EAI Endorsed Transactions
on e-Learning
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Teaching and learning with geotechnologies on primary education: Students' perceptions

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Abstract

Recent developments in computer and internet technology have resulted in many education reforms. Classrooms have been equipped to allow technological advances. Yet these rapid technological developments have not been accompanied by teachers' education. The migration of teachers' traditional resources to "digital" students is not always achieved. In this context, Geographic Information Systems (GIS) is powerful technology to enhance the teaching and learning of several subjects, promotion of interdisciplinary approaches, and combination of research and online maps to motivate students to learn. In this article, Portugal's territory GIS education context is analysed along with an experience with primary students.

Keywords: Primary education; Geotechnologies; GIS; Teaching and learning; Spatial thinking.

Received on 04 September 2017, accepted on 08 December 2017, published on 19 December 2017

doi: 10.4108/_______________

1. Introduction

Europe is facing difficulties in adapting to globalization and transitioning to a knowledge society. In 2002, the European Council highlighted lifelong learning core skills to recommend that citizens should be provided with skills that allow them to leave and work in an information/knowledge society. It also recognised the importance of the digital competences to overcome today's job market difficulties. The goals for Europe 2020 is a Europe that is more "intelligent, sustainable and inclusive".
In recent decades, computer and internet technology has grown rapidly in several sectors of society and is revolutionizing teaching and learning [1]. An educational focus on learner-centred constructivist approaches can prepare students to meet the challenges of contemporary society [2, 3]. Therefore, it is crucial for teachers to design and implement innovative approaches for their classroom practices [3]. Educational institutions are adopting online learning [4] and web-based education is growing faster [5]. Among the opportunities that technology can provide for the education process by creating innovative learning environments, the implementation of information and communication technologies (ICT) is far from their capabilities [3].
In recent decades, computer and internet technology has grown rapidly in several sectors of society and is revolutionizing teaching and learning [1], particularly three-dimensional virtual worlds [6]. Recent demands of an increasingly knowledge-based society and the advances in mobile phone technology are recognized as an input of mobile learning growth [7]. An educational focus on learner-centred constructivist approaches can prepare students to meet the challenges of contemporary society [2, 3]. Therefore, it is crucial for teachers to design and implement innovative approaches for their classroom practices [3]. Educational institutions are adopting online learning [4] and web-based education is growing faster [5]. Among the opportunities that technology can provide for the education process by creating innovative learning environments, the

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implementation of information and communication technologies (ICT) is far from their capabilities [3].

Geographic Information Systems (GIS) technology makes it possible to describe the characteristics of specific locations on the Earth's surface and to analyse spatial patterns. Recent advances in GIS tools have simplified the process of acquiring, storing, analysing, and sharing geographic information through the internet. Yet it is scarcely used in the educational context [8-10]. It can be used to promote active learning, because of its capabilities to develop spatial analysis, spatial thinking and spatial problem solving. Education systems can benefit from their capabilities to analyse several map layers for spatial representation and consequently identify spatial patterns [4, 11, 12]. Geographic information technologies enhance interdisciplinary and student learning through spatial thinking [13].

Although GIS is recognised as an essential area to embrace in initial and continuing geography teacher education, it has historically been perceived as a planning tool. Nowadays, it is coming out to promote transdisciplinary research—namely, to link space and time [14]. A transdisciplinary approach integrates problems not restricted to the boundary of one discipline, but rather uses multiple disciplines to solve them. This approach is connected by spatial notions and allows for the development of a spatial analysis [15]. Spatial analysis and operations can be classified into six categories:

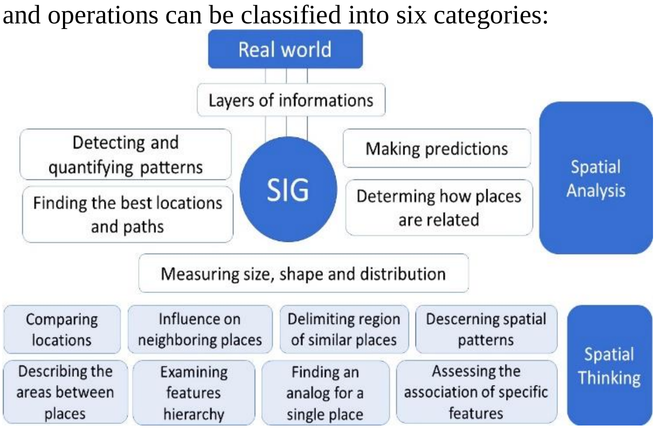

Figure 1. Relationship between GIS and spatial analysis and spatial thinking. Author's work based on [16, 17]

