European Journal of Geography

Volume 13, Issue 3, pp. 050 - 069

Regular Issue
published quarterly

Editor: Dr Panos Manetos, pmanetos@uth.gr

Article Info
Accepted: 30/05/2022
Corresponding Author: (*) geod16005@aegean.gr
DOI: https://doi.org/10.48088/ejg.o.riz.13.3.050.069

Research Article

Investigating the Impact and Effectiveness of an ICT-based Teaching Scenario on Secondary School Students' Geospatial and Statistical Literacy: A Case Study from Greece

Ourania **RIZOU**[1*], Aikaterini **KLONARI**[1] & Dimitris **KAVROUDAKIS**[1]

[1] *University of the Aegean, Greece*

Keywords
Statistical literacy,
Geospatial literacy,
ICT-based scenario,
Interdisciplinary education,
Population distribution and density

Abstract
The case study investigates students' statistical and geospatial literacy and their reaction to an ICT-based teaching scenario. The study involved 41 High School students' in Lesvos Island, Greece. The intervention was applied in the ICT lab, in the context of a second-semester project on Geography. The means we employed to carry out students' activities included worksheets and the web-based platform statistics4school. In order to check the effectiveness of this intervention, the sample completed assessment sheets and an anonymous self-reporting questionnaire. According to the results, students declared that they became more confident with statistical concepts and geospatial thinking. The same perspective was also reflected in their responses regarding developing cognitive and social skills and literacy in general. The intervention's findings establish the basis according to which implementing new ICT-based teaching scenarios will support statistical, geospatial, and digital literacy.

Highlights:

- Statistics sits at the center of modern day information processing and decision making

- Geoliteracy leads to a more viable and sustainable future, being an integral part of a multitude of activities, scientific fields & educational practices

-Students becoming more confident about statistical concepts and more geospatially literate

- Students developing cognitive and social skills

- New pedagogical trends use ICT-based scenarios

*The publication of the **European Journal of Geography** (EJG) (http://eurogeojournal.eu/) is based on the **European Association of Geographers**' goal to make European Geography a worldwide reference and standard. Thus, the scope of the EJG is to publish original and innovative papers that will substantially improve, in a theoretical, conceptual or empirical way the quality of research, learning, teaching and applying geography, as well as in promoting the significance of geography as a discipline. Submissions are encouraged to have a European dimension. The European Journal of Geography is a peer-reviewed open access journal and is published quarterly.*

1. INTRODUCTION

The recent –and ongoing, sadly– COVID-19 pandemic has revealed, among many other issues, the extent of poor statistical literacy amidst the population, globally, which can lead to misconception (Hidayati et al. 2020; Hood 2020; Johannssen et al. 2021) and hasty decisions (Muñiz-Rodríguez et al. 2020; Rasmussen et al. 2020; Spiegelhalter 2020). It has also introduced the vast majority of people – especially those of younger ages – to some grim aspects of globalization.

Statistics is a subject, which pertains to the collection, organization, encoding, presentation and interpretation of data (Elfitra & Siregar 2020; Hassan et al. 2020). As we stand in the main hall of an era were vast amounts of information (Elfitra & Siregar 2020; Rohita 2020; Setiawan 2020) is circulated and recycled via the Web and because of the Internet of Things (IoT) (Hajjaji et al. 2021), we can understand the importance to have modern citizens possess a high degree of statistical literacy (Legaki & Hamari 2020; Hande 2020; Risqi & Setianingsih 2021).

Geography, on the other hand, as an applied science, according to Michael Pacione (1999, p. 1), is "*concerned with the application of geographical knowledge and skills to the resolution of real-world social, economic and environmental problems*". Over the last few decades, we have observed a prominent increase in the demand for cartographic backgrounds (Rizou et al, 2022). This in turn is reflected in the material of many taught courses today (e.g. economics, humanitarian studies, social sciences, archaeology, history, environmental training, geography -naturally), in various levels of education. Additionally, most applied geography contemporary systems incorporate Geospatial Technologies, or GST, as their core mechanic, in one form or another. This is owed to the high development rate and bloom of Information and Communication Technologies (ICT) in recent years –part of which is the GST- and their diffusion across a variety of fields (Rizou et al. 2022).

The goal of this case study was to evaluate the students' response to an experimental teaching method which was based on an ICT-enhanced scenario, aiming at introducing them to the statistical analysis of population distribution and density in certain regions. In addition to that, we wanted to explore the effect this course would have on the development and acquisition of various types of literacies and skills on their part – both social and cognitive.

2. LITERATURE REVIEW

2.1 Statistical Literacy

Statistics finds countless applications in daily activities and for this reason it has long been deemed imperative to have citizens capable of grasping, correctly interpreting and appropriately communicating statistical information. Drawing on the generic definition of literacy, i.e. the ability to read and write, one can easily understand the definition and importance of statistical thinking and statistical reasoning as integral attributes of the statistically literate person (Campos & Perin 2020).

Arguably, one would expect that teachers and students come to possess a high level of statistical education; on the contrary, this ratio is rather low, for a number of reasons (Masfigatin & Suprapto 2020; Rohayati et al. 2020; Muñoz et al. 2020; Rasmussen et al. 2020; Almašiováet al. 2021). One can therefore see why emphasis has been put in Curricula reforms to introduce statistical training at a very early age (Frischemeier 2020; Royahati et al.2020; Risqi & Ekawati 2020; Grando & Lopes 2020). Part of the solution is to begin with the training of the educators themselves, as one would expect. However, being the rather abstract and dreaded taught subject Statistics is today, it is in dire need of more appealing and evocative teaching methods; Geography can become the backbone of such a method.

