

## The Use of Geographic Information Systems (GIS) in Geography Teaching

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**Abstract:** The science of geography has provided many great conveniences to people in almost all fields of life with the advanced technology, tools, materials and methods including geographic information systems, global positioning system, remote sensing, computer and the internet since the early 21<sup>st</sup> century. Allowing transferring into computer environment, querying and analyzing all geographic information belonging to the earth, geographic information systems are an important information technology used in every stage of life for generating permanent solutions to the problems encountered by communities. Even though GIS is taught at the highest level in geography courses as of primary education in such developed countries as the USA and Canada, geographic information systems, which are an important part of geography, cannot be utilized in Turkey adequately, just like the science of geography itself. The geography curricula prepared in recent years have highlighted that new teaching methods that involve the active participation of students should be adopted instead of traditional methods. However, it can be said that these teaching methods are not implemented sufficiently. In consideration of the above-mentioned deficiency, this study focused on the necessity of benefiting from geographic information systems technology to achieve a more effective geography teaching. Literature review was conducted in the present study.

**Key words:** Geography education • Geographic information systems technology

### INTRODUCTION

Today, the importance of technological elements (the internet, TV, mobile phone and other technological devices) in school life and learning has increased. Technology-based communication networks have started to be at the center of social relations and social skills of students as a result of the increase in the use of technology-centered social networks (Facebook, Twitter, Youtube, etc.) in particular. The interests and expectations of those students who use social media more effectively change, which brings to the fore the issue of making more use of technology in teaching methods and techniques used for achieving learning among students. In this regard, there has been a rise in the debates concerning the contributions of technology-supported teaching, which makes more use of visual and auditory elements, attracts the attention of students and focuses on the needs of students more, to the learning of students [1].

Rapid developments in technology and the increased use of the advanced technology in the classroom environment lead to a change in the physical and social structure of the teacher-centered traditional classroom environment based on one-way communication. The use of smart boards instead of blackboards and chalks in classrooms is important in that it shows the application area of technological developments in classrooms [2]. The main goal of giving more coverage to technology in the classroom environment may be to enable teaching to have an easier and more understandable structure and to meet the different needs of students [3]. It has been stressed that technology-based education enables students to learn more effectively, improves their interest in and desire for learning and makes it easier for them to do individual research [4]. At this point, one of the matters to be discussed is the use of technology in education for its relevant purpose. The observation of the principle of compliance with time and purpose is quite

important in the achievement of the pre-set purposes in educational environments. In this respect, certain points may be taken into consideration while selecting the technological materials to be used in lessons. Some of these points are the suitability for the relevant purpose and subject, availability, easiness to use, appropriateness for the learning of students, the attitudes of students and teachers towards technological tools, the existence of a physical infrastructure supporting the use of technology in the classroom and the effectiveness of technological tools in the learning of students [5].

In recent years, many attempts have been made in Turkey to develop effective teaching models and materials by using information technologies. In consideration of these attempts, one of the technologies that can be used in technology is the geographic information systems (GIS) [6, 7]. Geographic information systems (GIS) emerged at Harvard University in the USA in the 1960s. In recent years, it has become a concept of debate in Turkey, as in the entire world [8]. GIS can be defined as a software and hardware system which is used for storing, re-arranging and analyzing geographic information and can be utilized in geography teaching [9]. According to another definition, GIS is a system combining statistical analyses and database technology and allowing collecting, storing, analyzing, managing and presenting data [10].

GIS can be regarded as a system based on the integration of the common database systems developed for querying and statistical analyses with maps. This differentiates GIS from traditional computer systems [1]. Affected by such different disciplines as geography, mathematics, computer, geodesy and photogrammetry, GIS has a wide application area in the fields of geography, environmental sciences, forestry, land use, regional planning, security, health and agriculture [11].

**GIS & Education:** Being one of the newest tools and research facilities in education, GIS is a rapidly advancing technology. One of the most important features of GIS is its dynamism. In addition, when data are updated, new information is automatically reflected on the GIS applications that include visual presentations belonging to geographic characteristics [9]. Another important distinctive feature of GIS is that it can be used by all disciplines having a field of study covering space, time and human being. Although GIS is commonly used in various fields including geography, educational sciences, forestry, land use, regional planning, security, health and agriculture, the use of GIS in education is quite new [6, 11].

The use of GIS in education reflects transition from behaviorist approach to constructivist approach in learning. With its methods based on problem-solving and research, GIS introduces a different perspective to the teaching practices conducted at schools. This perspective changes the roles of students and teachers in the learning and teaching process, too. Accordingly, students play a more effective role in the learning process, communicate with their peers and produce information and make evaluations and analyses together with them. Teachers are not accepted as the only source of information, are expected to pedagogically improve themselves continuously, create learning motivation among their students and make the learning process easier. In other words, teachers enable students to reach the information in sources rather than conveying such information to them [12]. It has been suggested that the effectiveness of the activities conducted inside and outside the classroom, the interesting nature of such activities and the fitness of these activities for the purpose are important for teaching programs to achieve success and states that GIS, which is a system integrated with technology, can make a considerable contribution to the effectiveness of geography teaching [13].

