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IMPROVING THE TEACHING-LEARNING PROCESS OF GEOGRAPHY BY INTEGRATING ONLINE WEBGIS APPLICATIONS

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ABSTRACT

In order to increase students' participation in learning activities, a significant role is played by the use of the computer in Geography lessons. The efficiency of computer-assisted learning involves correlation between several essential factors: the quality of online platforms and educational software, the use of appropriate teaching strategies and the creation of learning situations that enable students to learn actively. In this context, the aim of the paper is to observe and evaluate students' involvement in learning activities and their interest when various web applications are integrated in the teaching-learning process through which students discover information themselves and solve work tasks. We have chosen as a case study a Geography lesson for the eleventh grade students. In this lesson, we proposed to the students several learning activities based on two web applications, created in ArcGIS Online. In order to highlight the efficiency of these applications and cartographic support, a questionnaire was applied to the students, where they evaluated the degree of interactivity of these applications, their accessibility, usefulness, as well as their interest towards this type of learning activities.

***Keywords**: computer assisted learning, web applications, ArcGIS Online, education, high school*

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INTRODUCTION

The transition from descriptive Geography to Geography based on discovery, exploration, visualisation, and problem solving involves new and innovative didactic resources, which may contribute to a more efficient educational process. A solid and efficient educational process is determined mainly by how the information is perceived and processed, from the teacher to the students, through diverse didactic methods and resources (Gecit & Delihasan, 2014).

Constructivist learning, in which the student perceives learning as a dynamic and active process (Haslaman et al., 2008; Lache Moreno, 2011) includes, as one of the most important stimuli, the use of multimedia didactic resources in the teaching–learning process. Didactic strategies, in which multimedia resources are exposed, increase students' interest towards the learning process and positively influence their attitude and involvement in learning activities (Deb Roy, 2015; Tudor, 2012).

Such multimedia resources include access to diverse applications like Google Earth and Google Maps (Arghiuș & Arghiuș, 2008; Galbin, 2015; Lisle, 2006; Mérenne-Schoumaker, 1997; Vescan et al., 2013), photographs which illustrate geographic phenomena and processes (Mateiu et al., 2014) or other educational software, like Oikos (Marchiș & Botte, 2008) or GIS (Azzari et al., 2013; Dresden, 2006; Ertz et al., 2014; Etherington, 2015; Galbin, 2015; Irimia & Irimia, 2013; Moreno-Sanchez, 2012; Osaci-Costache, 2013; Tsou & Smith, 2011; Vescan et al., 2013).

The use of the computer in classroom, during the lessons, and computer-assisted learning (Szilágyi & Szilágyi, 2013) offer the possibility for the students to explore varied problems, and to process actively the content (Harmon & Hirumi, 1996, as cited in Szilágyi & Szilágyi, 2013). It is recommended that these resources offer a certain degree of freedom, so that students can discover the information by themselves and develop their critical thinking ability (Aksit et al., 2012). Consequently, having been trained into problem-solving situations about explaining geographical phenomena and processes, the students learn actively (Esteves, 2012; Lache Moreno, 2011; Marchiș, 2008; Văcaru, 2008). Furthermore, students gain digital competences and abilities, which are defined in the national curriculum as key-competences (Dulamă & Roșcovanu, 2007; Dulamă, 2010; Galbin, 2015; Osaci-Costache, 2013; Stănilă et al., 2016). These competences are being developed in time, gradually, by exploring several different learning situations (Aksit et al., 2012; Dulamă & Roșcovanu, 2007; Dulamă, 2010; Semenov, 2005; Tardif, 1999).

Open-source software integrated in the teaching–learning process, such as QGIS (Vescan et al., 2013) or ArcGIS Online (Osaci-Costache et al., 2017), offer the possibility for teachers to create diverse types of materials which can be included in the process of teaching–learning–evaluation, and facilitate direct and in real time interaction with students, through applications. Moreover, teachers can follow and analyze each student's progress and performance. Also, those who have digital competences can freely access open-source software and an extended database without depending on licensed software (Petras et al., 2015). It is important that the applications have a degree of difficulty that is adapted to the age, knowledge level and digital competences of every target group.

