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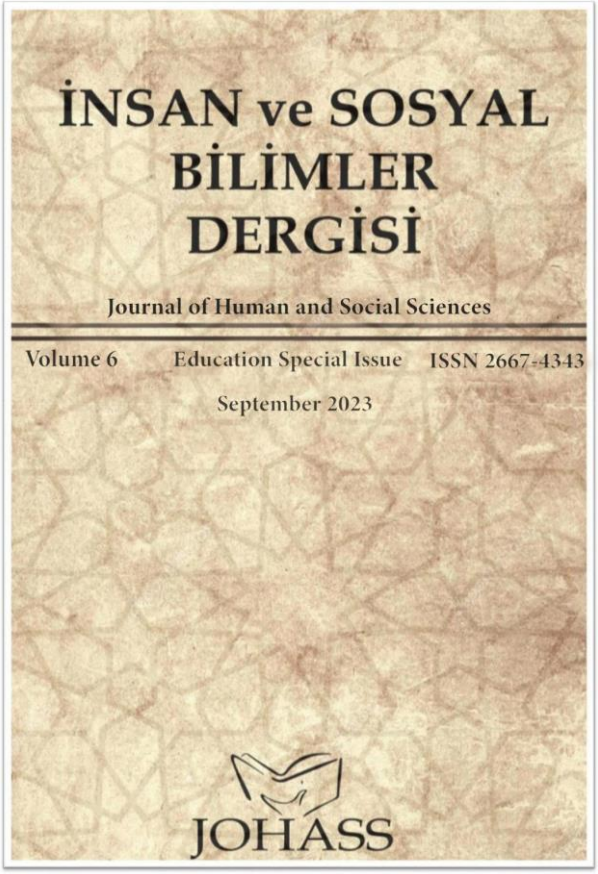

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How Can A GIS Application Develop Geographical Skills of Students: The Case Dashboards

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How Can A GIS Application Develop Geographical Skills of Students: The Case Dashboards

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Abstract

Geography is the user guide to the world. Thanks to geography, people should be able to perform all kinds of activities in their daily lives more efficiently and use geography in their future planning. However, for this, geographical knowledge should not be memorized; instead, it should be transformed into geographical skills. Geography teachers have a great duty in this regard. To develop geographical skills for students is a multidimensional process. Considering the expectations of today's students, one of the most appropriate tools that can be used in teaching these skills to students is dashboards, a technology based on geographic information systems. Dashboards can transform geographical information into maps, graphics, indicators, and lists thanks to their superior features, thus increasing their usability. Geography teachers' designing geography teaching processes using this technology will enable students to develop their geographical skills. However, at this point, it is seen that geography teachers are not sufficiently equipped in this regard, and examples are needed. In this study, it is aimed at explaining how dashboards can be used to teach five basic geographical skills known as asking geographical questions, collecting, organizing and analyzing geographical information, and answering geographical questions to students. In order to achieve this goal, a descriptive literature review, one of the qualitative research methods, was used. In light of the literature review, how dashboards can be used in the acquisition of five basic geographical skills is explained with examples, and suggestions on how dashboards can contribute more to the geography teaching process are given.

Keywords: Dashboard, GIS, geographic skills, geography teaching

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Introduction

In the introduction part of the study, information about the development of GIS technology, dashboards, and geographical skills is given, and why this research is needed is presented in the light of the literature review.

Development of GIS Technology and Dashboards

It can be said that the core of the science of geography is based on the relationship between the physical characteristics of the world and the various activities of people. The key element in revealing this relationship is the geographical data collected by adding spatial information to the data. By combining and analyzing geographical data, the concept of geographical information, which expresses various characteristics of geographical events or phenomena, emerges. Geographical information is obtained within the scope of four basic principles. These principles can be listed as the principles of distribution, relationship, comparison, and causality (Özçağlar, 2003). The full implementation of these principles is only possible through spatial analysis. Therefore, it can be said that spatial analysis based on geographical information is the most significant subject of geography.