2.2 Geospatial Literacy

Geography is one of the oldest disciplines with a dynamic that is fluid and constantly changing as it is based on the use of a multitude of teaching methods (Meisandy et al. 2021; Prastiyono et al. 2021; Yahaya et al. 2021;). Despite the fact that in recent decades a reform in the Geography curricula is underway, both in national and international level, students have yet to achieve an equally high level of geoliteracy (Dolan 2019; Bikar et al. 2021; Yahaya et al. 2021). Geoliteracy, or **geospatial literacy** as it is typically referred to by academics, has no formal definition. Instead, according to Moorman (2019, p.9) it is more of a moniker used to *"describe the basic geographic declarative knowledge of a population, an ability to make geographic decisions, geographic reasoning and a general understanding of geographic concepts"*.The broad spectrum of Geography's contribution today, in such varied fields such as climate-change studies, human geography, disaster relief and public safety planning, demonstrates if anything the bulk of geospatial data exchanged between these sciences as well as the complexity of these (big) data – both presently but also in the predictable future too (Robinson et al. 2016).

Moreover, the importance and amount of contribution of spatial thinking –developed as part of the student's geoliteracy– within the STE(A)M disciplines (science, technology, engineering, art and math) cannot be stressed enough. Today, images and graphics (either still or animated) are recognized as valid mediums of communication in contemporary societies, as they have been proved to contain meaning and convey messages (Moorman 2019). In extension, cartography and geovisualization lead in the creation of meaningful maps which go further than the simple depiction of environments and places to promote the creation of multimodal information transfer instruments (e.g. Virtual Globes, interactive maps etc.). Thus, the combination of visual and digital literacy effortlessly and naturally leads students to develop their geospatial literacy, acquiring in the long run the skills necessary for the analysis and comprehension of data which are visualized in various manners (e.g. maps, graphs, charts etc.) (Robinson et al. 2016; Dolan 2019; Moorman 2019).

2.3 Teaching approaches (to support statistical & geospatial literacy)

Some of the applications modern people commonly use are 3D maps, virtual globes (e.g. Google Earth) and intelligent route discovery (navigational) applications, on either their smartphones/tablets or personal computers. Therefore, it seems not only natural but also inevitable to introduce Geographical Information Systems (GIS) in the classroom (Alajmi 2021; Rizou et al. 2021). The point where Statistics crosses paths with Geography and ICT (Internet and Communications Technology) is the crossroad where the student, through broad comprehension and correct interpretation of real-world data (raw or processed), acquires proper geospatial and statistical training. As a direct result, they develop the ability to critically view and assess a situation, arming themselves for a more viable and sustainable future (Campos & Perin 2020; Frischemeier 2020; Suhermi & Widjajanti 2020; Zakari 2020; Rizou et al. 2021; Komiljonovna 2022). This is what Geography brings into play with the help of ICT, as the use of interactive maps and visualized geospatial information provide a more comprehensive representation of real-world data. Furthermore, being at the heart of so many other sciences, it is a subject well-suited to support interdisciplinarity (Rizou & Klonari 2016; Robinson et al. 2016). As a result, it holds the potential to become both the framework and the basis of organizing and executing research work, through the goals it sets in the Curriculum.

Modern pedagogical methods have been introduced to schooling, sporting inter-disciplinary and holistic approaches which better prepare future citizens for the challenges ahead. Infusing teaching sessions with multimedia presentations and multimodal scenarios, these methods lead to a higher degree of student participation and simultaneous training into a multitude of literacies (Gomez-Trigueros 2019; Rizou et al. 2021). We are aware that the new pedagogical

approach in education is **student-centric** (Rizou & Klonari 2016), as this has been found to produce the highest knowledge gain (Douglas et al. 2018) as well as lead to the acquisition of the so-called 'soft skills' (e.g. creative thinking, collaboration, persistence, stress management etc.) – both of which are invaluable assets for tomorrow's citizens. The core of this approach, more often than not, is found to be the **guided inquiry learning method** of teaching (Douglas et al. 2018; Wang et al. 2022). Additionally, when this is accompanied by the use of open source tools (Qais et al. 2019; Mucundanyi & Woodley 2021), emphasis shifts to **cooperative teaching** and fruitful interaction among students (Qais et al. 2019). Through guided inquiry, students are elevated to being more than passive audience to a stage where they actively participate in the classroom, asking (more) questions, putting their knowledge to the test and into practice, carrying out their tasks and activities with a higher degree of avidity and commitment (Gholam 2019).

Moreover, learning outcomes are known to be affected by the circumstances in effect in the classroom since some teaching method which is solid, in theory, otherwise may prove to be –partly or wholly– impracticable in actual conditions. For this reason, we needed to test our method's effectiveness while not neglecting its plausibility and applicability within the existing classroom conditions of Greek schools. In our case study, we aimed at taking full advantage of guided inquiry applied on a query set by the students during one of their semester projects. This is how and why this case study came to be, as a form of inquiry-based guided exploratory approach to teaching.

3. RESEARCH QUESTIONS

To conduct our case study for the purpose of evaluating the effectiveness and impact of the teaching method outlined above across a number of independent parameters, we posed the following three research questions:

1. How well was the lesson organized inside the classroom? – i.e. group separation, role assignment, adequate technological equipment, teaching method, completion time, interplay between students.