In addition to the importance of space to understand history and geography and promote transdisciplinary concepts, educators are still averse to including GIS in their curricula [18-21]. Active learning is more likely to encourage students to adopt a more thorough attitude to learning than, for example, the transmission model would do. It is recognised that learning by doing and adopting a more student-centred learning can be employed to face 21st-century challenges [22, 23]. Students should be prepared to solve problems and encouraged to become self-directed and engaged learners. Inquiry-based learning is a strong pedagogical tool that promotes the acquisition of new knowledge, skills, and attitudes [13, 24, 25].

GIS is a computer-based system that captures, prepares, manages, manipulates, analyses, and disseminates geographical data. GIS capabilities for analysing and visualising spatio-temporal data can be more easily implemented with geospatial technologies than with any other technologies. Most older barriers can easily be mitigated with web development, where many location-based services are available. It can promote the exploration on analogical resources (printed maps), desktop geospatial technologies (Google Earth), or web-based GIS distributed in multiple platforms, such as smartphones or tablets [26-28].

Furthermore, today GIS has been introduced into our everyday lives. It allows us to mix all kinds of produced data by geocoding it (e.g., by street address or geographic coordinate). In this way, one can have information by organising the data through layers. Making maps is only one GIS component because in effect it can help us make better decisions and improve communication. Thus, it is common to find GIS in public agencies, utilities companies, social media, transportation, geoportals, location websites, GPS drivers, and geocaching. One need not be a teacher, just a citizen to feel how GIS intersects our everyday lives [29]

Teachers' education should promote GIS skills and spatial thinking in degree curricula. However, this technology is rarely applied in the classroom. Meanwhile, many teachers' weak background in managing these technologies result in an adverse environment to implement geographic information technologies (GIT) while students are more willing to learn about technology. Prensky [30] makes this clear: "Those of us who were not born into the digital world but have … become fascinated by and adopted many or most aspects of the new technology are, and always will be compared to them, Digital Immigrants."

Bodenhamer [31] argues that "geo-spatial technologies are better equipped to construct the spatial narratives and deep maps that permit, indeed encourage, the sort of reflexive, recursive, and collaborative environments that will mark history in the future". The present study centres on the perceptions of primary education students (9 to 10 years old) related to geospatial technologies. The activities were developed to highlight spatial analysis and encourage the exploration of the space and link the time (history) and space (geography). These technologies can simplify the complex facts associated to the history of Portugal, creating a spatial meaning for the location of historical events.

Portugal's curriculum requires an interdisciplinary approach, mainly to the first cycle of basic education as the three main areas of geography, history, and sciences are grouped in one discipline called environmental studies. GIS can create a powerful learning environment to promote interdisciplinary learning and knowledge through exploration and thinking.

2. Methodology and instrumentation

We used a mixed-methods research to collect both qualitative and quantitative data. Six schools were chosen from different geographical locations and from private or

their primary school location and explore through the street view to navigate around school towards their homes.

The last activity was more complex. It was developed to deepen the history subject students had learned some weeks before—namely, Portuguese castles.

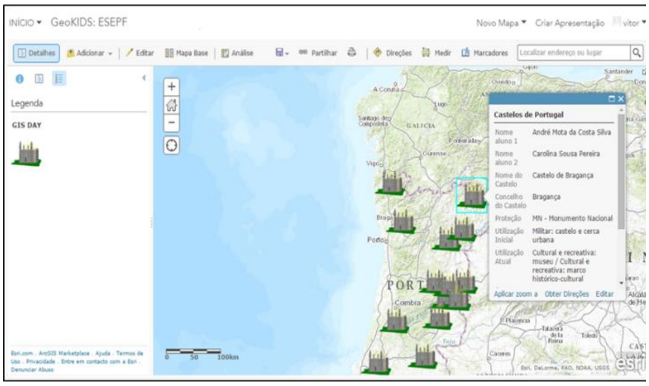

Figure 3. Collaborative dynamic webmap of Portuguese castles

The activity required students to acquire information and then, using the webmap, select a castle symbol and geolocate the castle based on geographic coordinates. Students also had to add castle attributes (graphic and non-graphic). A webmap

was prepared with an editable feature so that students could fill in the required attributes. Each pair of students had two castles to map, and the objective was to analyse collaborative work because the final map was a sum of individuals' contributions. Students knew that a mistake in their pairs would affect the final collaborative map. The information about castles was collected from the Portuguese Culture Institute which has available castles descriptive information. Students were also challenged to add pictures in two ways: one located on the web (by capturing the picture's address) and the other by uploading a picture from the desktop.

