International Journal of Web-Based Learning and Teaching Technologies
Volume 18 • Issue 1

Student Engagement and Educational Benefits of Web GIS-Based Projects

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ABSTRACT

The evolution of geographic information systems (GIS) based on the internet (Web GIS) created new opportunities for the use of GIS technology in education. In the present study a learning environment was developed which incorporates the project-based learning (PBL) methodology based on Web GIS technology. In this context, 3 research projects (GIS based projects) were designed and implemented. Project 1 and 2 combined fieldwork and GIS, and the topic was related to local community issues. Project 3 was an internal project since it was conducted only in the computer lab with data collected from the internet. In order to investigate the effectiveness of this learning environment in students' engagement, a quasi-experimental study was conducted on 58 senior high school students. A pre-test was conducted in advance and a post-test upon concluding all three projects. The results reveal the pedagogical value of the aforementioned learning environment, since it provides multiple pedagogical benefits, having a positive effect on students' engagement.

KEYWORDS

Spatial Thinking, GIS-Based Project, STEM Education, Students Engagement, Web GIS

1. INTRODUCTION

Geographic Information Systems (GIS) are integrated computing systems for collecting, editing, and analyzing data. Web GIS is based on the cloud technology and are composed by a collection of mobile device native apps that help researchers accumulate, map and analyze authentic field data. According to Bednarz (2000), the Project-Based Learning (PBL) methodology is suggested as the best method for teaching and learning scientific skills when supported by proper educational technology. As Web GIS consists of powerful tools and methods for capturing, mapping and analyzing spatial and non-spatial data, they can technologically support the PBL methodology (Sofias & Pierrakeas, 2021). The combination of GIS technology with the PBL teaching method can increase learning outcomes in regard to analytical and critical thinking (Liu et al., 2010). Besides, "spatial thinking and STEM learning are correlated longitudinally as well as cross-sectionally" (Newcombe, 2017). Projects that are based on GIS technology (GIS-Based Projects) can be described as projects carried

DOI: 10.4018/IJWLTT.317089 *Corresponding Author

out to answer questions such as: "What is there?" and "Why is there?" or to understand a problem using GIS technology in the production, collection, analyzation, presentation, and visualization of data (Demirci et al., 2013; Fitzpatrick, 2001).

The advent of Web GIS, cloud computing, the ability to record data in the field using mobile devices and native applications, online open geospatial data, and the professional development of teachers and schools with modern laboratories, have created new opportunities and challenges for the utilization of the GIS technology in school education (Edelson, 2014; Kerski et al., 2013).

In light of the aforementioned technological evolution, a learning environment for school education that incorporates the PBL learning model as technologically supported by Web GIS was developed, with the view to answering the following research questions and providing some documented data as to the following research gap: Can the design and implementation of a research project within a learning environment that incorporates the PBL learning methodology, based on Web GIS technology, enhance students' engagement and is this potentially affected by gender? After all, the specific field of research concerning the connection that students acquire with their society, as well as the pedagogical benefits they gain as a result of conducting GIS-Based Projects, was recognized by Baker et al. (2012) as one of the six research gaps related to GIS in education.

Therefore, the novelty of this research lies both in developing the above-stated learning environment and in the degree of impact such an environment can have on students' engagement.

1.1 Factors That Contribute to Student Engagement

Students' engagement is "a multi facial and dynamic phenomenon that varies according to the individual, the rhythm, the activity and the time" (Lawson & Lawson, 2013) and contains "ways with which students actively participate in the shaping of their learning experience" (Trowler, 2010).

Student engagement is a dynamic situation that is shaped by environmental and individual factors. As far as the former are concerned, what is meant is the educational environment and the interpersonal relationships that are developed in it. Students best develop inner motivation of learning and engage in the learning process when they realize that their educators assign tasks that intrigue them, relate these tasks to elements from the real world, enhance their self-efficacy, praise their effort, and use formative assessment (Willms, 2003).

Individual factors are inner bonds related to school, self-regulated learning, and motivation. Emotional engagement is associated with the concept of school commitment and intrinsic motivation, behavioral engagement is associated with the manifestation of behaviors to achieve high motivation, while cognitive engagement is associated with the concept of self-regulated learning (Willms, 2003).

1.2 How Student Engagement Can Be Measured

Student engagement can be measured both qualitatively and quantitatively. A wide range of indicators can be used for both approaches, which reflect the different meanings of student engagement (Zepke, 2014). Although it is commonly accepted that student engagement is important for the learning process, there is not a common, widely accepted definition of its meaning and measurement. Most researchers agree that it contains multiple dimensions whose number and nature remain unclear. Some researchers evaluate three major dimensions: behavioral, emotional, and cognitive engagement (Fredricks et al., 2004), while others add the academic dimension as well as the support of educators and their interpersonal relations (Appleton et al., 2006).

Remarkable examples of large-scale quantitative study are the international research programs by the International School Psychology Association (ISPA) Research Committee, which evaluated the three basic dimensions of student engagement and the research program of NSSE (National Survey of Student Engagement) with five scales of engagement: reaction of students to academic challenge, active learning, interaction with educators, supportive learning environments, and enrichment of educational experiences (Zepke, 2014).