2. To what degree has this teaching method, built around an ICT-based scenario, helped students develop their statistical and geospatial literacy?

3. How well was this scenario and the activities it included structured, with the intent to meet the learning/cognitive needs of students of this age?

The first research question (henceforth Q1) pertains to the plausibility of the teaching method itself, i.e. the degree to which it can be implemented and carried out as intended in the classroom, given the specific limitations of allotted time and equipment availability in Greek schools. Similarly, the third research question (henceforth Q3) aimed at identifying possible issues with the teaching scenario, such as it being too complicated for some students to follow, containing hard activities or unclear instructions, being too demanding or too advanced for them, etc. Understandably, if we failed to get replies from our students at any point we should be able to identify the reason or reasons for this and tell whether it was owed to practical causes or weaknesses of the method itself.

The main research question however –and also the main focus of our case study– was to measure the impact and effectiveness this experimental teaching method had on the students in three different areas (Q2). Firstly, their awareness about Statistics and its direct and indirect connection with their daily routines. Secondly, their level of understanding the various uses of maps and other representation forms in conveying a multitude of information. Lastly, whether this method succeeded in making students become more interested and involved in the teaching process.

4. METHODOLOGY

4.1 Participants

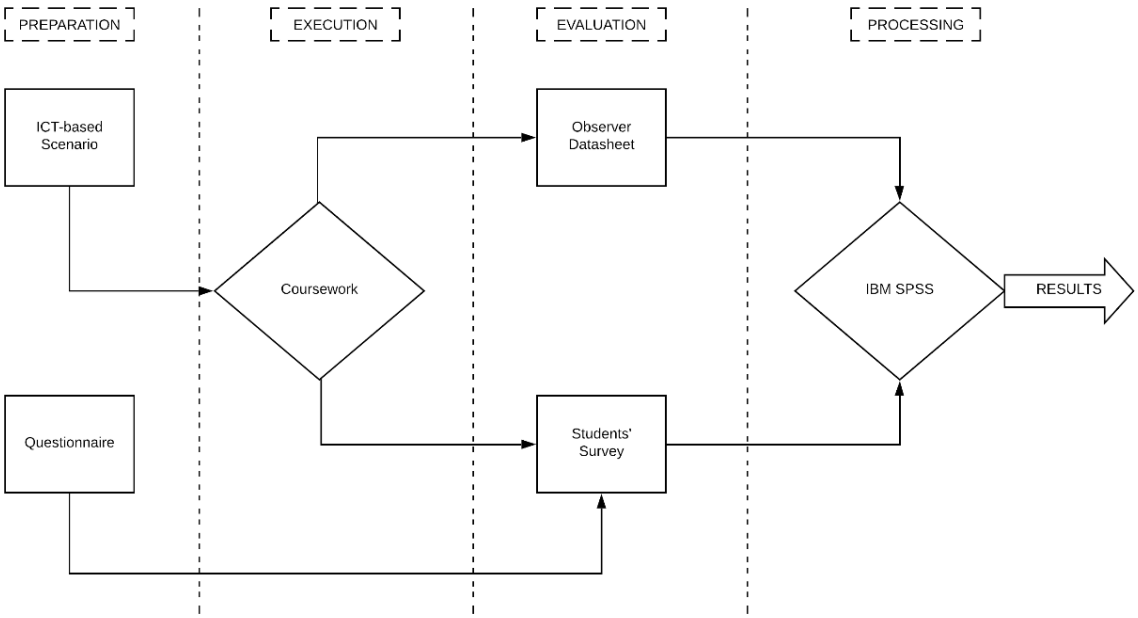
This case study, carried out within the turmoil of the Covid-19 pandemic, took 4 weeks to conduct (from March to April 2021). Our sample was a convenience sample under the circumstances of Covid-19 as there where many prohibitions imposed upon researchers in regards to entering the classroom. The case study itself was carried out in a single High School in the city of Mytilene, on Lesvos Island, Greece. Total completion time was 4 hours, with one 1-hour session per week. There were forty-one 9th grade students (14 boys or 34.14% and 27 girls or 65.76%). The facilities of a computer lab were used, specifically personal computers with internet access, a video projector, an interactive whiteboard and a printer device. An independent observer was present in the ICT Lab during the pilot application of the teaching scenario, in order to ensure the validity and integrity of the data/information collected since our sample was not adequately sizeable and for that our results need further investigation before we can generalize them.

4.2 Research Methodology

The research method used is commonly called a “one-shot case study”, in which a group is exposed to a treatment followed by a measure (Creswell & Creswell, 2018). This ‘treatment’, or intervention in our paradigm, was the teaching method.

Our research was carried out according to the following 4-step process (see Figure 1):

Figure 1. Research flow diagram



The preparation stage took place outside the classroom and included the creation of the teaching scenario and the accompanying digital material to be used in the involved activities (statistical data, activities worksheet, instructions sheet, students’ survey questionnaire). The scenario, titled ***"Investigating regional population distribution and density in Greece (and the factors that affect them) using an online digital tool"***, was presented to them as part of their 2nd semester project coursework in Geography (March 2021—April 2021).