Second cycle: Fifth and sixth grades

In the 5th grade students were challenged to find names of Arabic origin hidden in a crossword. Then students should present these names on a virtual globe using street address geolocation and analysing the final map. Students had to explore a webmap about the administrative limits of Portugal, topography, and Portuguese mountains (Figure 4). They also used a virtual globe to create a profile path. The sixth-grade activities also used a webmap based on castles related to Portuguese population distribution. Students also used the Instant Street View application to explore the school area.

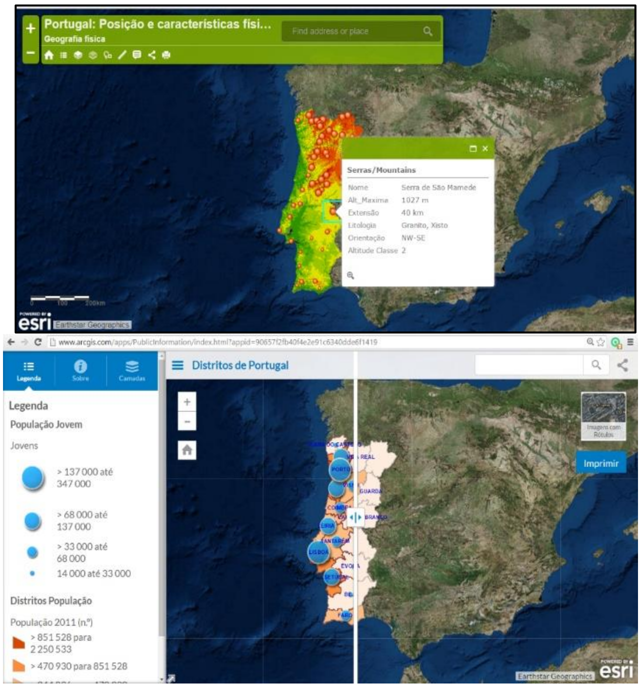

Figure 3. Webmap layout used by fifth grade (top) and sixth grade students (bottom).

3. Results

First cycle students' perceptions

Sixty-two students completed the survey: 26 in the second grade and 36 in the fourth grade. All participants considered the activities interesting and attractive. For the second-grade students, the most appreciated activity was locating spaces and activities using Google Earth and building Portugal's map (Figure 5). The flight radar activity was only tested in the fourth grade and, like Google Earth, was quite appreciated. Students recognised that geotechnologies contribute to consolidating acquired knowledge on maps as well as strengthening spatial orientation skills.

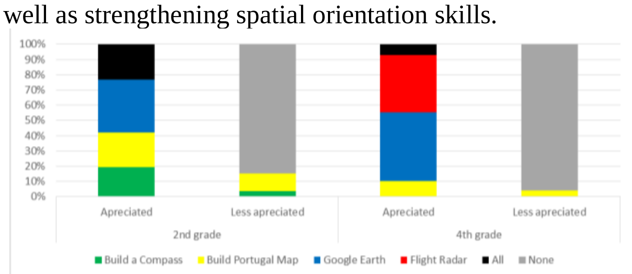

Figure 5: Most and least appreciated activities by second and fourth grade students

Students also considered that learning experiences with geotechnologies motivated them to learn and should be used more often in the classroom (Figure 6). Second grade students expressed that "I appreciated all the activities "(student B5-

SQ-5) or "There was nothing I did not like "(student B5-SQ-10).

Building Portugal's map was considered the least appreciated activity by three students: "What I liked least was learning about mountains" (student B2-SQ-14). Flight radar 24 platform is a live flight tracker in real time and can play a significant role in understanding aerial transportation, globalization, abstract paths, time travel/distance travel, and airports or continents. As mentioned by one student (A2-PQ-10), "I appreciate flight radar because I can observe aerial traffic in real time, flight path, start and end of the flight and follow the plane on the computer".