One of the most frequently used open-source software is ArcGIS Online, which enables creating new cartographic support and webGIS applications directly by the user. For new maps, the user can introduce different thematic layers – either from their personal database or from the collection of layers available in ArcGIS Online (Living Atlas). The layers include vectorial data and databases with different statistics values (in the attribute table) and are suited to both Physical Geography (for example, the rate of forestation, sequences from various landforms) and Human Geography (demographic, economic sets of data). The next step, after having designed the maps, is creating the web application, starting from the maps created before. The webGIS applications include one or more maps and allow for a dynamic and interactive visualization.

The integration of multimedia resources into the Geography lesson can be included in any moment of the lesson, and in all types of lessons, from which various and diverse strategies result, depending on different styles of teaching.

METHOD

Steps of research

The study includes three different steps of research, which can be generally used in other lessons where webGIS applications and maps created in GIS software are integrated (see Figure 1).

The first step was to design and adapt webGIS applications to the content and structure of the lesson, taking into account the Geography Curriculum. The applications were created in ArcGIS Online. An essential condition is that the teacher should have the necessary digital competences to use this type of software. It is also important that we take into consideration different aspects of the multimedia content: graphics, animation, instructional design, as well as application management (Dulamă & Ilovan, 2007), so that the applications are attractive to the students and can be integrated efficiently into the lesson. For the applications, different layers and open-source statistical data have been used – for countries (NUTS 0) and for administrative units (NUTS 2).

The second step involved using the applications during the lessons. This lesson was organised during Pedagogical Practice (Level II), a very important part in the training of future teachers. The applications were integrated in the lesson sequence of ensuring and intensifying the retention and transfer of the knowledge, in which the student should demonstrate that several abilities were developed, by completing the learning tasks in the lesson: "Contemporary geodemographic evolutions. Regional differences" from the learning unit "Population, natural resources and the development of contemporary world" (Ministry of National Education, 2006). The students were organized into six groups of four students for the first application, and they worked individually, for the second application.

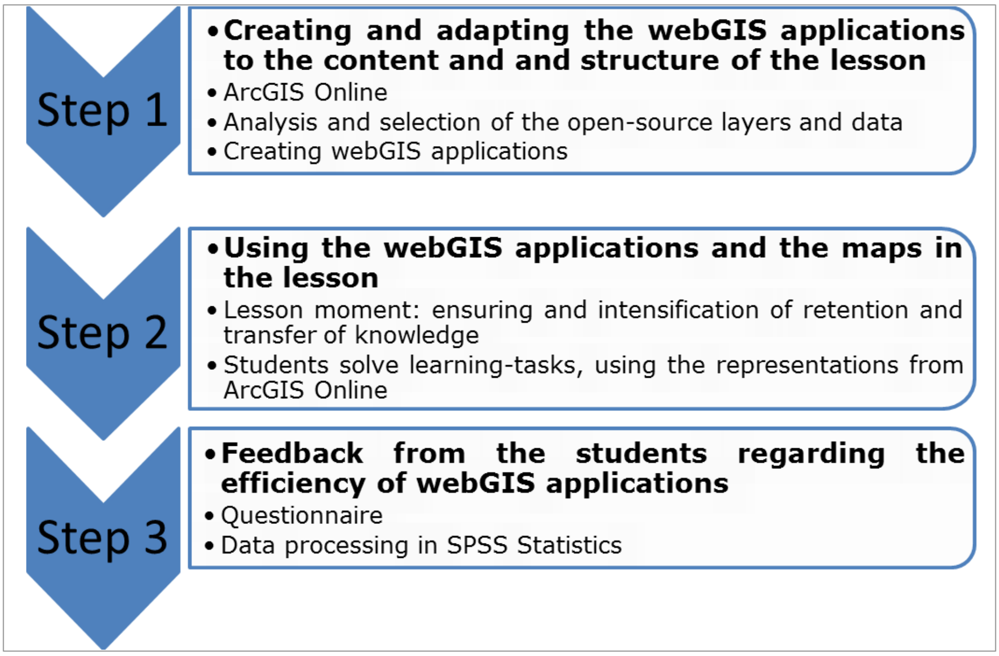

Fig. 1. Steps of research

For this lesson, there are targeted specific competences, selected from the Geography Curriculum:

"1.1 Oral and written presentation of the defining aspects refering to the population, resources and contemporary world development, using the appropiate terminology of the subject, in a corect and coeherent manner.