There is a technology that enables spatial analysis, which is the basis of the science of geography, to be done more comprehensively and in a short time. his technology is called Geographic Information Systems (GIS). GIS is the general name given to decision support systems consisting of components such as hardware, software, data, personnel and methods, which are used to solve economic, social, environmental, etc. problems experienced worldwide by performing the collection, storage, analysis, processing, management, querying and presentation of geographical data to users (Ministry of Environment, Urbanization and Climate Change, 2023).

Thanks to GIS, "geographic information" collected in line with the basic principles of geography is analyzed within a "system" within the framework of a workflow model based on information technologies. This analysis can be done easily thanks to the ability of GIS to work with layers. For example, temperature, precipitation, elevation and vegetation characteristics of a study area can be displayed on the same map with different layers and the relationship between these layers can be examined (Yomralıoğlu, 2005). Spatial analysis results obtained with GIS are visualized and presented with maps, graphics, etc. The most

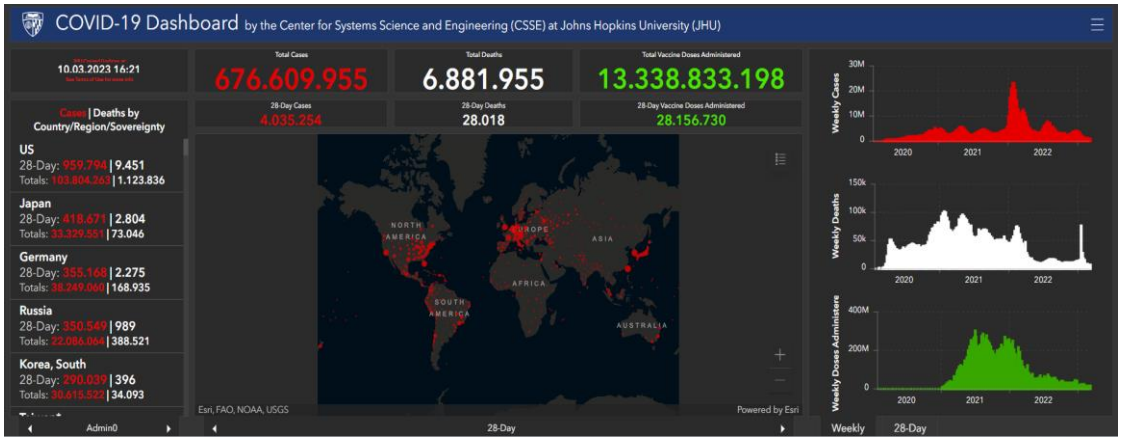
significant feature that distinguishes GIS from other computer systems is this visualization dimension (Turoğlu, 2000).

GIS technology, which has entered our lives with the development in technology, gains different features by being affected by technological developments. Although the use of GIS dates back to the 1800s, the widespread adoption of computer-assisted GIS extends from the 1960s to the present day. During this period, innovations such as remote sensing and global positioning (GPS) systems have increased the usability and efficiency of GIS. With these superior features, GIS is used in numerous of different fields ranging from transportation planning to environmental impact analysis, from the management of natural resources to the management and prevention of disasters (Kara, 2016).

As the use of the Internet has become accessible to more and more people around the world, GIS technology has changed its dimension and the concept called WEB GIS has emerged. In its simplest definition, WEB GIS is a GIS that uses WEB technology to communicate between a server and a client. In this definition, the server is cloud storage systems and the client is usually a web browser or an application on a mobile device. The most important advantage of WEB GIS for users is that it eliminates the need for hardware with high system requirements and provides a much easier and more practical use, especially thanks to its ability to work on mobile devices. Some of the advantages of WEB GIS are that the GIS products created can be easily delivered to millions of users around the world with internet access, can easily adapted to different operating systems or web browsers, and they are more accessible in terms of cost compared to classical desktop GIS applications, and have an interface that can be easily used even by people who do not have a very high level of computer literacy (ESRI, 2023a). One of the tools offered for use within the scope of WEB GIS applications is "Dashboards", a product of ESRI company. Dashboards allow users to present their location-based analyses on a single screen with simple and interactive data visualizations. In addition, with dashboards, the status of any geographical event or phenomenon can be monitored in real time, and the trends of this event or phenomenon can be visualized with graphics and various indicators (ESRI, 2023b). During the COVID-19 pandemic that began in 2019, the Dashboard created by John Hopkins University to monitor the course of the pandemic was followed with interest by the whole world (Figure 1).

