The Effects of Geographical Information Systems Use on Student Achievement in Geography Education

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Abstract: In recent years, there seem rapid changes in education and teaching. In order to provide effective learning, new methods, techniques and materials are developed and used. Given the new curriculum of the course of geography (2005) which tries to keep pace with this change, a constructivist learning and task based approach emphasizing skills, including alternative measurement and evaluation, strengthening the cooperation with the main and secondary disciplines and reflecting holistic and thematic views are evidenced. Along with this, computer assisted geographical information systems (GIS) is one of the most important materials for a correct, clear and easy transmission of the new geography teaching program. The applied part of the study was conducted on the students of Hacı Sami Boydak Anatolian High School and Şükrüpaşa High School in Yakutiye Municipality in Erzurum city. In this study, the subjects of Climate Types and Vegetation in grades 9 and 10 in Geography classes were determined to teach via GIS implementation. The study was conducted by means of treatment and control groups. Achievement test was applied to both groups, the result were analyzed via SPSS statistical program. During the classes, while GIS was used in treatment group, in control group conventional methods were applied. The results were evaluated and the effect of GIS technologies on student achievement was investigated. It was seen that, though, in achievement pretest, the mean of the correct answers of both groups was seen to be close to each other, in posttest results, the mean of the answers given by treatment group turned to be higher than the control group's mean. As for the findings of the study, it was seen that the achievement level of the students who were taught by means of GIS activities was higher. In sum, it was found that GIS based activities in Geography classes significantly increased the achievement level of the students compared to conventional methods.

Key words: Geography Education, Geographical Information Systems (GIS), Teaching Methods.

Introduction

Rapid increase in the production of information and technology and development of communication in the world led to the extensive and easier access to sources of information and, in this way, drastically changed the life. It became the initial problem of the educators to convey this accumulated information in every sphere to individuals effectively and equally. For the realization of this transmission and retention of learning, everyday, new methods, techniques are developed and new materials are used in education. With its subject topics, geography is one of the courses which are appropriate for the use of different instructional materials. Due to this convenience, different teaching designs and materials are developed in order to increase the effectiveness in the education and instruction of geography. One of them is the *Geographical Information Systems* (GIS) which is more extensively used day by day. In this study, the effects of GIS on the academic achievement of the students in geography education were investigated by an experimental research. The study consists of two major parts. In the first part, definition of the GIS, its role in geography education, and the utility of this system in the new changing geography curriculum in Turkey are questioned; and, in the second part, the results of a study aiming to investigate the effects of GIS on students' academic achievement are discussed.

What is GIS (Geographical Information Systems)?

Geographical Information Systems (GIS) is a computer system which was designed to collect every type of data, together with their coordinates, related to the physical and anthropological characteristics of the Earth in a database, to make some analyses on them in line with certain purposes, and to illustrate the results in the forms of maps, tables, and figures (Fitzpatrick,C. & Maguire,D.J. 2000,63–64). In other words, GIS is a computer-based data processing program designed to analyze and visualize the objects and events on the Earth (Demirci,A.,2008a,11). The system consists of basically four components. They are computer (hardware), programs used in computer (GIS software), the data to be analyzed through software, and the user who would organize and direct these three components (Figure 1).
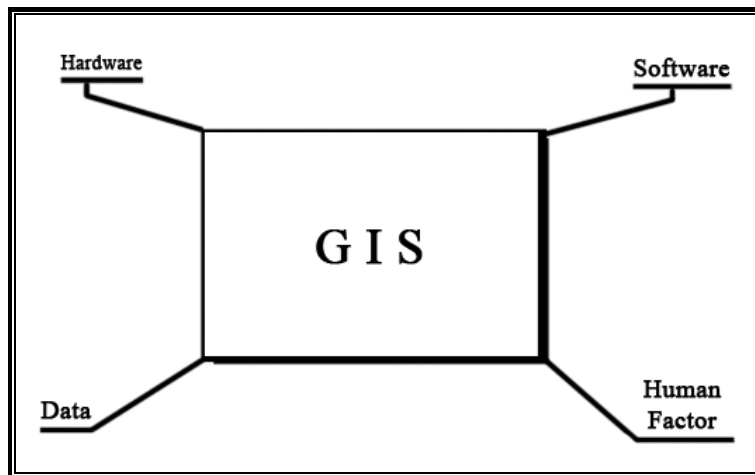

Figure 1. Components of GIS, Reference: Demirci 2008a: 12.