3.3 Using minimal cartographic and graphic representations, in order to interpret and explain the analysed reality" (Ministry of National Education, 2006).

Tasks for the first application

Each group of students chose one of the geographic regions proposed by the teacher: Western Europe, Eastern Europe, Middle East, South and South-East Asia, Northern Africa, and Central Africa. The learning tasks were to identify the countries from the chosen region, the values in each country for the two demographic indicators (i.e. Life Expectancy at Birth and Infant Mortality Rate), to calculate the mean value of these indicators and to mention two causes that explain the values for these indicators. Students had access to the application on the mobile, from the link provided by the teacher. These learning tasks were completed in ten minutes. At the end, a student from each group of students presented, in front of his or her colleagues, information about the chosen region.

Tasks for the second application

The students searched individually information, using the webGIS application, in order to answer teacher's questions: "What are the regions of Europe with the highest / lowest population density? Why? Mention two causes", "What are the regions with a positive and negative population growth? Name one cause for each case". These learning tasks were completed in five minutes.

In the last step of the research, we received feedback from the students, applying a questionnare (see Annex 1) regarding the efficiency of the integration of these applications in the lesson. Several studies also use the questionnare as a method to evaluate didactic methods in the educational process (Tudor, 2012; Jucu, 2014; Szilágyi & Szilágyi, 2013; Galbin, 2015; Osaci-Costache et al., 2017). The questionnaire was created by the authors and was applied to the 11th grade students at the end of the lesson, in March 2019. The questionnaire was printed and distributed in the class. The evaluation was based on a 5 points-Likert Scale. The questions in the questionnaire were related to the interactivity level of the webGIS applications, accessibility, usefulness, students' interest towards the application; also, students evaluate the task in which they worked as a group.

The results of this evaluation were introduced in a database and processed using statistical methods and techniques in SPSS Statistics.

Participants

The web applications were proposed to a group of 24 11th grade students, at "Jean Louis Calderon" High School, in Timișoara, in a lesson that was performed by the second author, as a part of the Pedagogical Practice, Level II. During the lesson, the first author, as a coordinator of the Pedagogical Practice from West University of Timișoara and the teacher from the high school, assisted.

RESULTS AND DISCUSSION

Analysis of the process of designing the webGIS applications

We created these two web GIS applications starting from the geographic content of the lesson. The objective of the first application was that students correlate two demographic indicators: Life Expectancy at Birth and Infant Mortality Rate, in different regions of the world (https://arcg.is/1m9OiS). We used two distinct layers, found in Living Atlas, ArcGIS Online: "Life Expectancy at Birth by Country every decade from 1960–2010", in which the values for Life Expectancy at Birth have been classified into class-values, for a better visualisation, and "Global Population and Maternal Health Indicators", in which the indicator "Infantile Mortality Rate" was selected and the values were classified. This indicator is illustrated on the map with a point for every country. The more intense the point on the map is, the higher the value of this indicator for the selected country is.

The two thematic layers were correlated and the webGIS application was created using the tool "Spyglass", which allows the visualisation of the content using the mouse. With one click on any state, the student can also discover other information regarding other indicators from the attribute table (Figure 2).

