The Contribution of Geographic Information Systems (GIS) to Geography Education and Secondary School Students' Attitudes Related to GIS

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Abstract

The purpose of this study is to determine the place of Geographic Information Systems (GIS) in teaching geography, the general level of secondary school students' attitudes towards Geography Information Systems and whether this changes according to different variables. The population of the research consists of the students studying in Istanbul, Ankara, Mersin, Manisa, Gaziantep, Samsun, Çorum, Kütahya, and Erzurum province in 2008-2009 academic year. The sample consists of 665 students who study at 15 academic high schools and were chosen by using the triple stratified cluster sampling method according to geographical regions and socio-economic structures (upper-middle-lower) in the population chosen from the city centre. The data were gathered by using the scale which was developed by Al-Kamali (2007) in order to determine the attitudes of students related to GIS and adapted to Turkish culture (linguistic) under the current investigation. The data obtained were analyzed by using means, standard deviations, t-tests, and Pearson correlation coefficients. According to the findings, the students' attitudes towards GIS are positive, but new and widespread applications are needed for students to learn their lessons with GIS in a more motivated way.

Key Words

GIS Applications, Attitudes, Geography Education, Student-Centred Education.

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Previously, using computer technology in learning activities conducted in schools has often been seen as a fad which would be obsolete within a short time. Many educators, teachers, and administrators were hesitant about whether computers were useful for a better education and higher student motivation (Bednarz, 1995, cited in Al-Kamali, 2007). Besides the problems of adapting the technology into the curriculum, the problems of using it by adapting it to course contents continue (Shin, 2006). Infrastructure and economic issues make it more difficult to find a solution to the problem of "appropriate use of technology to course content" mentioned above. For example, according to the research, which deals with the technologies used in geography lessons in Turkey, there are 48% computers, 35% LCD projectors and 26% internet connections available in geography classes, but only 7% of teachers stated that they used the computers, and 2% stated that they used LCD projectors in every lesson. There were no teachers who used the internet in every lesson (Demirci, Taş & Özel, 2007). Using the technology only for "making presentations" by teachers and students may lead to negative solutions during the teaching-learning process by reducing the beneficial effects for students and teachers alike.

Nowadays, however, students are more eager to learn about technology than teachers. Prensky (2001, p. 1) locates the position of the younger generation learning now and the mature generation who teach them technology, thus: 'We, who were not born in this digital era but have it any period and are trying to adapt ourselves, are affected by it and, compared with new generation, are in the position of "Digital Immigrants". Our students are changing radically compared with the past. Nowadays, students are far away from the people that our education system had in mind. Many naming names have been given to this generation. The most suitable name I can think of is "Digital Inhabitants" '. Adapting the GIS to education and making it obligatory in such circumstances can help reduce the acceptance process in a short time. This system is used much more in the educational field in developed countries (Baker, 2005; Demirci, 2004; Mota, Peixoto, Painho, Curvelo & Ferreira, 2006; Siegmund, Viehrig & Volz, 2007). GIS is an important means of knowledge technology in geography teaching (Gatrell, 2004; Milson & Alibrandi, 2008; Kerski, 2000, 2001, 2003; Özgen & Çakıcıoğlu, 2009; Wiegand, 2001). Chalmers (2006) states that he is pessimistic about the widespread use of GIS in schools in the next five years, and adds that the basic problem is teachers' time, rather than matters of rigging or software difficulties. But this method is seen as a knowledge substructure for the new generation in developed countries (Yuda, Itoh & Johansson, 2009). Even here this method has been years since ceased to be the only geography course content; now GIS teacher training is continuing at full speed in many areas such as science, mathematics, history, and physics (Johansson, 2006; Kerski, 2003; McClurg & Buss, 2007; Mota et. al., 2006; Siegmund et. al., 2007). According to the research literature, both educators and researchers stipulate that GIS be used in the learning-teaching process (Aladağ, 2007; Alibrandi, 2003, Alibrandi & Sarnoff 2006; Beishuizen, 2006; Demirci, 2004, 2006, 2007; Donert, 2006a, 2006b; Ida, 2006; Johansson, 2006; Kerski, 2000, 2003, Mark, Kay & Dan, 2003; Siegmund et. al., 2007). Also, it is stated that one of the greatest benefits of integrating GIS into school programmes is to create a "culture" that allows for an active research process, so that teachers can develop new ways of using GIS in their lessons (Jenner, 2006). But there are debates as to whether using GIS in education is a tool, or whether it is a goal in itself. In this context, four concepts are highlighted as shown in the Figure 1: *To teach GIS* at the bottom of the pyramid, from 5th class; *to teach with GIS* from 6/7th classes; *to learn with GIS* from 8th/9th classes; and to *research with GIS* from 10th/11th classes are all proposed stages that can be applied (Siegmund et. al., 2007; Schleicher, 2007, p. 25, cited in Schubert & Uphues, 2009, p. 277). Taking all these into consideration, the approach must not be "How can we bring GIS to the education programme?" Instead it must be "How can we help to achieve the objectives of the GIS curriculum?" (United States Geological Survey [USGS], 1997).

