate, particularly in plan map concepts.

Generally, the framework and the theoretical orientation of this study were based on the following assumptions:

1. Students acquire plan map concepts through out- school activities
2. Use of simple equipment can reduce the complexity of the concepts.
3. Use of simple equipment can overcome the unavailability of real laboratory and reduce the students' fears of using expensive and limited tools.
4. Use of simple equipment causes teachers to do activities beyond the textbooks as a complementary plan without time consuming.

PURPOSE OF THE STUDY

The primary purpose of this study was to determine the effectiveness of two different types of instruction on plan map concepts: that involved simple equipment, and implemented traditional methods. More specifically the research sought data to answer the following hypotheses:

1. There is a significant difference in the students' achievement on plan map concepts between the experimental and control groups.
2. There is a significant difference in the students' level of understanding plan map concepts between the experimental and control groups.

METHOD

Procedure

This study was conducted using students enrolled in a the surveying course during the Fall 1998 in vocational schools of the East Azerbaijan Province in Iran. The course content included the main topic of making plan map concepts.

A quasi-experimental design was employed. The subjects in both control and experimental groups received a traditional lecture method and practical work, using theodolite for an entire semester. Additionally during the semester the experimental groups used the simple equipment of plan map-making as an extra activity.

The plan map as the main part of surveying course was, two-credit, 18-week course offered through the vocational high schools. The class met once a week in 50-minute periods and 100-minute practical work. Worthwhile to mentioned that the same teachers taught both control and experimental groups. However, 50-minute of 100-minute practical work of the experimental group was devoted to use the simple equipment.

Participants

The sample consisted of public vocational school students in grade 11, ranged in age from 17 to 18, of the East Azerbaijan Province in Iran. Five school districts were randomly selected to represent a variety of students in terms of demographic characteristics. Within the districts, six groups of students were randomly selected, three as experimental and three as control group as multistage cluster sampling (Borg and Gall, 1989). Therefore, the study was based upon 155 students, of which 65 students were in the experimental and 90 in the control groups. This sample was part of a total 534 male students who took the surveying course in vocational schools.

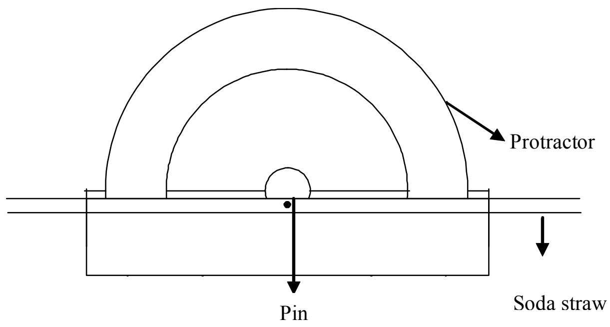
Measures

Forty multiple test items were used as pre-and post-test to measure plan map concepts. Four instructors and two specialists in surveying confirmed the test validity. The reliability of the test was measured by a split-half method, using Spearman Brown formula ($r = 0.69$). Since the current effort to reform science education emphasizes the importance of understanding for students (National Research Council, 1996), in response to such notion the author examined the subjects' understanding level in the plan map concept. For that reason the forty items were given to the instructors to select as being in a high level of instructional objective. As an aid for classifying the items, a table that is describing the major categories of each domain of taxonomy (Gronlund, 1976) was given to the instructors. The twenty items were selected as being in a high order level such as comprehension, application, analysis, synthesis, and evaluation of cognitive domains. These items were used to compare the understanding level of plan map concepts among subjects.

Materials

The material consisted of the use of equipment such as a protractor, soda straw, measuring tapes and ropes, paper, and pin. With these materials a piece of equipment was made as shown in Figure 1.

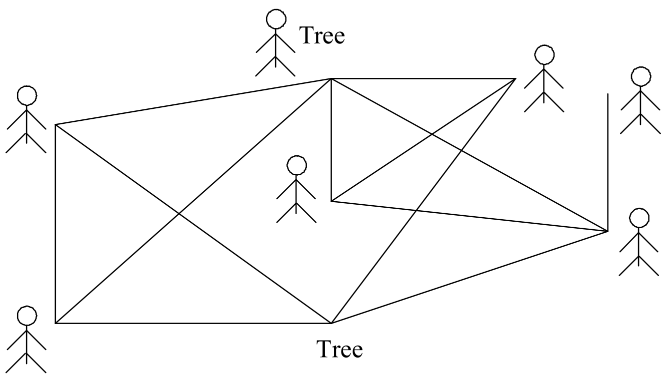
Figure 1. The simple equipment of plan map making



Before going into the field, the students of the experimental groups were asked to be divided into teams, keeping in mind that they could sight correctly and use the equipment. Then, the students were asked to use equipment according to instructions given by the teacher.