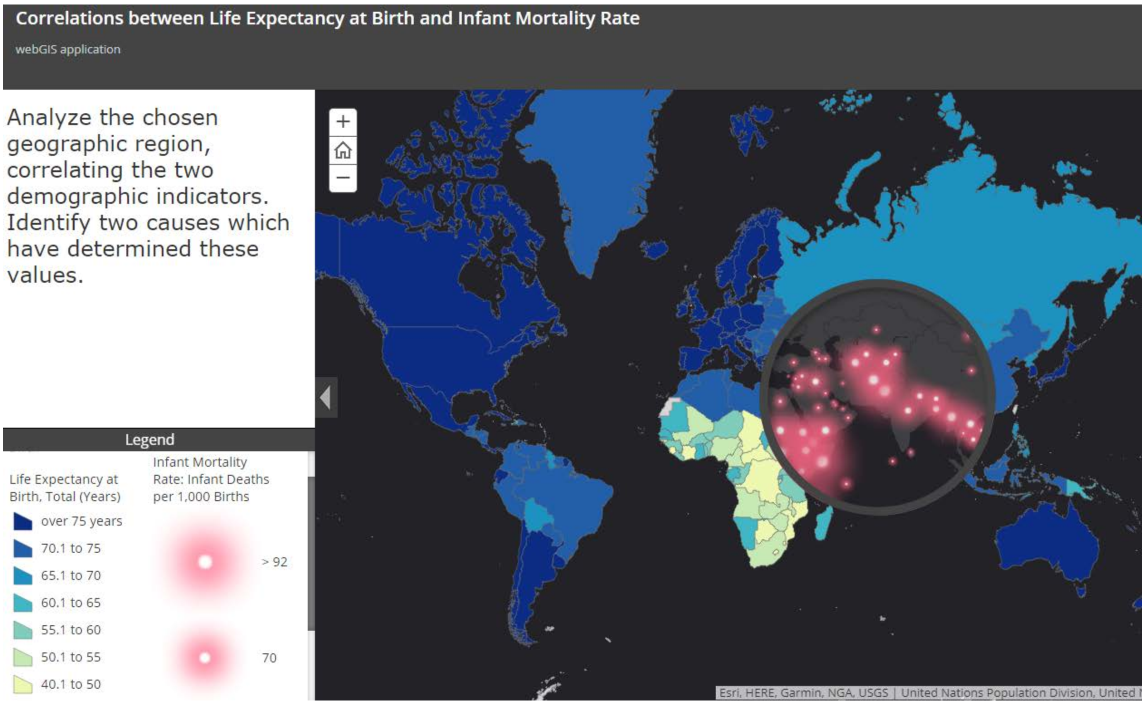

Fig. 2. Capture of the main page of WebGIS application "Correlations between Life Expectancy at Birth and Infant Mortality Rate"

For the second web GIS application, "Demographic aspects in Europe", we used two thematic layers: Europe NUTS 2 Demographics, where we have selected the indicator Population Density, and Europe NUTS 0 Demographics, where we have selected the indicator General Population Growth (Figure 3 and Figure 4). The objective of this application was the visualisation of demographic data by the students, from an online cartographic representation, in order to answer the teacher's upfront questions (https://arcg.is/1Kq8Hv).

The application includes three different tabs. The first two tabs illustrate the two thematic layers. What is new to the webGIS application and what is the element which differentiate the application from a static map is the fact that with one click on any country or administrative unit, the user can discover other significant demographic data.