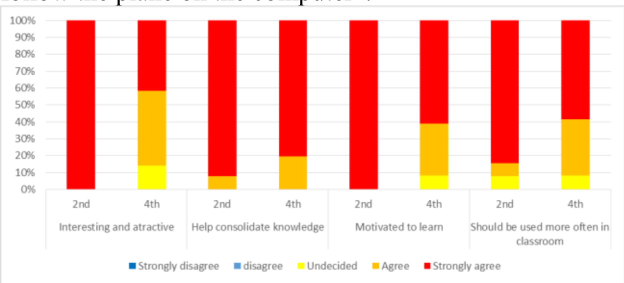

Figure 6: Second and fourth grade students' perceptions about geotechnologies beliefs

Regarding learning experiences, geotechnologies were perceived to be a way to improve knowledge using new tools, enhance ICT skills crucial for digital society inclusion, and consolidate acquired knowledge. In fact, knowledge skills can be enhanced by motivated students (Figure 7).

Figure 7: Pictures from classroom learning experiences.

Figure 8 illustrates the role of geotechnologies in skills improvement. The second-grade students did not perceive geotechnologies as improving group skills, although 4% of the fourth-grade students mentioned it: "I learn to work in a group" (student C4-TQ-27). Representing real-time data, 3D models and realistic photos located in space led students to mention "…see the world as I was there" (student A3-PQ-13) or "I learn much more about the world we live (student C3-TQ-23).

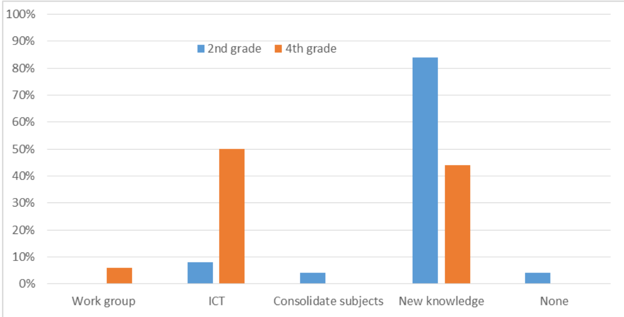

Figure 8: First cycle students' perceptions about improved skills with geotechnologies

In fact, manipulating digital technologies is recognised as a way to enhance digital literacy. The main difficulties expressed by students were understanding the aim of the exercises and geolocating castles on the dynamic map. Despite such difficulties, students revealed that this task was rich in the learning context.

Second cycle students' perceptions

For the fifth and sixth grades, 79 answers were collected. Learning experiences were applied to 49 students from two fifth grade classes and 30 students from the sixth grade.

Almost of all the students revealed appreciation for all the activities (Figure 9). Similar to the first cycle students, fifth grade students indicated that Google Earth was the most interesting application. The first class preferred to build the compass for geotechnologies activities. They highlighted that geotechnologies promote work groups. Students in this class come from higher socioeconomic conditions, and technology is frequently used in the classroom. In contrast, students from the other class come from a deprived socioeconomic area. Although they highlighted the role of geotechnologies, they indicated that geotechnologies should be implemented more often in the classroom: "… internet can be good for learning, and should be used more often in other disciplines than geography" (student C1-TQ-24).

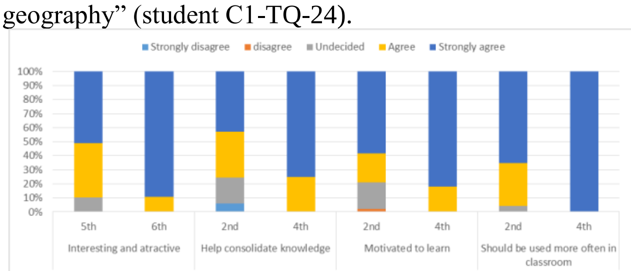

Figure 9: Second cycle students' perceptions about learning experiences

Using those geotechnologies that combine several layers of information through a map can make the thinking skills become natural: "There is intense traffic i the sky… the youngest districts in Portugal are Lisbon and Oporto" (student C3-TQ-28) or "Planes do not crash because they fly at different altitudes … More persons live in Lisbon than in other districts” (student C3-TQ-22)”. In addition,

With these activities I learned a lot, I learned that we can see the number of planes in the air, why the planes do not collide, we learn that there are programs that allow us to locate and see streets in places we cannot go there. We learn to get a better sense of what we can do on the internet. I learned that we can navigate the computer without playing. (student C5-TQ-16)

Students did not reveal any difficulty in manipulating the software. The internet connection was perceived in a negative light as it was down for several minutes in one class activity.

In this study, enhanced communication was reached. At the end of each activity, results could be shared through social networks, an app, or a multimedia file. Fifth grade students perceived that collaborative online work between students was enhanced while the sixth-grade students stressed the acquisition of new knowledge (Figure 10).