Each team was asked to indicate the north on their paper and then sight on a distant object of their choice, such as trees or sticks. The following figure is used to illustrate this technique.

Figure 2. The illustration of sighting



RESULTS

Since the students in the control and experimental groups did not match according to their pre-test scores, any differences in these scores was done by assessing the D score (D=posttest-pretest) to obtain a more reliable difference between the two groups.

A t-test model was used on the students' achievement scores. There was a significant difference between the D scores of experimental and control groups t(154)=-12.95, p<0.01. Thus, students who used the simple equipment achieved higher that the control group students. One-way analysis of variance (ANOVA) was also conducted to test the difference among groups of the study (Table 1, groups 1,2, and 3=experimental, and groups 3,4, and 5=control ones in range of mean scores).

Table 1. Analysis of variance among the D scores of the subjects

Source of Variance	Sum of Square	df	Mean Square	F	p
Between	146.4437	5	29.2887		
Within	542.8563	149	3.433	8.0390	0.0001
Total	699.3000	154			

There was a significant difference between the achievement of the students in the control and experimental groups f(5, 149)=8.0390, p<0.01. Thus, the first hypothesis of this study, which was "there is a significant difference in the students' achievement plan map concepts between the experimental and control groups" was confirmed. A post hoc analysis was done by Tukey method to see the differences of the groups with each other. The results are contained in Table 2.

Table 2. Tukey test between groups achievement

Mean Score	Group	5	4	6	3	1	2
1.0333	5						
1.4667	4						
2.0000	6						
2.3571	3						
3.2308	1	*	*				
4.0278	2	*	*	*			

P<0.01

Thus, it can be concluded that at p<0.01 there was a significant difference of the two experimental groups with the control ones, in regard to the subjects' level of understanding, but there was no significance difference of one experimental group (1) with the others.

An ANOVA was done in regard to the students' higher level of plan map concepts in the groups of the study. The results are shown in table 3.

Table 3. Analysis of variance results for high achievement plan map concepts among the subjects

Source of Variance	Sum of Square	df	Mean Square	F	p
Between	86.1660	5	17.2332	23.8785	
Within	107.5337	149	0.7517		0.0001
Total	193.6997	154			

Thus, the second hypothesis of the research "there is a significant difference in the students' understanding plan map concepts among the experimental and control groups" was confirmed.

In order to find out the difference between the groups a Tukey post-hoc analysis was conducted and the results were shown in table 4.

Table 4. Tukey post-hoc analysis on the students' high achievement

Mean Scores	Groups	6	4	5	1	2	3
1.0467	6						
1.3033	4						
1.4767	5						
2.7500	1	*	*	*			
2.7610	2	*	*	*			
2.7857	3	*	*	*			

$p<0.01$

It should be mentioned that the plan maps made by the subjects, are comparable by the ones that are made by the theodolite. The students used the formula of $S = \frac{1}{2} ab \sin \alpha$ for calculating the given area. More figures of the plan maps are presented in appendix A and B.

CONCLUSION

This study provides evidence that students' achievement were enhanced through using the simple equipment as an extra activity of plan map making. During the treatment period, the experimental groups, except one, were able to improve plan map concept and skills. While in comparing to the experimental groups, none of the control group could make an improvement of plan map concepts and skills. The most surprising result of this study is that the statistical analysis indicates a highly significant improvement in the students' achievements for all experimental groups, when those high levels of cognitive skills were measured.

The theoretical framework proposed in this study appears to be consistent with the experimental data. The enhancement of the students' performance reveals that the simple equipment reduces the complexity of plan map concepts. This reasoning is in the line of Japanese superiority on test achievement on school science, which emphasized on using simple and everyday materials (Walbeg, 1991). This kind of activity provides opportunities for pupils to learn and acquire the concepts in informal setting (Griffin, 1998) of learning processes. As Lock (1998) identified, fieldwork such as this may be more effective than equivalent laboratory approaches. Finally, using the simple equipment overcomes the costs and time constraints associated with real laboratory experience (Kirschner and Willbord, 1998).