During the execution phase, the teacher guided the students through the activities, took notes of their responses and reactions and generally directed the flow of the teaching method. For the most part, the ICT-related activities (data visualization and analysis) were performed through the web-based platform https://statistics4school.eu/, which offers the set of tools we aimed for. At the end of the teaching course, the teacher handed out a survey for the students to take.

Their pre- and post- session responses to the questions on the activities worksheet, together with the completed survey and the observer's datasheet were collected to be analyzed, in order to get answers and gain insight into our research questions posed above.

4.3 Measures

In order to carry out the evaluation, we collected data from 3 different sources: a) the replies on the students' worksheets, along with the teacher's notes, b) the survey they were asked to complete at the end of the teaching process and c) the independent observer's datasheet.

The results we collected from the first source were purely quantitative, i.e. we wanted to find out the number of students whose understanding of the topics discussed was increased (before-after comparison). The input from the independent observer was used as a validity and integrity check of the data collected due to our limited sample size, as explained above.

The evaluation of the students' point of view about our experimental teaching session was based solely on their responses as they were captured on the survey they had to take. This questionnaire consisted of closed-ended type questions, 17 items in total. It was estimated that 10' minutes were enough for completing and submitting it. Outside the demographic data section, we used Likert Scale with five (5) possible answers and essay, which ranged from "Strongly Disagree" to "Strongly Agree". The responses were organized, coded and analyzed using IBM SPSS v25.

The questionnaire comprised two main sections plus the demographics one. The details for each section are summarized in Table 1.

Table 1. Description on the sections of the questionnaire instrument

Section	Description (variables)	Number of items	Aim
A	Demographic data	2	Gather generic and anonymous information (gender, class)
B1	Organization & structure of teaching method	10	Measure students' satisfaction with the whole teaching process
B2	Methodology of teaching method	5	Find out students' views on the effectiveness & appeal of the intervention
	Total	17	

4.4 Teaching Scenario

4.4.1 Overview

The first activity of the scenario aimed at getting students familiarized with retrieving statistical data from the Hellenic Statistical Authority (ELSTAT); for our purposes, these data pertained to the distribution of the population across the regions of Greece. The main goal, however, was to assist the students understand the meaning of the retrieved data. With the aid of the platform's features, these data were visualized and a discussion took place around the images produced. Ultimately, the students' level of understanding the factors that

contribute to the increase or decrease of said population in a certain region (e.g. immigration and low birth) was evaluated.

At first the students were asked to give the definitions of population distribution and density as they remembered them from previous courses. In the process we also attempted to verify if they were able to distinguish and justify the factors which affect both in a given region. Then, as they were instructed into the meaning and use of the basic statistical functions (e.g. mean/average, minimum, maximum, etc.) they came to realize and understand their true meaning and usefulness in their daily lives through paradigms such as changes in consumer income, minimum admission base in Universities, average course grade, percentage of unemployed, deaths and cases of COVID-19, etc. Further, as they visually represented the statistical data with the help of graphs and maps –using the geospatial background of Greece and its administrative regions– they were able to compare the results and draw conclusions. Finally, they were asked to re-define their initial responses regarding the terms in questions, seeing if and how much they could expand on these as a result of the newly acquired knowledge.

4.4.2 Execution

Teaching Scenario - *"Investigating population distribution and density in a geographical region (and the factors that affect them) using an online digital tool"*

1st teaching hour: Students were divided into heterogeneous groups of 3-4 individuals, and one computer is assigned to each group. The groups were made up in such a way that in each one there were students who are distinguished for their ease in the use of mathematical and geographical concepts, maps and ICT, and students who are struggling with these particular topics.

Through guidance, with detailed instructions given in the worksheet and accompanying manual, students were asked to implement the activities described therein, with the ultimate goal of developing critical thinking and cultivating both their statistical and geographical literacy.

The students, through the implementation of the 1st activity (worksheet), initially attempt to record the meaning of the terms 'Population', 'Population distribution' and 'Population Density' (see Figure 2)

Then, with the help of the pictures and the text that was provided, should this have been deemed necessary, they were asked to reformulate or complete the definition of the aforementioned concepts and calculate the population density. The island of Lesvos was used as an example.

2nd teaching hour: The content of the 2nd activity aimed students to identify densely populated and sparsely populated areas as well as the causes that contribute to the formation of the population distribution in Greece. The findings were presented in the plenary of the class, in order to discuss and clarify – using examples – the factors that shape the population of Greece and its local distribution.

3rd teaching hour: In the next stage, again following the detailed instructions given in a separate work sheet, they implemented the 3rd and 4th activities by using the tools embedded in the web-based platform https://statistics4school.eu/. In these activities they will need to enter statistical data supplied to them (source: ELSTAT), concerning the distribution of the Population and the Population Density during the period 1991-2011, for the 13 Regions of Greece. Furthermore, they studied the changes in the values of these data, and evaluated them. The comparison between the geospatial changes through time were carried out via the tools of the web platform. These included:

1. *simple statistic functions*: Minimum, Maximum, Median, Standard Deviation, Sum, Percentage variation

2. *graphs*: Column, Pie, Scatter, and

3. *geospatial background of Greece*, at the levels of Prefecture or Municipality, using a color palette grading (see Figure 3).

4th teaching hour: The last activity contained questions designed to test the achieved level of comprehension, as they were asked to predict the population of the 2021 census and indicate ways they believed can reverse the continuing decline of the population of Greece (see Figure 4). Upon completion, the teacher invited each group to submit to the plenary of the class the answers given by the students, with the ultimate goal to make them think creatively in order to make the connection between the topic of the worksheet and their daily life. In the end, they answered the questionnaire.