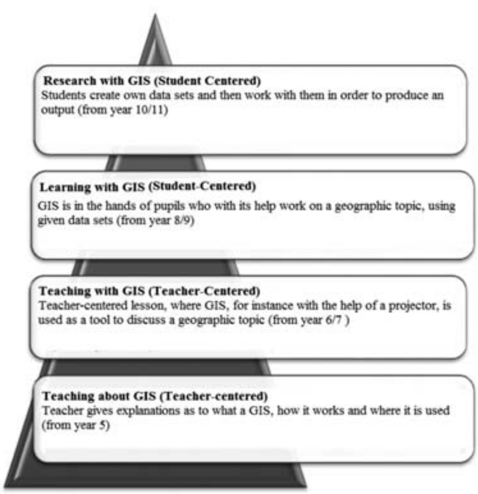

Figure 1. *The Pyramid of Education Phases in GIS*

The Contribution of GIS to Education in Schools

Physical disabilities, which are one of the most important factors for the pervasive use of GIS in schools, have given way to the effectiveness and adequacy of teacher education (Lam, Lai & Wong, 2009). But the important point here is that researchers, policy producers, and curriculum developers must pause over how to use GIS in the educational environment and to achieve positive learning outcomes (Bednarz, 2004).

Consequently, it will be appropriate to teach primarily with GIS in lessons where geographic inquiry skills should be improved (Demirci, 2008; Karatepe, 2007). According to the PDÖ-GIS approach suggested by Aksoy, GIS applications provide more effective learning with a problem-based learning model (Aksoy, 2004, p. 189). At this point, one of the reasons why we must focus on GIS, especially recently according to the traditional educational understanding, is that it allows us to be able to go beyond knowledge and present levels of comprehension with new approaches (Artvinli, 2009). GIS helps develop multi-faceted skills in the students. It also develops many skills, including individual and team work, through events (Kidman & Palmer, 2006). These skills, and the effects of GIS on geography training, can be classified as follows (Biebrach, 2007):

Inquiry-Based Learning: One of the best ways to teach the "Geographic Inquiry Skill", which is one of the eight geographical skills in the geography curriculum (Milli Eğitim Bakanlığı [MEB], 2005), is to use GIS in both the classroom and field works (Favier & Joop, 2009; Shin, 2006). In the report of the International Geographical Union's Geography Education Commission, the importance of education based on geographic inquiry-based skills in terms of developing students' thinking skills is mentioned (International Geographical Union Commission on Geographical Education [IGU-CGE], 1992). One of the optimum learning conditions is to handle the job in different levels of difficulty (Biggs & Moore 1993, p. 269 cited in West, 2003). GIS takes the knowledge - such as describing the data, complex tables and maps, and diagrams - at different levels, from easy to difficult (West, p. 268).

Visual-Spatial Comprehension Power: GIS allows the user to visualize and analyze previously hidden relationships, patterns, and trends with a new method (Shin, 2006; Wiegand, 2001). The benefit of GIS stems from its ability to provide maps and information which are physically impossible to get with requested requirements and information.

To Reconcile Information in order to Define the Current Relationship: Students by making sense of this information fit it into a specific logic and learn it by establishing relations with the problem because it will be used for GIS application in student-centered lessons that are processed with the help of GIS information. In another way, the student learns the subject described by CBS as he himself entering the relevant data, processing and analyzing them. In this way, the student learns the knowledge not by memorizing a lot of information but, with the role in the context and the frame of its environment and with the awareness of how important is it (Demirci, 2004).