It has been argued that higher effectiveness and more permanent learning in science, geography and technology teaching require students to have advanced research skills, do research independently, create questions that lead their research, develop data collection tools, collect data and analyze the collected data in an effective manner [14]. In this regard, GIS, which provides students with a rich learning environment, can contribute to the achievement of an effective learning in the above-mentioned fields.

The examination of educational studies on GIS shows that they are mostly aimed at making the use of the system widespread in primary education and secondary education. These attempts for generalizing GIS started with the foundation of The Environmental Systems Research Institute (ESRI) in 1969 [15]. In 1988, *National Center for Geographic Information and Analysis* (NCGIA) was founded with the aim of improving research on geographic information systems [Audet, 1993; cited by (16)]. In 1996, Berkley University Earth Research Group developed ArcView GIS based Geodesy program to be used in primary education and secondary education. The program presented ready data to students on many subjects [17]. A project titled, "Geographical Information Systems Applications for Schools (GISAS)" was carried out on the subject of the use of GIS at schools between 2003 and 2006.

In educational environments, GIS is mostly used in the form of GIS-supported education. There are two forms of such GIS-supported education: (1) GIS education in such university departments as geography, engineering, geology and urban planning; (2) GIS education in primary education and secondary education. Here, the point to be taken into consideration is that GIS Education and Education through GIS are different. The objective of GIS education is to teach GIS. In Education through GIS, on the other hand, GIS is regarded as a tool in the process of providing a more effective education. In other words, the main purpose of Education through GIS is to do geographical research and spatial analyses [6]. In this context, four different concepts are emphasized. Among these concepts, teaching GIS is suggested to be implemented as of the 5<sup>th</sup> grade, teaching through GIS is suggested to be implemented as of the 6<sup>th</sup> and 7<sup>th</sup> grades, learning through GIS is suggested to be implemented as of the 8<sup>th</sup> and 9<sup>th</sup> grades and research through GIS is suggested to be implemented as of the 10<sup>th</sup> and 11<sup>th</sup> grades [18].

Thanks to its educational advantages, GIS attained a place in the primary education and secondary programs of the USA, Canada and England in the first place and then in the primary education and secondary education programs of such countries as Denmark, Germany, France, Finland, Sweden and the Netherlands. It started to be used in courses such as sciences, chemistry, biology, mathematics, environmental sciences and social studies besides geography [7, 19, 20]. GIS is widely used as an educational tool making it easier to answer such questions as, “what”, “where”, “how” and “why” that constitute the fundamental principles of geography throughout the world [21, 22, 23, 24]. It was incorporated in the secondary education in Turkey with the new geography curriculum prepared in 2005.

Researchers, implementers and producers frequently emphasize that GIS is an important technology for students to achieve different mental activities and high-level thinking skills in the teaching process [25]. In addition, it contributes to the capability of students to do research, the spatial perceptions of students, the ability of students to analyze and synthesize and the improvement of such skills of students as critical thinking, problem-solving and making inferences by implementing geographical principles [7, 26, 27, 28]. Furthermore, GIS provides students with an opportunity to determine the data required for solving a problem, access the data and convert the data into a form that can be used in the GIS program. Those students who use GIS can visualize the

data in different forms (i.e. map, graph, three dimensional image, etc.), which is an important function of GIS and can make various analyses. These students can reach a solution through such analyses. In this process, such skills of students as problem-solving, research, source recognition, cooperating with others, using the information and making sense of complex relationships are improved [29].

Another skill improved by GIS is spatial perception [30, 31]. GIS enables students to draw maps and graphs, measure the distance between two points, calculate the area of a place and place any point whose coordinates are given in the map. Also, it is reported that GIS improves the computer usage skills of students and makes their attitudes towards technology more positive [16].

**Geography Teaching & GIS:** A great majority of the studies concerning the use of GIS in education have been conducted at either university level or secondary education level. Some people argue that the level of GIS programs is not appropriate for primary education students and the computer skills of students are not adequate. However, it is reported that the use of GIS can be beneficial in primary education if there are well-prepared materials, a good planning is done and an effective guidance is provided [16, 31, 32]. The review of related literature demonstrates that there is a series of studies finding out that the use of GIS in primary education social studies course improves the academic achievement of students as well as their motivations for and attitudes towards this course [6, 7, 33].