Figure 1

A Dashboard With Real-Time Data Flow Prepared by John Hopkins University to Monitor The Pandemic (John Hopkins University&Medicine, 2023).



Using GIS to Develop Geographical Skills

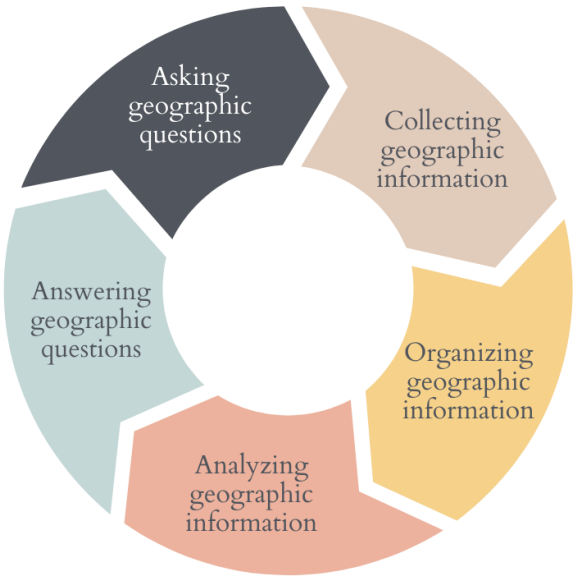
Geography examines the characteristics of landforms, the distribution of population, economic activities such as agriculture and industry, natural disasters and much more. Therefore, these subjects are taught in geography courses all over the world. However, it is also essential to focus on issues such as how the information related to these subjects can be used outside the teaching process, that is, how it affects people's daily lives and how it can be used in future planning (Artvinli, 2012). Nonetheless, geographical knowledge is often perceived only as correctly showing the location of countries on a map or knowing the capitals of these countries (Kubiatko et al., 2012).

If any information cannot be used in daily life, its function cannot be more than a burden in our minds. This principle holds true for geographical knowledge as well. Geographical knowledge gains meaning when it is transformed into skills and integrated into daily life. It is precisely at this point that geographical skills should come to the agenda. When the geography curricula of the developed countries in the world are examined, it is observed that geographical skills are included in addition to the classical achievement statements. With these skills aimed to be acquired, students are expected to understand the characteristics and potential of the space they live in and thus to construct the spaces in a way that will provide maximum benefit (Çiftçi & Yücel, 2022). Although there are skills with different names in the geography curriculum of each country, it is seen that they are derived from the five

fundamental skills in the Lifelong Geography document made in 1994. These skills are given in Figure 2:

Figure 2

Five Basic Geographical Skills (Geography Education Standarts Project [GESP], 1994).



In studies investigating students' views on geography lessons, it has been concluded that they mostly think that geography lessons consist of memorization and find geography lessons boring (Aydın, 2012; Dikmenli & Çiftçi, 2016). In many studies on this subject, it is stated that the biggest problem seen in the teaching of geography course is that the geography course is designed as a teaching process in which students are made to memorize (Akyol, 1999; Sekin & Ünlü, 2002; Şahin, 2003; Ilgar, 2006; Gökçe, 2009). Sözcü, Türker and Dündar (2023) concluded in their research on high school students that geographical information is not used much in daily life. Geographical knowledge and skills are acquired by students through geography teaching. The sources of geography teaching are elements such as teachers, curriculum, textbooks or teaching materials. Therefore, the reasons for the transformation of geographical knowledge into geographical skills should be sought in these sources.