Developing Thinking Skills: Basic Thinking Skills (Department for Education and Employment [DfEE], 1999) are: *information processing skills, reasoning skills, questioning skills, creative thinking, and evaluation skills*. GIS application is a process that enhances students' thinking skills such as processing the information obtained (selecting useful information, meaning, categorization, classification, comparison, differentiation, and analyzing them), their justification, and making appropriate inquiry into the reasons (Lidstone & Stoltman, 2006; Wiggleswort, 2003). In the end of this process, students can use creative thinking skills with mental processes activities such as generalizing, hypothesizing, and working on alternative solutions. According to Kerski (2003), using GIS develops high level analytical and synthetic thinking. GIS supports students' geographical skills by improving spatial thinking ability. There are three dimensions of spatial thinking: Spatial-visual stimulus, spatial orientation, and spatial mutual relations (Gollede & Stimson, 1997 cited in Bednarz, 2001). The parallel relations between spatial relationships and mapping process at geography are presented in Table 1. The spatial relationships in the left column of the table are stage of spatial thinking which are the most developed in geography education (Bednarz).

Table 1.
Spatial Thinking Skills

Spatial Relations	Processes Used in Cognitive Mapping and GIS
• Abilities (skills) that recognize spatial distribution and spatial patterns	• Constructing gradients and surfaces
• Identifying shapes	• Layering
• Recalling and representing layouts	• Regionalizing
• Connecting locations	• Decomposing
• Associating and correlating spatially distributed phenomena	• Aggregating
• Comprehending and using spatial hierarchies	• Correlating
• Regionalizing	• Evaluating regularity or randomness
• Comprehending distance decay and nearest neighbour effects in distributions (buffering)	• Associating
• Way finding in real world frames of reference	• Assessing similarity
• Imagining maps from verbal descriptions	• Forming hierarchies
• Sketch mapping	• Assessing proximity (requires knowing location)
• Comparing maps	• Measuring distance
• Overlaying and dissolving maps (windowing)	• Measuring directions
	• Defining shapes
	• Defining patterns
	• Determining cluster
	• Determining dispersion

The parallel processes that are next to each other in the right column of the table are used in the creation of conceptual maps by individuals. Conceptual maps are the store of information which the individual obtains when interacting with the environment. Conceptual maps are the basis of both spatial and non spatial decision-making processes (Bednarz, 2001).

Professional Learning: GIS has become a source of employment in the geography profession. Especially in Turkey, no one employs the identity "geographer", but GIS experts or analysts do exist. For this reason there is an increasing awareness among students that GIS is required as a professional option (Meaney, 2006, p. 284). As a result of GIS applications in schools, which had not been seen in a professional dimension till now, students' perceptions are changing (Kolvood, 2007).

Motivation: Motivation is one of the most important factors affecting students' attitudes towards the course. Students' motivation can be increased by using GIS in courses. This is a common result of many studies (Al-Kamali, 2007; Biebrach, 2007; Jekel, Pernkopf & Hölbling, 2008; Mota et al., 2006; Tuna, 2009; West, 2003). Teaching lessons with a language spoken in everyday life by students (digital inhabitants as they are) increases their motivation towards lessons. On the other hand, not knowing how to use the software and the complexity of using GIS can negatively affect student motivation (Biebrach).

The Purpose

To develop a more student-centred approach in GIS will help determine not only teachers' or trainers' but also students' attitudes to it, and make GIS applications more student-centred. Passing quickly through the stages of teaching teacher-centered GIS, which is used more nowadays (especially in Turkey), and *teaching with* GIS and using stages of *learning with* GIS (which is student-centred) and *research* with GIS are all very important. For this reason, the purpose of this study is to answer the question "*how are secondary school students' attitudes related to geographic information systems?*"

Sub-Problems

- Generally, at what level are secondary school students' attitudes related to geographic information systems?
- Do the students' attitudes relating to geographic information systems differ according to gender?
- Are there significant relationships between students' attitudes to geographic information systems and class level, or the level of computer use and frequency of use of GIS in geography lessons?