Figure 2. 1st Question and visual related to 1st activity

Figure 3. Population map with information

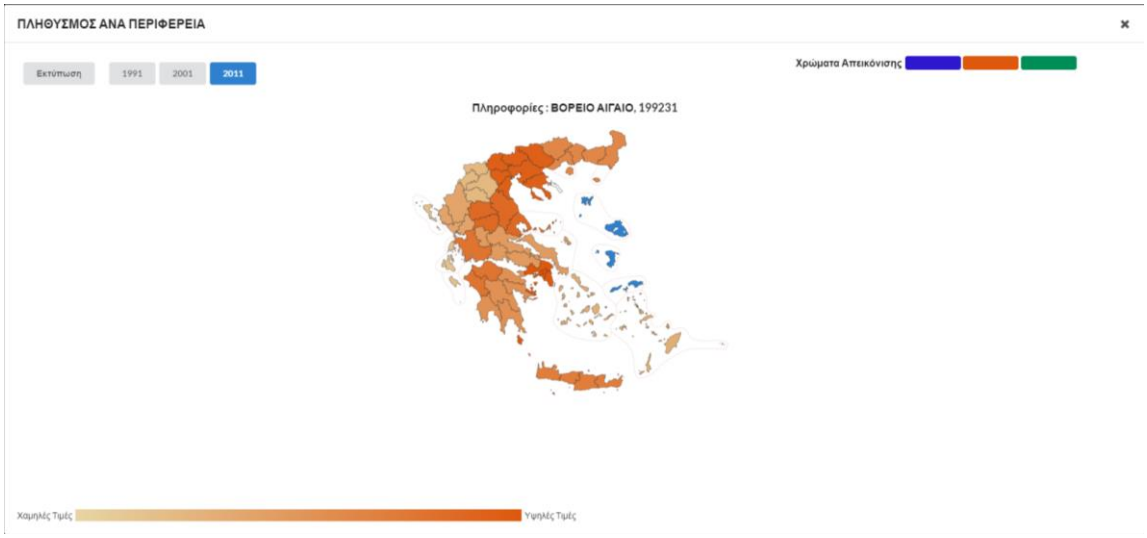
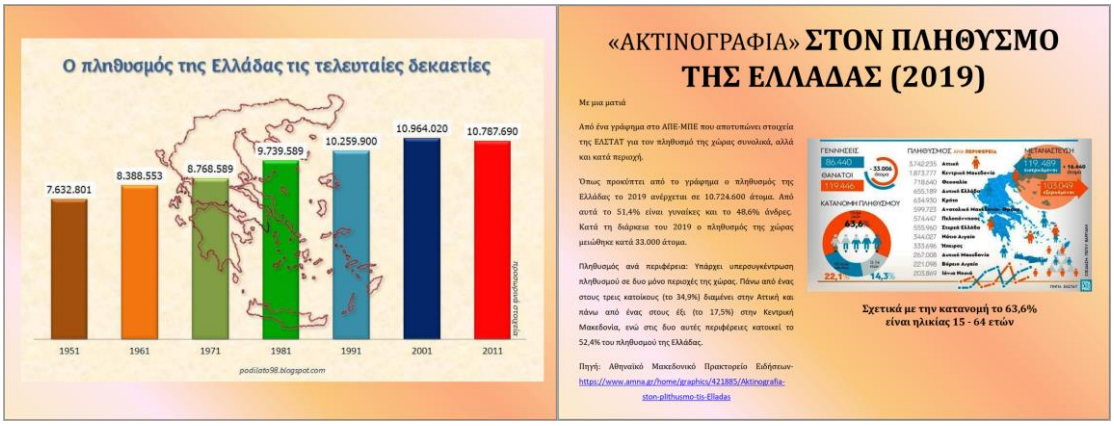


Figure 4. Screenshot from last activity



5. RESULTS

At the end of the pilot teaching method, the **questionnaire** completed by the students served as the evaluation basis for the effectiveness of the ICT-based teaching scenario in developing their statistical and geospatial literacy. Overall, the findings were positive and confirmed the expected results.

The first step was to test the collected data for whether or not they were normally distributed in order to select the suitable statistical tests to run on them. The Mann-Whitney U (2-samples) non-parametric test was used to test independent samples at p=0.05 level of significance. Subsequently the coded responses were collectively analyzed using mean and standard deviation. Results are interpreted based on the research questions and hypotheses.

Based on Table 2, we can see that students' responses to the first research question (i.e. organizational part of the course) reveal a positive reception. Mann-Whitney tests show that both male and female respondents demonstrate an approximately equal degree of satisfaction, with the first group scoring slightly higher. Additionally, the values of U=177.500 and p=0.749 indicate an overall acceptance, regardless of gender. Now, cross-examining students' opinions on Q1 versus the group they were sorted into we notice that students from the 2nd group were more satisfied (1st group Mean = 18.10 and 2nd group Mean = 23.76, at p=0.126) – this could be owed to a number of reasons, with group composition being the most probable cause.