Although the age we are in is expressed in different ways in different sources, it can be said to be an age of technology in general. Because in this age, technological developments are faster than ever before. One of the areas affected by these developments is education. In order to educate students who are born directly into technology (Prensky, 2001), there seems to be no other way out than integrating technology into education. Technology integration

into education is a complex process with many dimensions (Kabakçı Yurdakul & Odabaşı, 2013). In order to carry out this complex process successfully, teacher competencies should be increased with a focus on technology, and the education system, curricula, textbooks, teaching materials and other elements should be designed in accordance with technology integration. When the literature is reviewed, it is seen that one of the things to be done to ensure successful technology integration is to provide teachers with the necessary support for technology integration. This support can be provided in the form of in-service trainings, professional study groups or sample lesson designs in which technology is integrated. However, the result of the literature review is that this support cannot be given too much for geography teachers to successfully integrate technology into their lessons (Allan et al., 2010; Jang, 2010; Açıkgül, 2017). According to Kerski (2021), in order to develop GIS usage skills in teachers, instead of buttons, menus or interfaces, the focus should be on how to use which parts of the user interfaces to develop students' problem-solving, critical thinking and spatial thinking skills.

When the words geography and technology come together, the first technology that comes to mind is Geographic Information Systems (GIS) technology. GIS has many sub-applications within itself. One of them is the panels called "Dashboard". Thanks to GIS-based dashboards, geography lessons can be transformed into geographical skills by transforming geographical knowledge into geographical skills. Geography teachers want to integrate GIS into their lessons, but they do not know how to do this because they have not received adequate training on this subject at university (Babacan, 2015). Geography teachers need to know how to do this and should have pre-service or in-service training (Artvinli, 2009).

The aim of this study is to demonstrate with examples how dashboards can be used to teach geographical skills to students. Thus, it is aimed at guiding geography teachers on the use of dashboards in teaching geography skills to students and to contribute to closing the gap in the literature on this subject. In this context, answers to the following sub-problems were also sought:

- How can dashboards be used in developing the skill to ask geographical questions?
- How can dashboards be used to improve the skill to collect geographic information?
- How can dashboards be used to improve the skill to organize geographic information?
- How can dashboards be used to develop the skill to analyze geographic information?
- How can dashboards be used to develop the skill to answer geographical questions?

Method

In this study, which aims to reveal how GIS technology-based dashboards can be used to teach geographical skills to students, a descriptive literature review from qualitative research methods was used. Qualitative research collects data through methods such as observation, interview or document analysis and summarizes them in various ways (Creswell, 2012). In this study, document analysis was used to make explanations about how geographical skills can be developed with GIS-based dashboards. Document analysis is the analysis of written materials containing the information that needs to be accessed to achieve the purpose of the research (Yıldırım & Şimşek, 2018). In this context, various sources on the use of dashboards in geography teaching processes were examined. In addition, under the coordination of the researcher, the data of an in-service training aimed at increasing the use of GIS by geography teachers in Turkiye were utilized.

Following the document analysis, the collected data were analyzed using a descriptive analysis method. In descriptive analysis, the data collected are organized in line with the research objectives and presented to the reader (Yıldırım & Şimşek, 2018). In this study, the data collected were organized and interpreted according to the five fundamental geographical skills and the results were revealed.

Findings

In this section, in light of the literature review, explanations on how to use dashboards in teaching five basic geographical skills to students are given.

Using Dashboard to Develop the Skill of Asking Geographical Questions

The first step in conducting research on any geographical topic should be to ask questions. Because at the end of the mental process that starts after the question is asked, possible answers emerge and a hypothesis is formed. The need to verify hypotheses by spatial analysis also determines the road map of geographical study. The basic questions that can be asked in a spatial analysis study without the use of dashboards have basic and one-dimensional features such as "What, where, how much?"; Thanks to the ability of dashboards to process many different data layers and make analysis and visualization, geographical questions become more comprehensive and multidimensional such as "What is it related to,

what is the cause, what are the effects?". For example, the use of traditional teaching methods in a geography teaching process in which the subject of natural disasters is covered without the inclusion of any technology in the process will cause the inability to develop the skill to ask geographical questions about the subject. The geographical questions that students can ask in this teaching process will be non-multidimensional questions such as "What is a natural disaster?", "Where are natural disasters seen in the world?" or "How many people have lost their lives as a result of natural disasters?". With the inclusion of dashboards in the geography teaching process, the level of geographical questions can also increase.