GIS, due its name, is considered to be a technology developed only for the area of geography. Although it is partially true, since GIS is a system collecting, storing, processing, and analyzing data, it is in an interaction with many disciplines. GIS, a system helping the more effective services in various sectors, is a tool used to increase the quality in decision making and solutions of problems. Due its content and scope, GIS can be used by all of the disciplines and groups of profession whose domains cover the phenomenons of natural environments, variable of time, and human beings which somehow represent a part of the Earth (Turoğlu,H. 2000,4). In this sense, GIS can be

defined as a technology with the qualities that would facilitate the lives of people not only from the area of geography but also from every part of society.

GIS in the Institutions of Education in Turkey

GIS, which used in many official institutions and organizations in Turkey, is utilized mostly by universities in education. It has just begun to be used in primary and high schools. Since 2000, contents of all courses have been gradually changed by the Ministry of National Education with a student-centered educational approach. Trying to keep pace with developed and rapidly changing teaching strategies, Ministry of National Education advises the use of materials, especially, GIS technologies equipped with computers in classes.

While GIS is used as an instructional material in social sciences, environmentalism, and sciences courses in the world, in Turkey, it is used only in geography courses. Together with the change in the geography curriculum by the Ministry of National Education in 2005, GIS began to be used in geography education.

Unfortunately, limitations of GIS use in schools reveal themselves in the curriculum. In the part related to the application of the program, there is an expression "Depending on the technical equipments and physical facilities in schools, teachers may develop GIS practices themselves or examine the existing ones" (MEB 2005,11). However, since most of the schools do not have the equipments and facilities required for the GIS implementations and the teachers qualified enough to use the data and software, they are not ready to use these systems effectively.

GIS in the New Geography Curriculums

The discipline of geography has vital responsibilities in understanding the relationships between people and the nature and the relationships among themselves. One of the most important aims of geography education is to help students learn the abstract and complex geographical issues meaningfully and far away from memorization and to prepare the conditions required. Therefore, educationalists need the well-selected methods and materials to be able to teach geography in the most effective ways. GIS implementations, the main concern of this study, can meet these needs. For this reason, GIS implementations were put great emphasis on in the new geography curriculum prepared in 2005.

Geography curriculum supports the use of GIS in the teaching of geography topics. In the program, it is clearly stated in the expression "Depending on the technical equipments and physical facilities in schools, teachers may develop GIS practices themselves or examine the existing ones" (MEB 2005,11). The suggestions for the use of certain acquisitions in the program can be regarded as a clear evidence for this support. When globally analyzed, it is easily seen that most topics (or issues) are convenient to be taught via GIS. However, for the extension of GIS in schools, geography teachers, at least, should attain GIS equipments and make practices. Otherwise, it is certain that the extension of GIS in schools will not be possible.

In the geography curriculum in Turkey, there are many activities which are appropriate for the use of GIS. Five of the topics suggested to be taught by GIS are in the 9th, nine of them in the 10th, two of them in the 11th, and four of them are in the 12th year program. The number of the targeted acquisitions in these topics is 28 in sum (See Table 1).