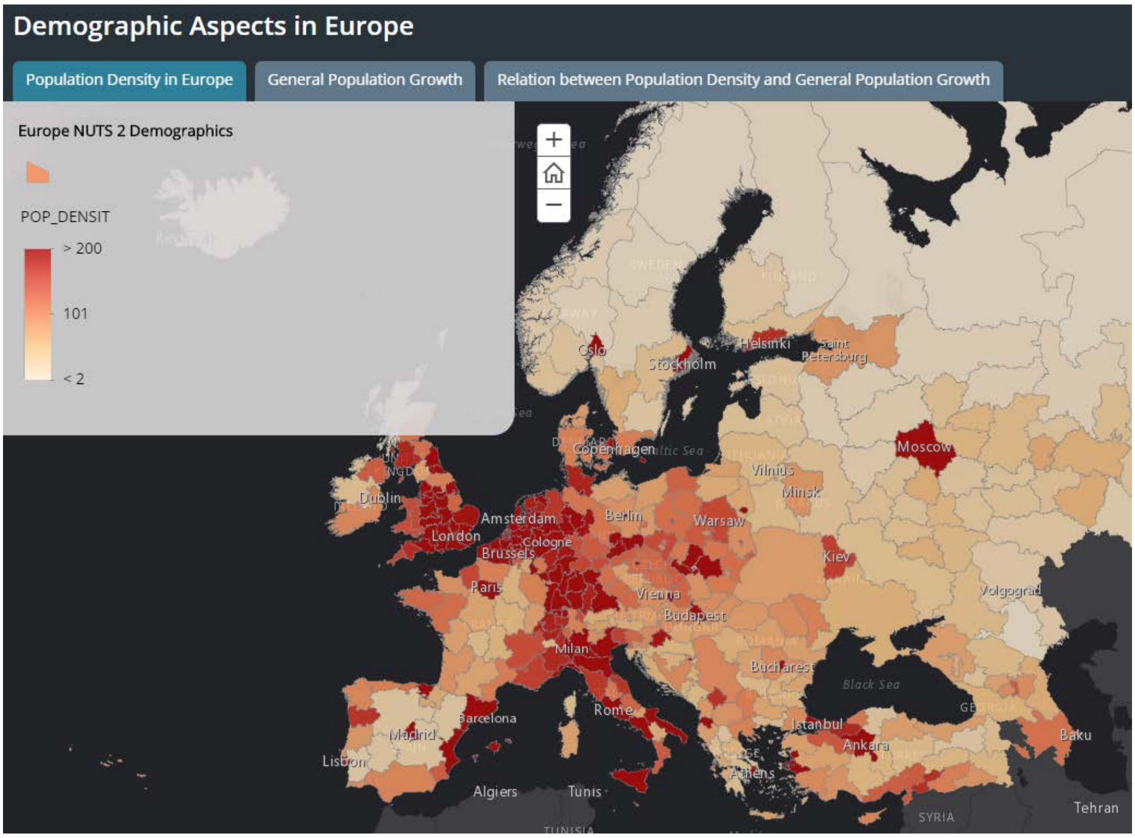

Fig. 3. WebGIS Application “Demographic aspects in Europe”,

tab: “Population Density in Europe“

The third tab shows the relation between the layers (Figure 5). On a 3x3 square, the user identifies, by colour, which are the countries where both the demographic indicators have high or low values or the countries where only one indicator has high/low values.

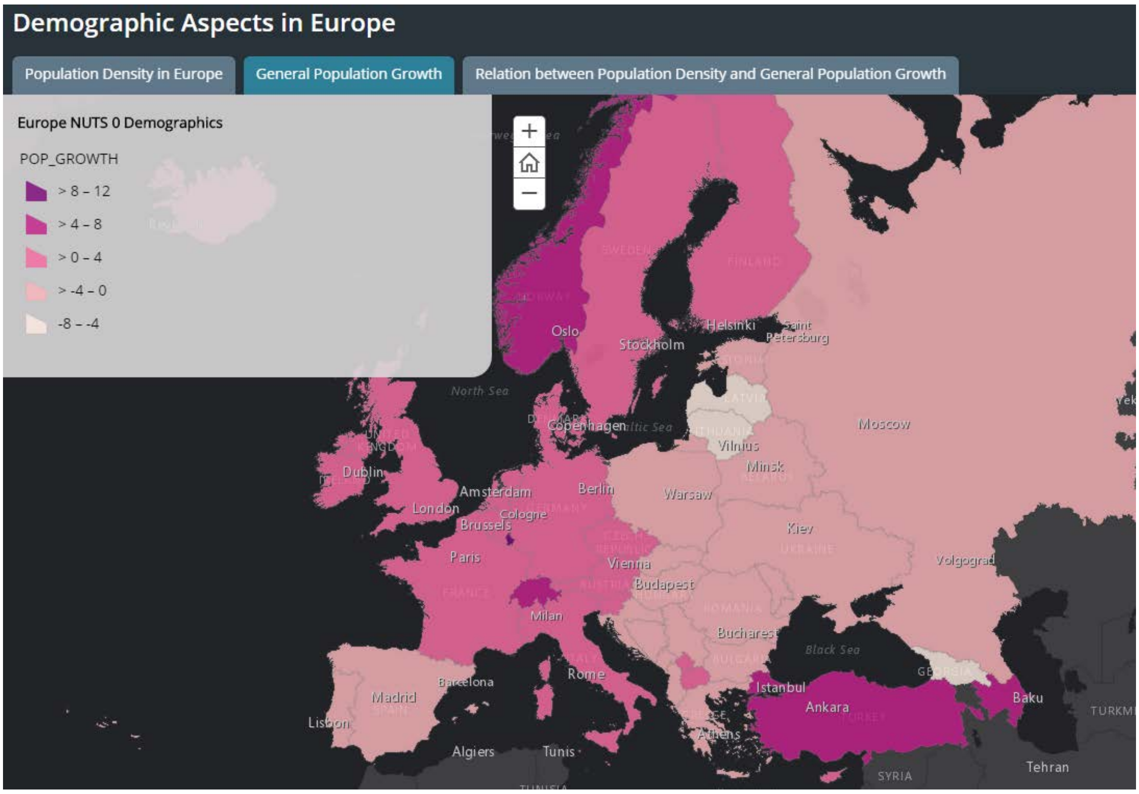

Fig. 4. WebGIS Application "Demographic Aspects in Europe",
tab: "General Population Growth"