After creating a basic map where the locations of natural disasters are added as point data, layers containing different data can be added to this map. For example, a layer of temperature distributions can be added to the map of a dashboard application related to forest fires, and graphs can be produced that reveal the relationship between forest fires and temperature distribution. This can lead to the question "Where in the world are forest fires most common?" and "What is the relationship between forest fires and temperature distribution?". Dashboard's ability to produce a graph that can reveal the distribution of data containing time information from past to present can enable a high-level geographical question such as "How has the frequency of forest fires changed from past to present?". Starting the geography teaching process with questions that mobilize high-level thinking skills such as this will contribute to the development of the remaining four basic skills.

Figure 3

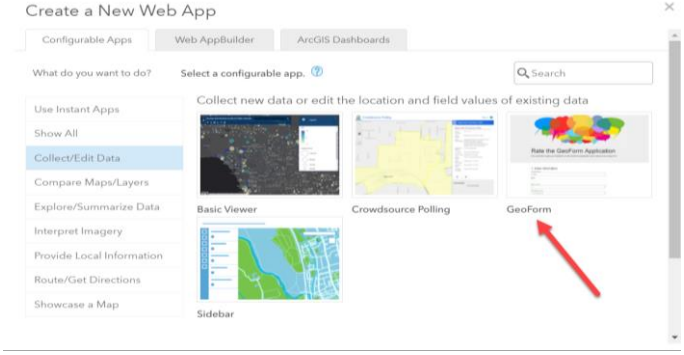
A Dashboard on Forest Fires (SAS, 2022).

Using Dashboard to Develop the Skills of Collection Geographical Information

The prerequisite skill for students' to ask geographical questions is collection of geographical information. Geographical knowledge emerges as a result of processing and analyzing various data belonging to a place or a person. For example, the expression "945 mm precipitation" is a data. However, the statement "Antalya's average annual rainfall is 945 mm" is geographical information. What gives the information given in this statement a geographical quality is that it contains location information (Koç, 1993; Gürleyen, 2016). Dashboards transform raw data into geographic information by adding location information and visualizing them with various indicators. Therefore, dashboards have a driving force that mobilizes students to develop the skill to collect geographical information. In order to develop geographical skills, it is necessary to have geographical knowledge (Türker & Sözcü, 2021). Geographic information can be obtained from two different sources. The first one, primary sources, are the questionnaires, videos and photographs taken by students during fieldwork, or the notes taken from their observations (Bednarz & Bednarz, 1995). Geographical skills cannot be taught only inside of the classrooms. Many times, it is needed to go to field work and observation on the nature (Dönmez & Artvinli, 2021). Different applications that can be used while creating maps in dashboards enable geographic information collected from primary sources to be easily added to maps. One of these applications is the "GeoForm" application (Figure 4). Thanks to GeoForms, geographic information with the desired spatial or temporal dimension can be easily collected from the field. Students who go to the field with mobile devices supported by GPS technology can transfer the information requested from them to the map through these applications in cooperation with themselves, thus improving their geographical information collection skills.

Figure 4

Maps to be Added to Dashboards can Collect Data From the Field With A Web Application Called Geoform (Created Specifically for This Article).



Using Dashboard to Develop the Skill of Organizing Geographical Information

Data collected from primary or secondary sources should be organized in a meaningful way after the process of transforming them into geographical information with GIS applications. Dashboards support the development of this skill in students with their features. For this purpose, column or pie charts, various indicators, lists, tables, enriched texts or embedded web objects can be added to the dashboard according to the nature of the data in the attribute table of the map (Figure 5) and can be designed according to the dashboard layout (Figure 6).

Figure 5

Dashboards can Include Many Different Elements for Organizing Geographic Information (Created Specifically for This Article).