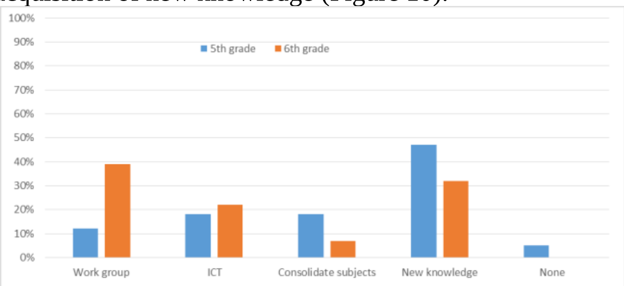

Figure 10: Second cycle students’ perceptions about improved skills with geotechnologies

The researcher observed that enthusiasm, motivation, and shared experiences were underlying the activities. For example, sixth grade students’ activities were implemented in a history and geography of Portugal class which lasted 50 minutes; the teacher challenged the researcher to extend the activities for the next 50-minute class due to students’ enthusiasm in exploring activities. Similarly, those students preferred to stay in the class during the interval to deeply explore the resources.

Discussion

In the first cycle, students most appreciated the Google Earth and flight radar platforms. They highlighted the ability to explore space, work with geographic coordinates on maps, and explore new places in a more realistic way. Geotechnologies were perceived as motivating tools for creating new learning experiences.

Few students mentioned the castles dynamic map as the most appreciated activity. This does not mean they did not appreciate the activity, but they experienced more difficulty completing it. This activity was the most complex because students were not only exploring information, as with the other platforms, but also producing information. First, they had to collect information on Portugal’s government culture site, geolocate the castle on the editable webmap, and collect and add additional multimedia information (pictures or videos) about that into the attribute table. Students engaged in this activity came from a deprived socioeconomic context with limited use of technology in the classroom and at home. Most of them were engaging with geotechnologies for the first time.

It is also important to stress that these kinds of activities require some degree of management experience. Thus, it is important to stress that this kind of technology should not to be used sparsely, but with some degree of frequency by teachers. Casually integrating it can result in failed results. Adopting it in an interdisciplinary way can be fruitful, and sharing it on multiple devices through an app can lead to enhancing students’ skills in manipulating GIS and learning outside classroom.

One of the most appreciated resources was the flight radar because it uses real-time data. It enhances spatial thinking skills since students naturally express justifications for the concentration patterns of planes or the “desert” of airline routes in some places. At the same time, students’ curiosity to answer emergent questions such as what if a plane disappeared from the radar, why planes appear with different colours in the map, and why planes have a line pattern when approaching airports.

Students’ statements demonstrated that the way the resources and activities are explained to students influence their commitment and consequently their learning. Clearly planned activities enhance students’ motivation which reduces disinterest. Yet doing so requires teachers’ efforts to promote geotechnologies’ potential for learning processes. Using them to streamline interdisciplinary efforts seems advantageous. For example, history subjects related to Portuguese invasions were used to clarify how geographical conditions affected troops’ movements and castles’ locations. Using online collaborative work to produce a dynamic map that can be shared with the community potentiated a student-centred classroom, responsibility, and autonomy. This is a transversal aim of Portugal’s educational curriculum that can be achieved using geotechnologies, preferably in an interdisciplinary way.

The findings of this study have implications geotechnology for teaching and learning in the elementary education which is a less studied level of education. In addition to the consensual ability to manipulate digital technology, it is important to understand how an interdisciplinary approach, student-centred teaching, and reflexive questioning can be enhanced together through technology. Because people experience geography every day and our activity affects the planet, geotechnologies play an important role in perceiving such effects. Similarly, the findings highlight the importance of those technologies to amplify students’ motivation to explore the earth in an interdisciplinary way, in 3D environments, with real-time data, and using dynamic maps that can be shared to several devices. Students from deprived environments were more organised and motivated to learn than usual whereas students from higher socioeconomic contexts were either less motivated or showed similar results as students from deprived families.

Limitations

Due to the findings achieved in this research, more doors were open than closed. First, the activities were applied in schools' different socioeconomic contexts, and some differences were detected; however, it should be interesting to analyse the outcomes more deeply. In this study, the rural context was not explored. In terms of inclusion, it could be interesting to find differences in students' attitudes and perceptions. In addition, the time spent in schools was limited to certain classes during the semester. It would be profitable to analyse the impact of geotechnologies in assessment results and analyse the impact of using them frequently and in an interdisciplinary way.

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