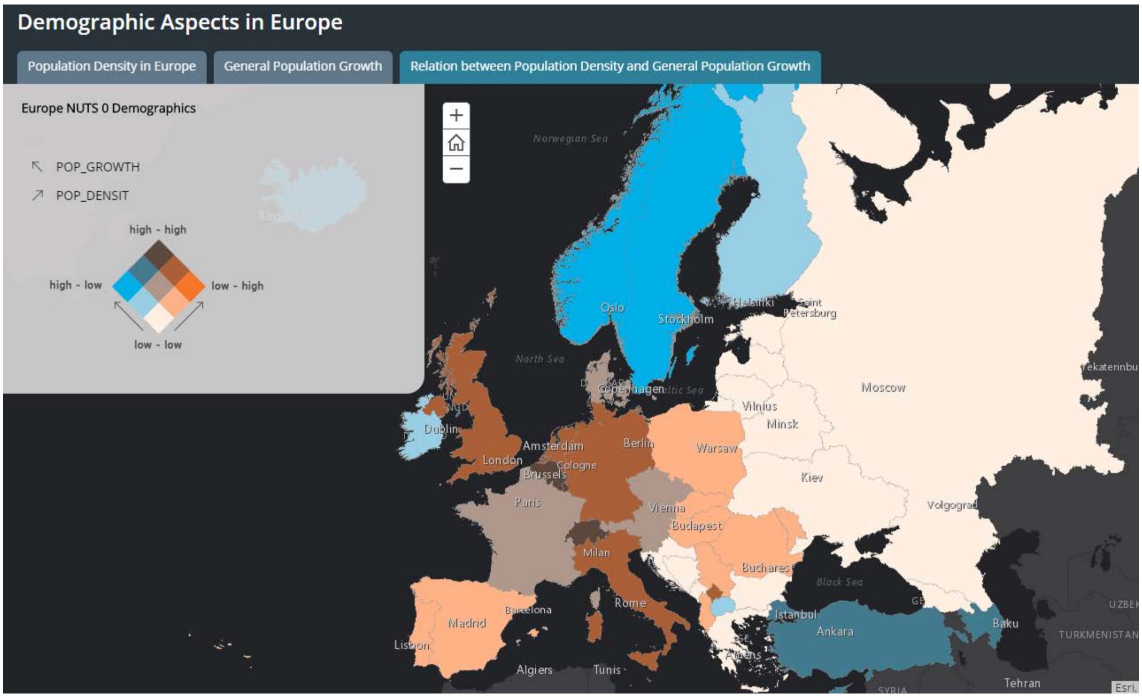

Fig. 5. WebGIS Application "Demographic Aspects in Europe",
tab: "Relation between Population Density and General Population Growth"

Analysis of the students' activities

At first, each webGIS application was projected on a screen in front of the class to be visualised by all students. The teacher explained how each application works and provided their links to be accessed from the mobile phone. Students did not encounter any problems accessing these links, and after a few minutes of getting familiar with the applications, they began to solve their tasks.

Within this lesson sequence, the following operational objectives were pursued:

O1. to identify regional differences of the demographic indicators;

O2. to mention causes for the demographic values in the chosen geographic region;

O3. to mention connections between the demographic indicators and the geographic environment.

For the first webGIS application, where the students were organized into groups, we noticed that the students shared their work tasks, without the teacher suggesting it. Every student searched the values of the two demographic indicators for at least one country and wrote them in a table created by the group. At the end of this first phase, a table with all the countries from the chosen region and the values of the indicators was completed. With the results from the table, the students calculated the mean value of each indicator. Then, they used brainstorming in order to identify the causes that explain the values of the indicators. The main causes were presented and explained in front of their colleagues by one representative from each group.

So, we can underline that in every group, a significant role was played by the interaction between the students, as every student had a task to complete.

For the second webGIS application, first the teacher explained to the students how the application works. For this activity, the students worked individually. Direct questions from the teacher were asked, using heuristic conversation. For example: "What are the regions of Europe with the highest population density?" The students searched on the webGIS application the answer, also with the help of the class-values from the legend. After one student answered correctly, a second question related to the first one was asked: "Why? Mention a cause that explains the values registered by this region". The same algorithm was used for all three tabs in the webGIS application. If the student gave an incomplete answer, another student would add relevant information to the answer or the students would search for any more relevant information using the application, in order for the conversation to be focused on the students. In this activity (Figure 6), all students were involved.