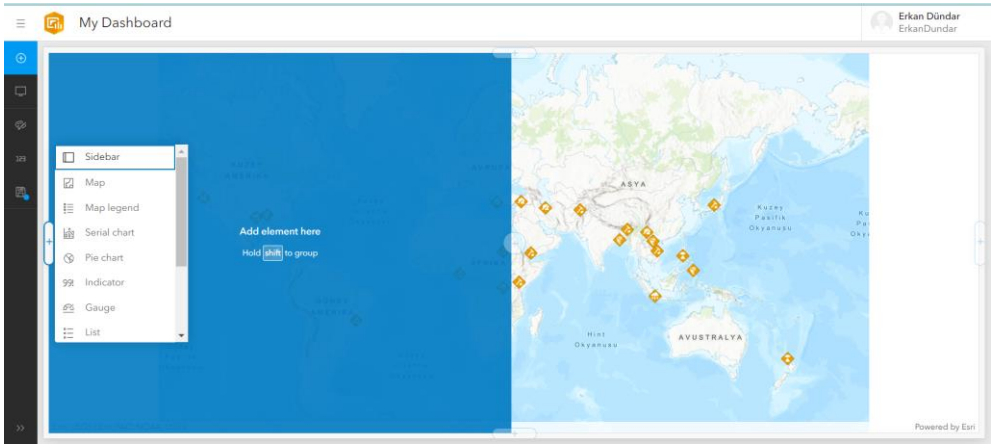
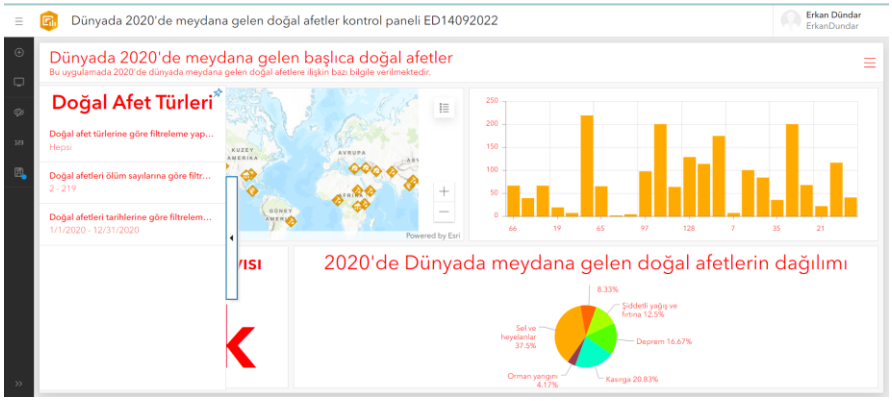


Figure 6

Elements Added to Dashboards can be Moved to Different Places and the Layout can be Easily Changed. (Created Specifically for This Article).



In the dashboard shown in Figure 6, the data collected by the students from secondary sources about the main natural disasters that occurred in the world in 2020 were transferred to the map with the Geoform application by adding metadata such as location information, description, numbers, date, and using this attribute information on the map, a pie and column chart, indicator and filter list element were added. Thus, the geographical information obtained by the students was organized in an orderly manner and made meaningful through the dashboard.