Table 2. Mann-Whitney U test (2-samples) results

	Q1		**Q2**		**Q3**	
Gender	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
	21.82	20.57	22.00	20.48	19.75	21.65
U	177.500		175.000		206.500	
p	0.749		0.714		0.634	
Class	**1st group**	**2nd group**	**1st group**	**2nd group**	**1st group**	**2nd group**
	18.10	23.76	20.73	21.26	20.98	21.02
U	268.000		215.500		210.500	
p	0.126		0.884		0.989	

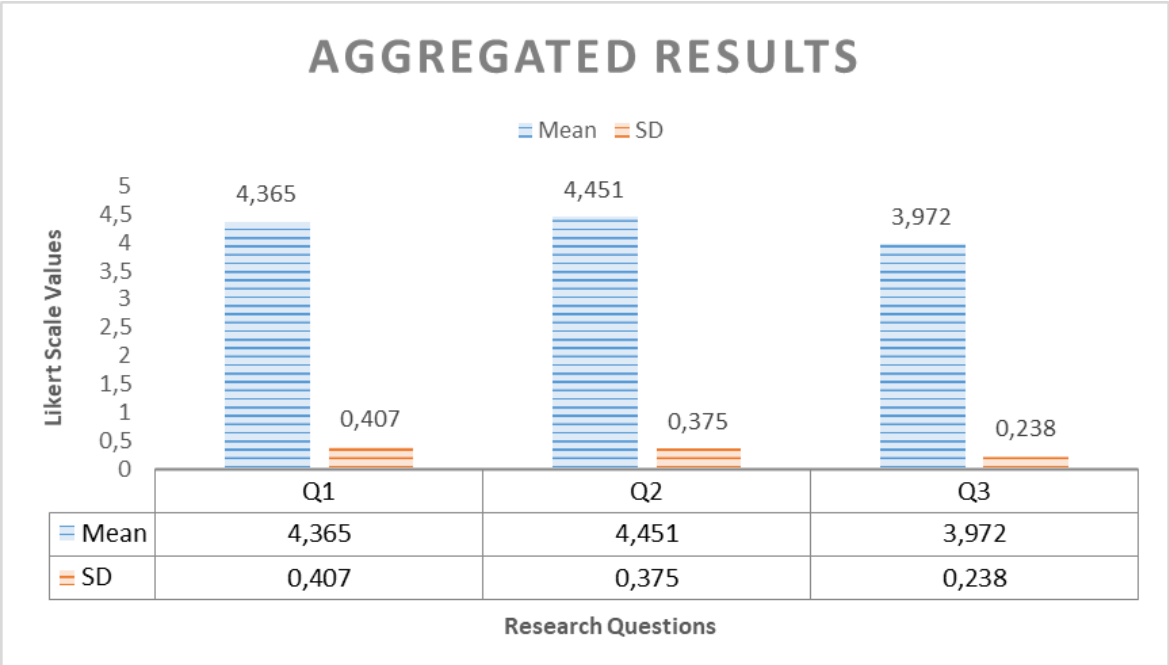
Findings about the 2nd research question (i.e. development of literacies) indicate that there was no statistically significant difference in the Mean scores depending on the gender variable. Although boys (Mean = 22.00) showed an increased understanding of the statistical functions and their intended use, girls (Mean = 20.48) had a very high grasp too. The opposite was observed in the 3rd research question's results (i.e. scenario structure and difficulty): clearly, it is the girls (Mean = 21.65) who claimed here to be more satisfied with the composition of the ICT-based teaching scenario and its activities. Generally, results showed that the 2nd group scored higher overall across all three research questions (Mean (Q1) = 23.76, Mean (Q2) = 21.26 and Mean (Q3) = 21.02), which again points towards a possibly uneven sorting of the students in the groups.

On the 5-values Likert scale we used, replies which scored 3.5 or higher are considered as 'positive' or 'in favor' ones. Respectively, responses with a score of 2.5 or lower was regarded as a 'negative' or 'not too fond of' ones. Obviously there is a 'grey area' of neutral/indecisive responses for scores in between (2.5-3.5).

The aggregated results (see Figure 5) lead us to the conclusion that students clearly demonstrated a positive attitude towards this pilot teaching method combining Statistics with Geography and the way it was delivered to them, as a whole. The results to Q2 scored the highest Mean value, across the two individual criteria (gender and group). This signifies an apparent improvement of the way they look upon Statistics as they are introduced to it through a new approach, by means of ICT. Clearly, their grasp of the use and usefulness of Statistics was increased through the visualization of data against the backdrop of Greece's territories – an image familiar to them because of their Geography.

At the same time, their involvement in the learning process (team-collaborative, explorative teaching, role assignment, etc.) as well as the appeal and engagement of the involved activities, again owed to ICT, was warmly received. As shown by the results to Q1 (Mn=4.365, SD=0.407), they felt that the course was well structured, with clear guidelines and easily executed activities. Additionally, students agreed that lab equipment was adequate and presentation media promoted understanding while making the lesson more inviting to attend.