Fig. 6. Images from the lesson sequence in which the two webGIS applications were used

During these learning-activities, only three students could not access the webGIS applications on their mobile phone due to the connectivity to the internet and the limited technical support for this kind of applications, but they used the computer from the classroom and worked with the help of the projected application or collaborated with their colleagues.

Analysis of students' opinions regarding the webGIS applications

The last step of the research consisted of administering a questionnaire to the students, as a feedback concerning the efficiency of the webGIS applications.

According to Figure 7, the highest mean score was registered for the Level of Interactivity of the applications. WebGIS applications are in general interactive; they are based on the computer or on other digital instruments and the student is actively involved in the task-solving process. Furthermore, students evaluated the usefulness of this activity with a mean value of 4.46. These applications were also new to the students (mean value 4.29) and the students showed interest towards them (mean value 4.25), working in groups (mean value 4.33). The only element with a mean value below 4 was accessibility, as the students did not have access to a multimedia classroom and could only access the applications on the mobile phone. The use of the applications was limited, taking into consideration that not all mobile phones may provide full technical support for webGIS applications. Furthermore, in order to access ArcGIS Online, an essential condition is internet connection.

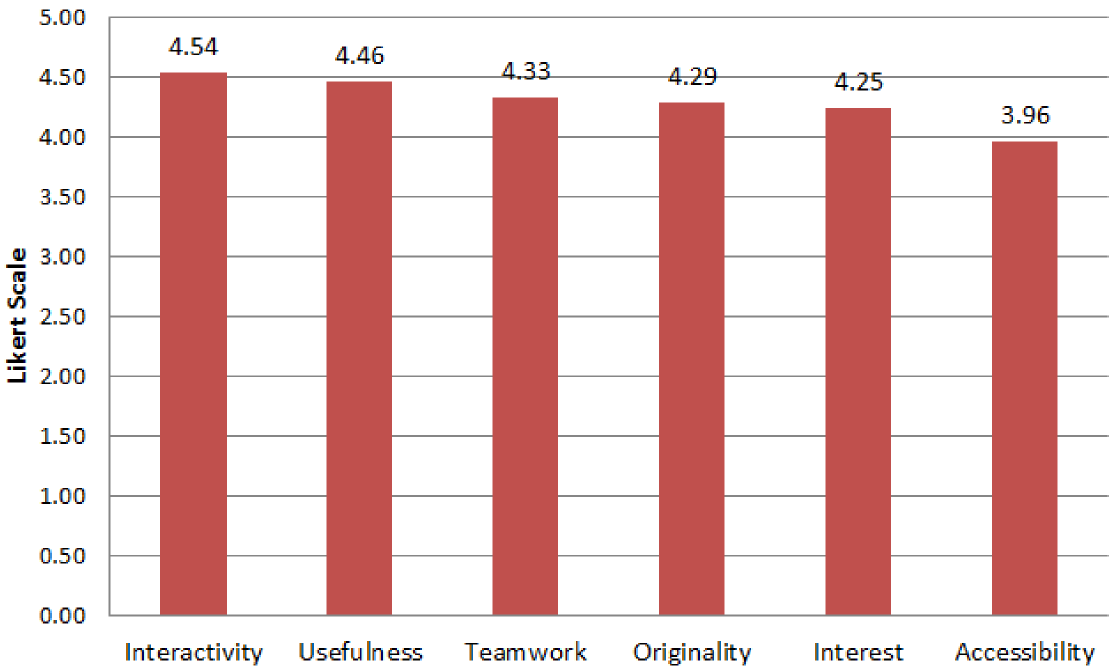

Fig. 7. Students' opinions regarding the webGIS applications used during the lesson

Moreover, the frequency of the results (see Figure 8) illustrate the same tendency: high level of interactivity (17 out of 24 students noted this element with a maximum score) and a lower level accessibility (the least number of students with the maximum score).

For example, *usefulness* was evaluated with a maximum score of 15 out of 24 students, as the webGIS applications were used in class, directly by students. Therefore, the use of the webGIS applications improved the quality of the lesson and ensured that the content of the lesson is understandable to the students.