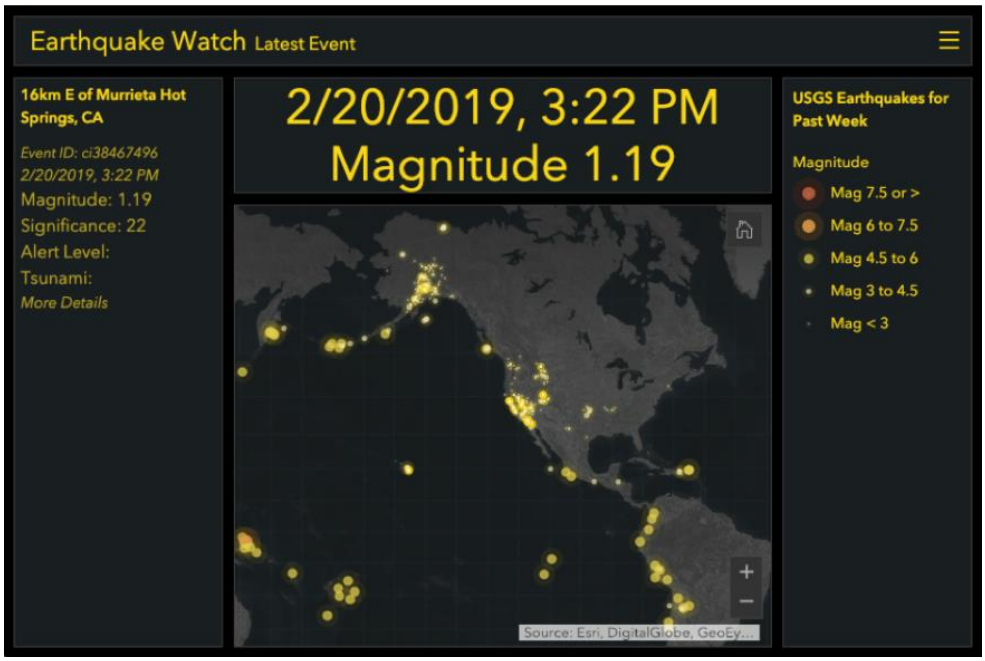
Using Dashboard to Develop the Skill of Analyzing Geographical Information

The skill to analyze geographical information, which can be defined as recognizing patterns and relationships between organized geographical information (Taş, 2008), can be easily developed by students thanks to visual elements such as map-based graphics, tables and indicators provided by dashboards. Dashboards facilitate the analysis of geographical information by increasing its comprehensibility with the visualization it enables. Another important feature of dashboards that should be emphasized in analyzing geographical information is the ability to monitor real-time data. In this way, it is possible to instantly analyze geographical information that may change especially in a short time. With this feature, every data added to the map by different users is instantly reflected in the visual elements of the dashboards and new patterns and relationships can be analyzed up to date. In this way, dashboards can be used effectively in solving real-world problems thanks to their live data flow feature (Milson & Kerski, 2012). For example, thanks to a dashboard created for instant monitoring of earthquakes (Figure 7), activities such as intervention and search and rescue can be organized quickly. Or, in the geography teaching process, students can analyze the most up-to-date geographical information by updating a dashboard where they can reveal the age and gender distribution of the population in their neighborhood according to the changes that may occur in the population. Different results are reached as a result of analyzing geographical information (Taş, 2008). The use of dashboards will attract students' attention in reaching these different results by analyzing geographical information. For example; the maps that students create on a dashboard about the population of the neighborhood where they live or the visual elements they add to the dashboard will enable them to analyze the spatial distribution and patterns of the population. In addition, the graphs they will create from the data they obtain will enable them to analyze the trend of the population and the relationships between the elements with which it interacts, the numerical data to be added will enable them

to analyze the ranking of the population in space according to different dimensions, and the integration of written geographical information and other elements will enable them to reveal the rationale and result of their analysis.

Figure 7

A Dashboard Application Tracking Recent Earthquakes (Nyenhuis, 2022).



Using Dashboard to Develop the Skill of Answering Geographical Questions

The skill of answer geographical questions is the skill to answer the geographical question asked at the very beginning of the process as a result of the spatial analysis. Students will be able to make inferences to be obtained from geographical information organized with elements such as graphics, maps and indicators offered by dashboards more easily, so they will be able to answer geographical questions easily.

As emphasized before, dashboards ensure that the geographical question to be asked is at a higher level and naturally the answer is also at a higher level. For example, the use of dashboards in a geography teaching process related to the classification of settlements according to the amount of population will enable the creation of different categories by analyzing the attributes consisting of the data collected about the population, and visualizing each of these categories with different dashboard elements will provide not only an answer to the question "What are the settlements according to the amount of population?" but also the answers to the questions "Where are the settlements concentrated according to their

population?", "What are the geographical factors that affect the population amounts of these settlements?". In addition, dashboards created in the process starting with any geographical question can be added to a storyboard. Thus, geographical questions can be answered more clearly with a storyboard consisting of different slides that emphasize the desired elements of the dashboard and are enriched with extra explanations. Although answering geographical questions is normally the last step of geographical research, answering geographical questions in a learning environment where dashboards are included in the process leads to the emergence of different geographical questions, thus returning back to the beginning of the cycle. This, in turn, restarts the cycle, ensuring that geographical research is an ongoing and continuous process.