Figure 5. Aggregated results from questionnaire

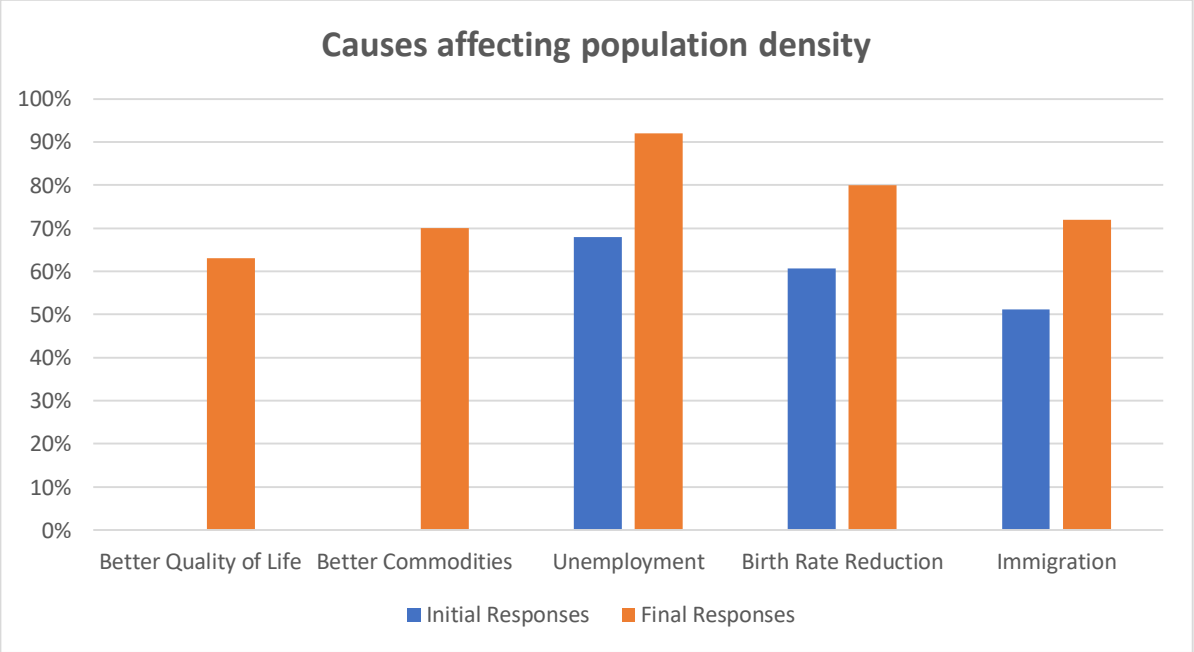


On the other hand, the results to Q3 (Mn=3.972, SD=0.238) precisely reflect the persistent need to have the activity questions and facts phrased unambiguously and in perfect clarity, in order to support the teaching process to the best possible degree. We should not fail to underline the fact that students, through their replies to the questionnaire, demonstrated a fair amount of satisfaction about the structure of the taught scenario and the activities this involved – but at the same time also clearly indicating that we must not feel complacent but strive to improve upon it.

To further investigate Q2, as this is obviously the most important research question here, we wanted to measure the extent to which the students' Statistics knowledge and geospatial skills improved thanks to the ICT scenario and activities. In order to do so, we used as metrics the **datasheets** completed by the teacher and the **worksheets** the students completed and returned. Collectively, these showed us that initially, there was a relatively small percentage of students (26.8%) who were somewhat familiarized with Statistics and the geographical background of Greece – the latter due to their Geography courses. When asked, initially, to provide a definition for 'population', 'population density' and 'population distribution', correct answers were given by merely 34.14% of them. It was noted that 39.02% searched the Web while the rest of them offered either a vague or wrong answer. At the end of the 1st Activity, when they were asked to revisit their responses we found a clear and definite improvement (73.17%).

In the process of the 2nd Activity, approximately 2/3 of the students provided correct answers from the very beginning (65.83%). More specifically, they were asked to give examples of statistical terms they use in their daily routines. Furthermore, they were asked to list factors which they thought that might affect population distribution in a given region. After the completion of the activity, through the presentation of each group's responses in the classroom and the discussion that followed, the number of correct answers rose to 85% This fact clearly signified that students were able to identify and comprehend the factors which affect the value of population in a certain region. Their replies are shown in Figure 6. Note that the first two replies/factors received no 'hits' initially.

Figure 6. Responses at "Causes affecting population density"