Method

Research Model

This research is a relational model for determining whether secondary school students' attitudes towards GIS differ according to different variables. Models of this type usually measure statistically the degree of relationship and provide correlations (McMillan & Schumacher, 2006).

Population and Sample

The population of the research consists of the students studying at secondary schools in 2008-2009 academic year. The sample consists of 665 students who study at 15 high schools and are chosen by using the triple stratified cluster sampling method according to geographical regions and socio-economic structures (upper-middle-lower) in the population chosen from nine city centres [İstanbul, Mersin, Manisa, Gaziantep, Samsun, Çorum, Kütahya, Erzurum and Ankara].

Data Gathering Instruments

The GIS Attitude Scale: The scale was developed by Al-Kamali (2007) in order to determine the attitudes of students to GIS. The scale is between the *I completely disagree* and *I completely agree* intervals and consists of 24 five-point Likert-type items on a single dimension. The Cronbach Alpha internal consistency coefficient of the scale is .91. The confirmatory factor analysis study which has been carried out to determine the validity of the Turkish form in the context of the current research has been conducted in two phases. In the first phase, whether the estimated values of the Turkish form exceeded the theoretical limits has been identified before confirmatory factor analysis of the one dimension obtained from the original factor structure. According to the obtained results, the values do not exceed the theoretical limit, whereas the other compatibility indexes of the model [*GFI*=0.71, *AGFI*=0.69, *PGFI*=0.65, *RMSEA*=0.11, *CFI*=0.75] indicate that the proposed scale is not appropriate. According to this result, the values obtained in the context of working models relating to standard compliance show that they do not verify partly the modeled structure, which is 24 questions and with one-factor. Therefore, exploratory factor analysis has been conducted in order to determine the factor structure of the Turkish form. Whether factor analysis is to be interpreted has been decided by taking the results of KMO and Bartlett Test into account. For the construct validity study of the scale, factor analysis of collected data can be done with Kaiser Meyer Olkin and Bartlett = . 92 (p <.01). Next, factor analysis was started with 24 items by using the varimax vertical axis turning technique. As a result of factor analysis, the eigen value of the 20 items of the scale consists of one subscale that is greater than 1. The total variance percentage of the scale, which is explained at subscale, is 40.18, factor loadings of the items range from 0.48 to 0.72. The reliability has been examined by the internal consistency method, and the Cronbach alpha internal consistency coefficient of the scale is 0.88. Consequently, the GIS Attitude Scale has been organized as 10 positive and 10 negative, a total of 20 items, and it is 5-point Likert type as *I completely disagree* (1), *I don't agree* (2), *I am neutral* (3), *I agree* (4) and *I completely agree* (5).

Process

Research data were obtained by applying data collecting means to the sample students group in 2008-2009 academic year. The response time of data collection is approximately 10-15 minutes. Before the statistical analyses, demographic variables have been grouped. Next, the items on data collecting means applied to students have been graded with 5 Likert-system. Means (X) and standard deviations (SD) have been calculated for evaluating the general level of students' attitude towards GIS. The *Independent group t-test* has been used to evaluate the differentiation of GIS attitudes of students according to gender. Also the relation between students' attitudes towards GIS and class level, levels of computer use and frequency of computer use in geography lessons have been determined with *Pearson Moments Correlation* analysis.

Findings

The arithmetic mean relating to item points of students' attitudes towards GIS and standard deviation scores have been presented in Table 3. When the results obtained are analyzed it is seen that the item "*Using GIS in geography lessons helps students to learn better this lesson*" (*X*=4.31, *SD*=0.82) is the most dominant item. Respectively, "I want to learn technology (GIS) in geography lesson" (*X*=4.28, *SD*=0.90), "It is a waste of time to learn with GIS" (*X*=4.23, *SD*=1.44) and "I would be happy if I had the opportunity to use GIS in geography lessons." (*X*=4.23, *SD*=0.94) items follow the previous item. On the other hand, the "I do not consider myself efficient in using GIS in lessons" (*X*=2.88, *SD*=1.25) item is the lowest rated item. Respectively, the "I think the best way of learning geography is not GIS" (*X*=3.22, *SD*=1.17) and "I prefer using the lesson book and listening to the teacher instead of GIS" (*X*=3.46, *SD*=1.24) items follow the previous item. When the obtained item points have been evaluated on the basis of total points, the arithmetic mean is determined as 3.94 and standard deviation is determined as 0.63. According to this finding, academic high school students' attitude towards GIS is positive.