Discussion and Results

Until the recent past, geography education primarily involved conveying shallow information to students such as how certain landforms are formed, showing where countries are located on the map or knowing what their capitals are. However, in recent years, countries have started to include geographical skills that will enable students to use this knowledge in solving real life problems in their daily lives, in addition to the geographical knowledge expressed by the topics in the geography curriculum. Thus, it is aimed to transform geography course from being a boring course in which only theoretical knowledge is conveyed to students and to transform geographical knowledge into useful skills. For this purpose, it is a common point emphasized in various studies that the resources of geography teaching should be focused on teachers, curriculum, textbooks and teaching materials. In the age in which technology has become the focal point of our lives, the use of these technologies in teaching geographical skills to students has become a necessity rather than a choice. For this reason, GIS applications in secondary school geography lessons should be designed at the level of learn with GIS and research with GIS (Artvinli, 2010). When the words geography and technology are considered together, the first technology that comes to mind is GIS. GIS takes its source from the science of geography and includes the use of technology that can increase students' interest in geography lessons (Alibrandi, 2003; Beishuizen, 2006; Donert, 2006; Kerski, 2000; Taştan, 2021). GIS includes many sub-applications in connection with its structure and usage areas. One of them is WEB GIS-based "Dashboards", which is an application that both transforms geographical data into geographical information and

organizes geographical information with visual elements such as various graphics, indicators and lists to provide students with geographical skills. Dashboards can be used to help students acquire the five basic geographical skills identified by Geography for life, which are the starting point for other geographical skills. These skills can also be considered as a stage of the geography course teaching process. In this process, thanks to the ability of dashboards to visualize geographical information with different elements, students can ask higher-level geographical questions; with auxiliary applications that can provide data to dashboards, very different data from primary or secondary sources can be transformed into geographical information by adding them to maps, this information can be organized in a single dashboard to answer the high-level geographical questions asked, especially thanks to the live data flow feature, data analysis that is always up-to-date can be done, and high-level geographical questions asked at the very beginning of the process can be answered clearly thanks to supporting applications such as story maps. These contributions of dashboards to the geography teaching process will enable the student to have basic geographical skills by staying in an active position continuously, and thus to use these skills acquired from the geography course effectively in solving real-life problems in daily life. In this way, the geography course will cease to be a boring course that needs to be memorized and will become one of the most important components of education in developed countries. It is seen that these results obtained from the research overlap with the results of many researchers that as a result of integrating GIS, especially WEB GIS, into geography teaching processes, students' academic achievement, interest and attitudes towards geography course increase (Çukur, 2005; Özgen & Çakıcıoğlu, 2009; Aydoğmuş 2010; Ünal, 2012; Kaya & Kaya, 2013; Taştan, 2021).

Based on the results of this study, it can be said that WEB GIS-based dashboard technology is one of the important technologies that can be used in teaching geographical skills to students.

Recommendations

Within the scope of this research, suggestions for integrating dashboards into the geography teaching process and using them to develop geographical skills are as follows:

- Dashboard technology should be integrated into the objectives and skills in the geography curriculum through exemplary lesson designs.

- In-service training should be provided for geography teachers about dashboards and their capabilities. These in-service trainings should address how to create sample course designs in which dashboard technology is integrated.
- In the geography teaching process, guidebooks on the use of dashboards, especially in achievements related to maps and graphics, should be prepared and delivered to geography teachers.
- Technical support should be provided to solve the problems that may be encountered in the use of dashboards in the geography teaching process. Collaboration should be made with GIS service providers in the formation of this technical support team.
- Online professional working groups should be established so that geography teachers who receive in-service training can share good examples of dashboard use among themselves. Academicians who have studied GIS should also be included in these groups, and university and field cooperation should be ensured.
- Studies should be conducted to investigate the effects of dashboards on students' academic achievement in geography courses and their attitudes towards geography courses.

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