Geography educators look for ways of improving the geography knowledge of primary education students, in particular, or teaching geography in an easier manner. Today, there is a consensus that the most important tool to achieve this is GIS. GIS is used for teaching geographical subjects in social studies courses in many US states [9, 19, 31].

GIS enables teachers to teach lessons in a practice-integrated and activity-focused manner [29]. Being a problem-based teaching method, GIS makes it easier for teachers to teach in a student-centered and problem-based way. Thanks to GIS, teachers can adopt a project-based approach and enable students to work on particular projects both individually and as a team. Thus, it can be argued that GIS is a tool that can be used by teachers for both endearing the related courses to students and teaching lessons effectively [1]. It has been referred that the use of GIS in primary education and secondary education geography courses facilitates spatial

Table 1: The GIS Practices Proposed in the Geography Curriculum

No	Grade	Proposed Acquisition Number	Proposed Activity Subject
1	9	A.9.4	Maps (Explanations Section)
2		A.9.4	Coordinate System (ExplanationsSection)
3		A.9.5-A.9.6	Contour Lines
4		A.9.5-A.9.6	Climate in Turkey
5		A.9.7	Climatic Elements in Turkey
6	10	A.10.2- A.10.3	Hot Water Resources
7		B.10.2	World Population
8		B.10.3	Population Change
9		B.10.4	Population Dynamics
10		B.10.5	Population Pyramids
11		B.10.9-B.10.10	The Classification of Economic Activities
12		C.10.10	The Urban Fabric of Turkey
13		C.10.11	Variation in the Distribution of Population in Turkey
14	11	C.10.12	The Dynamics of our Population
15		B.11.4-B.11.5-B.11.6	From Production to Consumption
16		D.11.2	The Diffusion Areas of Turkish Culture
17	12	C.12.4-C.12.5	The Commercial Fabric of Turkey
18		C.12.8-C.12.9	Future Scenarios Concerning the Population of Turkey
19		D.12.6	The Positions of Countries
20		D.12.8	Regionalization in the World

Source: Demirci (2008: 56)

research and examinations in particular [23]. Furthermore, GIS can go beyond traditional geography teaching and ensure a more effective learning as it functions as an advanced mapping system and allows spatial analysis [7]. In parallel with this statement, other authors [33] argue that students can achieve a multi-directional and causal learning through the maps related to geographical formations, climate, natural resources and economic activities to be prepared by them via GIS in geography courses. In conclusion, it can be said that, as stated by several authors [34], GIS plays a crucial role in the achievement of a more effective and more permanent geography teaching that is associated with real life to a larger extent.

The last geography curriculum put into practice in 2006 includes some proposals regarding the use of GIS. Of all subjects proposed, 5 are included in the 9<sup>th</sup> grade, 9 are included in the 10<sup>th</sup> grade, 2 are included in the 11<sup>th</sup> grade and 4 are included in the 12<sup>th</sup> grade. Total number of acquisitions associated with GIS practices is 28 (Table 1). GIS can be used in other subjects than the proposed ones, too.

The examination of the research findings of one study [31] regarding the use of GIS in geography teaching reveals that GIS may ensure a more effective geography teaching at the primary education level, but data should be presented for problems associated with the real life and GIS modules should be suitable for the levels of primary education students. The literature review on the use of

GIS in geography teaching conducted by Baker suggests that the GIS practices conducted in the classroom may make it easier for students to learn geography [14]. On the other hand, some research findings suggest the opposite in regard to the effectiveness of GIS in geography teaching. For example, the results of a study conducted by Kerski show that research-focused geography courses where GIS tools and materials are used do not improve the geographical skills of students adequately [19].

There are some studies concerning the applicability of GIS at schools in Turkey [1, 23, 35, 36, 37]. For instance, the results of Özgen and Oban Çakıcıoğlu indicate that the geography course presentations made via GIS are more effective than the courses where classical method is employed [37]. Some of these studies have been carried out in the field of social studies education [6, 7, 33].

## RESULTS AND DISCUSSION

This paper aimed at making a literature review concerning the place and importance of geographic information systems (GIS) in geography teaching. According to this literature review, the use of GIS in geography courses is important in that it enriches teaching, ensures a more effective and understandable in-class geography teaching and guarantees a more permanent learning among students. The fact that GIS supports activity-focused learning and is practice-oriented both makes geography teaching easier and more

effective and may have a positive effect on the learning motivations of students. In addition, GIS enables students to achieve a multi-directional learning and establish a causality relationship between the concepts learnt. Although GIS is observed to be a technology-based application supporting geography teaching, there are quite a limited number of studies aimed at understanding the contribution of this technology to the achievement of an effective geography teaching. In other words, it can be concluded that the future empirical studies to be carried out on this subject are critical in terms of the generalization of the use of GIS in geography courses.

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