Independent group t test results, which have been done to determine whether sample students' attitudes to GIS differ according to gender variables, are presented in Table 4. According to obtained findings, the differences between the arithmetic mean of the groups were not statistically significant ($t=-0.210; p>.05$). According to this finding, the GIS attitudes of male and female students are at the same level.

The relation between students' attitudes towards GIS and class level, levels of computer use and frequency of computer use in geography lessons has been determined with *Pearson Factorial Moment Correlation* analysis, and its results are presented in Table 5. A negative relationship has been found between students' attitudes towards GIS and the level of computer usage, but a positive relationship has been found among students' attitudes towards GIS and class level and the frequency of using GIS in geography lessons. According to the obtained results, the increase in the level of computer usage affects students' attitudes towards GIS negatively.

Discussion

According to the results, students' attitudes towards having lessons with GIS are positive. This result corresponds to the literature (Aladağ, 2007; Al-Kamali, 2007; Baker & White, 2003; Biebrach, 2007; Johansson, 2006; Kerski, 2003; Özgen & Çakıcıoğlu, 2009). Also Healy (2005) states that GIS has a positive effect on students' motivation, attitude and interrogation skills. Learning with GIS motivates students and this technology curiosity can be used in teaching geography with the help of GIS.

In Turkish culture there is a tendency to ask directions rather than consult a map. One reason is that individuals in our society graduate from the education system without gaining adequate levels of *map reading and interpretation* skills in geography lessons. Giving more importance to GIS in education and encouraging students to develop their skills could resolve this situation (Shin, 2006). GIS is an educational approach where students can perform higher levels of thinking skills. For a generation of students who are intertwined with technology and spend the majority of their time on computers it can be the means to professional development.

According to research results, no significant connection is to be found between the frequency of using GIS in geography lessons and class levels and gender. Under normal conditions there should be a significant difference according to class level and the frequency of using of GIS in geography lessons as a result of education with GIS. The insignificant difference in the emergence of these two variables can be explained by the nature of the intended course using GIS in schools., because the students who use GIS applications more often and in an advanced stage (from 9th class) must create the difference. The fact that no such difference emerges can be attributed to the absence of content differences in GIS application design according to grade level. The courses where GIS is used, especially the 11th and 12th classes, do not affect the software's quality. Tomal (2009) also expresses in the same way the reason for there not being a difference between 9th and 11th students in terms of not using the knowledge from geography lessons in daily life, and he has questioned the qualifications of the teaching lesson during two years. Not having a significant difference according to gender overlaps with similar investigations (Al-Kamali, 2007) and this is a desired situation.

A negative relation has been found between students' attitudes towards GIS and their level of computer usage. This result can be explained by the complexity of the GIS applications available for students. This result is consistent with West's study (2003) in an interesting way. The author associated this negative attitude with the dominance of GIS software in the research he carried out on this subject. West states that students feel uncomfortable on this issue and while they are using computers they do not feel very comfortable. According to him the reason for this is that GIS software is designed primarily for use in industry, and mastering it requires special training and practice, and he connects students' negative attitudes on this issue to inexperience. In addition to this, it can be said that the basic levels of GIS-teaching GIS or teaching with GIS are teacher-centred practices in Turkish schools. Because a student who doesn't practice cannot be motivated enough in a complex lesson process with passive methods, that same student cannot attain the desired performance. For this reason, GIS applications in secondary school geography lessons should be designed at the level of *learn with GIS* and *research with GIS*. When it is looked at from this perspective, as it is in developed countries (Mizutani &

Morimoto, 2009), GIS applications in Turkey need the cooperation of teachers and geography educators and researchers who can source from the universities to secondary schools.

GIS applications today are professional skills which require a special area of expertise. Producing GIS software which intermediate level computer user can use without taking up too much time is required. Teachers should not need to be experts. Simple interfaces of GIS technology producers and simple and widely available methods are not being developed.

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