The element *teamwork* was also frequently evaluated with a maximum score. Taking into consideration that the students collaborated when solving the learning tasks and were all involved in the activity, it is no surprise that the students' opinion was favourable to teamwork.

The *originality* of the webGIS applications was also appreciated by the students, with a total of 20 out of 24 students, in which these elements were evaluated with scores of 4 and 5. Even though webGIS applications can be created easily and used in any type of lesson, they are not so commonly used in the classroom.

Even though the element *interest* was not so frequently noted with a maximum score, students' interest is still an indicator of the success of the webGIS applications. This is partly because the element "interest" was not evaluated with a lower score than 3.

The *accessibility* of the webGIS applications was evaluated with lower scores. The main disadvantage was linked to the lack of access of a multimedia classroom, in which the students would have used the applications with no restrictions.

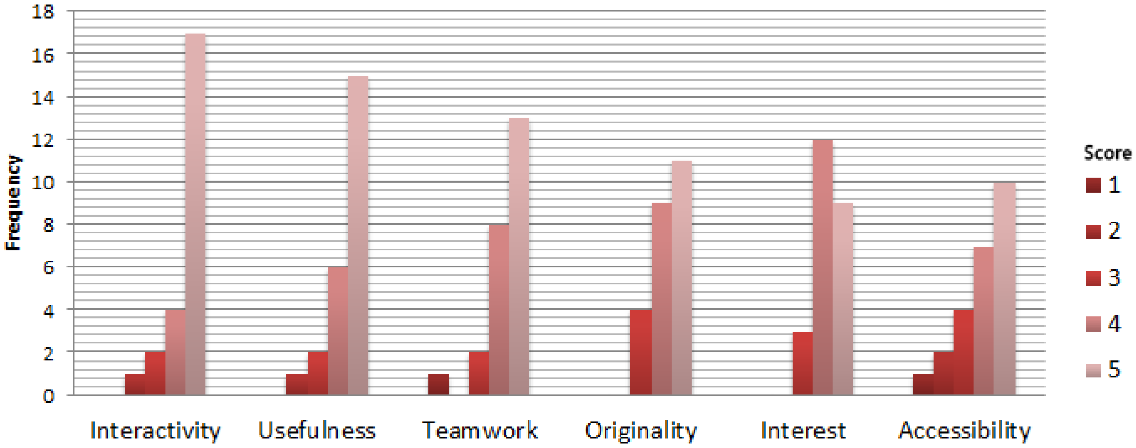

Fig. 8. Frequencies of the scores for the evaluated elements of webGIS applications

CONCLUSIONS

A solid and efficient educational process should focus on the student, on the way students receive and understand the information, so that the student can learn actively, by solving different learning tasks. In this matter, using multimedia resources in the classroom has many advantages for the student's learning process.

A webGIS application is one of many examples in which multimedia resources are integrated in the lesson, in classroom. These applications may improve the quality of the lesson and may determine a better understanding, interpretation and long-term learning of the geographical content. WebGIS applications are open-source tools, which can be created by the teacher and used by the students, in classroom, or on any device. Moreover, the content of these applications can be adapted to different types of lessons and to many lessons, with diverse grade of difficulties.

The main finding of this study is that, as modern tools used in the classroom, students perceive the applications in an interactive manner. Moreover, the interactivity of these applications may increase students' interest and positive attitude towards the learning process and their participation in the classroom, as they solve diverse learning tasks and develop geographical and digital competences, defined as key-competences.

In the classroom, these types of applications can be used individually or in groups of students and enable the teacher to formulate many learning tasks, with different difficulty levels.

It is recommended that the web applications be integrated in a multimedia classroom, so that every student can individually have access to a computer. If the school cannot provide access to multimedia classrooms, the applications are also available on mobile phones, tablets or other digital instruments, as the webGIS applications are public and free.

In conclusion, it is important for an efficient and qualitative educational process that we find innovative didactic strategies, in which we focus on students' needs and their development of abilities, by integrating multimedia resources.

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Annex 1

Questionnaire regarding the webGIS applications used during the lesson

On a scale from 1 (minimum) to 5 (maximum), how do you evaluate the following elements of the webGIS applications used during the lesson?	1	2	3	4	5
Interactivity					
Usefulness					
Teamwork					
Originality					
Interest					
Accessibility					