Number	Grade	Suggested Outcome Numbers	Suggested Topics of Activities
1	9	A.9.3	Maps (in the section of definitions)
2		A.9.4	Coordinate System (in the section of definitions)
3		A.9.5-A.9.6	Contour Lines
4		C.9.5-C.9.6	Climate of Turkey
5		C.9.7	Elements of Climate in Turkey
6	10	A.10.2-A.10.3	Thermal Springs
7		B.10.2	World Population
8		B.10.3	Population Change
9		B.10.4	Dynamics of Population
10		B.10.5	Population Pyramids
11		B.10.9-B.10.10	Categorization of Economic Activities
12		C.10.10	Urban Structure of Turkey
13		C.10.11	Differences in the Distribution of Population in Turkey
14		C.10.12	Dynamism of Our Population
15	11	B.11.4-B.11.5-B.11.6	From Production to Consumption
16		D.11.2	Span of Spread of Turkish Culture
17	12	C.12.4-C.12.5	Trading Structure of Turkey
18		C.12.8-C.12.9	Scenarios in the Population of Turkey for Future
19		D.12.6	Locations of Countries
20		D.12.8	Regionalization of the World

Table 1. The Topics in the New Geography Curriculum Appropriate for the Use of GIS (Demirci 2008a: 70).

Study

The Effects of the Instruction of Vegetation and Types of Climate Topics in the 10th Year Geography Course through GIS on Achievement Levels of Students (Turkey-Erzurum Sample)

In this section of the study, the findings obtained from the instruction of pre-determined geography topics (Vegetation and Types of Climate) to students in two different methods were presented. First of them was the conventional method whereas the second was GIS-supported method.

The universe of the research consists of the high school students studying at schools in the city centre of Erzurum in 2008-2009 education years; and the sample consists of 86 10th year students from Hacı Sami Boydak Anatolian High School and Şükrüpaşa High School in Yakutiye in Erzurum.

Formation of the Experimental and Control Groups

Tests including the questions related to "Vegetation and Types of Climate" topics were given to all 10th year students from both of the schools; and, according to the results, two classes (one experimental and one control) from each school, in sum, four groups, were determined (See Table 2).

Research Group							
Hacı Sami Boydak Anatolian High School				Şükrüpaşa High School			
10 Science-A (Experimental)		10 Science-B (Control)		10 Social-A (Control)		10 Social -B (Experimental)	
Female	Male	Female	Male	Female	Male	Female	Male
7	13	5	14	10	14	7	16

Table 2. Research Sample.

By this study, it was aimed to investigate the effects of the instruction of "Vegetation and Types of Climate" topics in the 9th and 10th years using the Geography Information Systems on the academic achievement levels of students. Using the software of GIS, some practices were made together with the students and they were allowed to develop their own materials. Later, on the basis of the material developed by the researcher, topics were taught in connection with the data formed by the students according to the instructions. In this way, it was intended to help students acquire the skills to use the program and participate in the classes with the materials they developed themselves.

In this experimental research, the real experimental design, the model with pre-test/post-test and experimental/control groups, was conducted. In this model, a pre-test and a post-test were given to randomly chosen experimental and control groups before and after the instruction of "Vegetation and Types of Climate" (See Table 3).

G1	PRE-TEST	X1	POST-TEST
G2	PRE-TEST	X2	POST-TEST

Table 3. Research Model.

G1: Experimental Group, G2: Control Group,
Pre-test and Post-test: Achievement Test,
X1: The group taught through GIS implementations,
X2: The group taught through conventional methods.

Throughout a four-week period, the experimental group students were taught "Vegetation and Types of Climate" topics enriched with the prepared course plans and activities based on GIS, and the control group was taught the same topic through the conventional methods in accordance with the targeted outcomes.

Procedure

In the procedure of the research, the steps below were followed;
■ In the research, as the data collection instrument, an achievement test consisting of 20 questions which some experts were councilled about was used.
■ A course plan was prepared for the activities to be held and the treatment took four weeks.
■ Both experimental and control groups were taught by the same teacher.
■ A computer downloaded ArcWiev 9.2 program and a projector were taken to the classroom in which GIS implementations would be carried out and a list of instructions was given to each student.
■ GIS implementations were carried out together with the students.
■ In the control group, teacher-centered conventional instructional methods, in which the teacher, all the time, was active, were used. In addition, maps and atlases were utilized in the classes.
■ During the classes, similar extra activities were carried out in the groups and the students were given some questions and asked to answer in order to identify whether they had understood the topics or not.