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Appendix A
An example of plan map made by the experimental group

Station	Length	Angle
OA	27.90(m)	∠ AOB = 80°
OB	39.80(m)	∠ BOC = 30°
OC	36.00(m)	∠ COD = 62°
OD	49.00(m)	∠ DOE = 91°
OE	41.40(m)	∠ EOF = 48°
OF	30.90(m)	∠ AOF = 49°

$$S_1 = \frac{1}{2} OA \times OB \sin C = 27.90 \times 39.8 \times 0.988 = 548.$$

$$S_2 = \frac{1}{2} OB \times OC \sin C = 39.80 \times 36.00 \times 0.500 = 358.$$

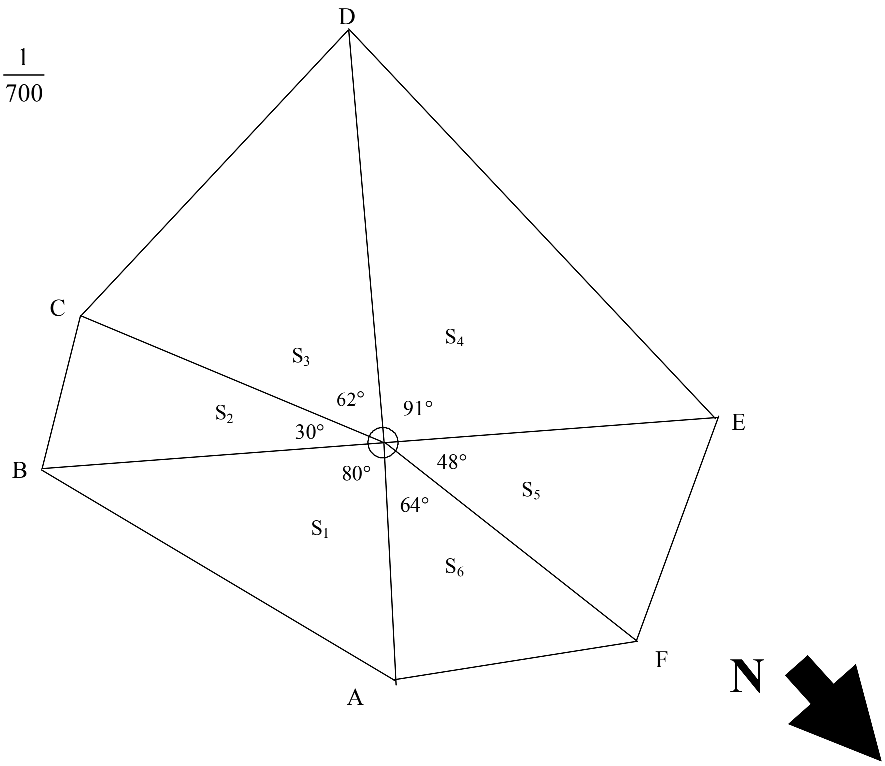
$$S_3 = \frac{1}{2} OC \times OD \sin C = 36.00 \times 49.00 \times 0.909 = 801.$$

$$S_4 = \frac{1}{2} OD \times OE \sin C = 49.00 \times 41.4 \times 0.999 = 1013.$$

$$S_5 = \frac{1}{2} OE \times OF \sin C = 41.40 \times 30.9 \times 0.689 = 440.$$

$$S_6 = \frac{1}{2} OF \times OA \sin C = 30.90 \times 27.9 \times 0.739 = 318.$$

$$Scale = \frac{1}{700}$$



Appendix B

An example of plan map made by the other experimental group

Section	Length	Angle	Area
S_1	13.80(m)	26°	47.94
S_2	15.85(m)	34°	56.72
S_3	12.80(m)	20°	34.80
S_4	15.90(m)	32°	59.61
S_5	14.15(m)	22°	47.55
S_6	13.05(m)	25°	36.53
S_7	13.25(m)	47°	54.99
S_8	11.35(m)	40°	44.13
S_9	12.10(m)	35°	35.39
S_{10}	10.20(m)	35°	43.43
S_{11}	14.85(m)	35°	58.77

$$Scale = \frac{1}{200}$$