Findings and Interpretations

While the mean of the scores of the experimental group students taught through GIS-based activities from the test on "Vegetation and Types of Climate" was $\overline{X}$ =8,20 before the treatment, after the treatment the mean was found to be $\overline{X}$ =14,65. On the other hand, whereas the mean of the scores of the students taught through conventional methods (e.g., question-answer, direct instruction) was $\overline{X}$ =8,20 before the treatment, it changed to $\overline{X}$ =11,39 after the treatment. According to these results, it was determined that although achievement levels of both groups got higher the increase in the scores of the experimental group students was greater (See Table 4 and Figure 2).

	Groups	$\overline{X}$	S.S.	N
Pre-test	Experimental	8,20	2,44	43
	Control	8,20	2,62	43
Post-test	Experimental	14,65	1,67	43
	Control	11,39	2,70	43

Table 4. Means and Standard Deviations for Achievement Test Scores of All Students.

As a result of the treatment, it is seen that students' behaviors (knowledge) related to "Vegetation and Types of Climate" changed positively. The differences between the achievement levels of the groups can be associated with the student-centered GIS practices in the experimental group.
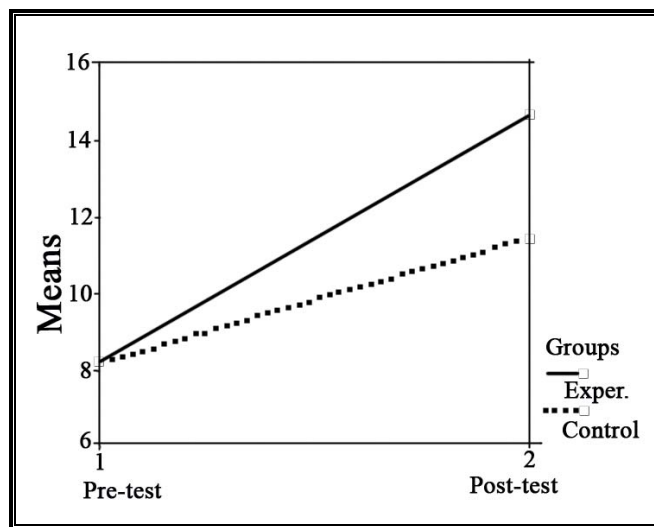

Figure 2. Pre-test and Post-test Scores of Experimental and Control Groups.

Results and Suggestions

Development and use of new technologies in education increase the quality and effectiveness of instructional services. GIS is one of these new techniques. Furthermore, according to the observations, it was understood that students are more willing for classes carried out through GIS-based activities.
As understood from the findings from the treatments, students' achievement levels in geography courses based on GIS technologies are higher than others.

When geography classes are taught by the conventional methods, learning based on memorization appears and the topics cannot be remembered in long term. During geography classes, teaching settings which will involve as many senses as possible should be designed. In addition, in GIS-based classes, education, being far away from memorization, is realized by the participation of the students on the basis of practices.

Rate of retention in learning through computer is higher. Also, one of the skills acquired by the students thanks to GIS-based activities, as pointed at in geography curriculum, is the skill to use information and communication technologies.

More time should be allotted for the GIS use in geography education and, for this purpose; some revisions should be made in the content of geography courses.
In a study on the utility of GIS technologies in schools (Demirci 2006,5), it was found that none of the teachers could use the GIS Technologies. To solve this problem, use of GIS Technologies by teachers should be increased and laboratories of GIS technologies should be designed and developed in the faculties serving to train geography teachers.

One of the most important problems in geography education is that there are not enough and appropriate places to preserve the instructional tools and materials. Modern classrooms in which geography instruction can be realized most effectively and the components of GIS can be placed and used should be formed.

As in developed countries, the utility of GIS technologies should be tested in not only in geography but also in other, especially, science, courses. The most important components of GIS are data and software. Without them, implementations of GIS are not possible. These sources should be provided to teachers and students by their institutions.

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