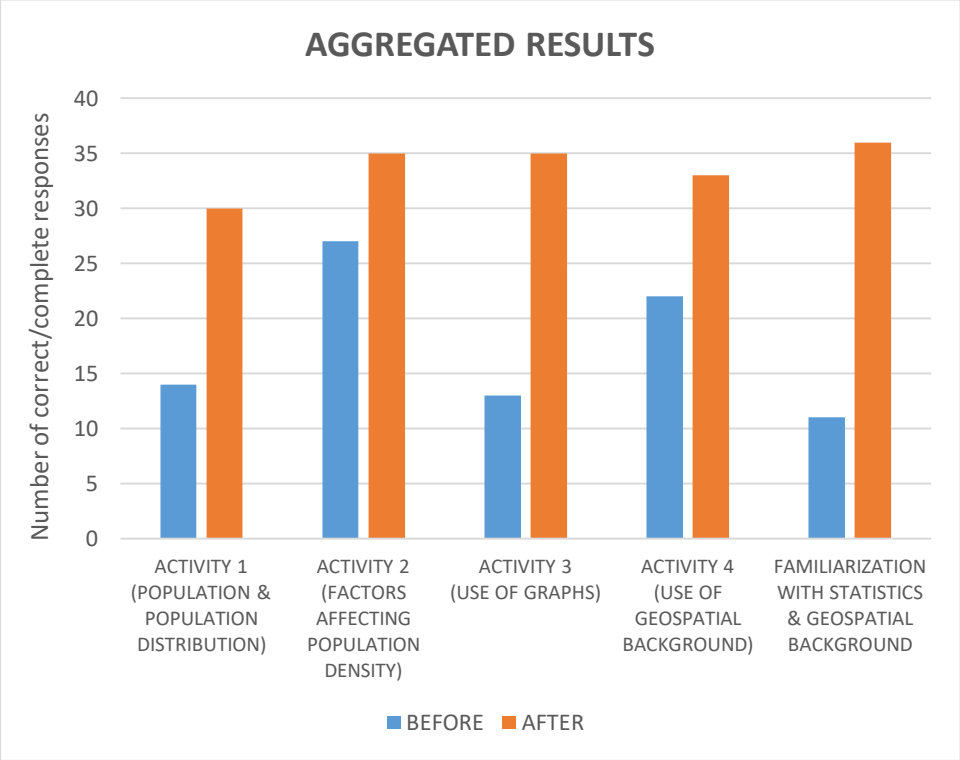


The results collected from Activities 3 and 4 demonstrate once more the deficient statistical and geospatial literacy of the students. More specifically, when they were asked to submit an assessment of the statistical data at hand by looking at the respective graphs (charts), most students (68.29%) tried to 'cheat' by providing the exact numerical value. This number was significantly decreased (14.63%) after the discussion which followed the presentation of the results in the classroom. During this stage, with the aid and intervention of the teacher, the question was approached and better explained through examples, leading to a deeper and clearer comprehension.

Furthermore, it was observed that the color palette of the 'Map' visualization scheme led more than half of the students (53.65%) to provide the wrong answer; clearly they thought the color grading to signify the variation of statistical data 'correctly' or accurately – i.e. lower to higher value. At this point it was deemed necessary by the teacher to offer examples so as to help the students better understand and interpret the meaning of statistical data, when these are displayed and compared against a set geospatial background. Following this and upon revisiting the initial questions, 33/41 students (80.49%) were in a position to provide the correct answers.

Upon completion of the teaching session, we prompted the students to go back to their initial responses and compare them to what they came up with in the end. When asked about the obvious deviation in their before-after responses, they agreed that it was owed to the fact that they hadn't realized the multiple uses of maps, despite having used them extensively in the past – thinking of them as merely instruments of depicting lands and outlining journeys. The aggregated results are shown below (see Figure 7).

Figure 7. Aggregated results from activities



6. DISCUSSION & CONCLUSIONS

This survey was conducted with the aim to explore an 'unconventional' method of presenting Statistics to students, blending guided exploratory teaching and inter-disciplinary

paradigms with ICT through a STEM augmented scenario. Specifically, we set out to investigate students' statistical and geospatial literacy and their reaction to and effectiveness of the ICT-aided teaching scenario. According to the results, students declared that they became more confident with statistical concepts and geospatial thinking (Klonari & Passadelli 2019). The same perspective was also reflected in their responses regarding cultivating cognitive and social skills and literacy in general. The intervention's findings establish the basis according to which implementing new ICT-based teaching scenarios will support statistical, geospatial and digital literacy (Klonari & Passadelli 2019; Suhermi & Widjajanti 2020; Rizou et al. 2021). Students developed a new approach to geography and statistics as they comprehended the concepts better. From the responses we received it was confirmed that students absorb knowledge better with the combined use of guided inquiry and cooperative teaching, paired with and augmented by new technologies in media presentation. At the same time, as a by-product, teaching material is being created which can be re-used and expanded upon, through free sharing among educators.

The contribution of the online platform (*statistics4school.eu*) was deemed catalytic to the success of our intervention. Through the tools it offers the students were able to easily carry out the scenario's activities, aided by the clear instructions given to them in the accompanying sheets. It should be noted, however, that a few of them needed more help and guidance than others. Surely, there are other GIS applications which could be employed. *ArcGIS* for example, is a software filled with features to the brim – and a price tag to match. *WebGIS* is another great tool: very presentable and easy to use and definitely one to recommend – if only it wasn't using shapefiles, which educators in Greece are neither trained nor required to learn how to use. Presently, the use of GIS –and related software– does not exist as a prerequisite in the Greek Curricula.

Students testified that they were satisfied with the whole process. According to their responses, the case study was well organized – something we anticipated as the latter was based on a student-centered teaching model. Since students were teenagers, it was not surprising to find that they were motivated by the use of ICT in their learning process (Akshay et al. 2020; Oliveira et al. 2020), regardless of their gender. For the most part it was an easy job to create a climate of respect and acceptance where students could share ideas, develop and learn together and borrow from one another, as well as think independently. It was proven that encouraging students to make their own choices and participate in such a teaching process improved their statistical and geospatial literacy greatly (Oliveira et al. 2020; Rohayati et al. 2020).

On the matter of the method's effectiveness, before the case study students admitted in the classroom that they didn't realize how statistics is part of their daily routine: they found it difficult to provide examples for this, while some of them could not offer any response at all. During the intervention, we noticed that a very high percentage of students tried to find the 'right' answer – described as the Hawthorne phenomenon (Nielsen & Miraglia 2017). The teacher was asked many times what the right answer to the activities questions was. She explained through examples, that in statistics there is no 'right' or 'wrong' answer but only 'good' or 'bad' (re)presentation and interpretation of data (Spiegelhalter 2020). On the matter of visualizing data, the majority of students have at first cumulatively presented their answers to the questions of the associated activities graphically using solely the color pallet available in the graphs and map pages. Through the presentation of each group's results in the classroom the teacher was given the opportunity to talk about the demand and importance of understanding and correctly interpreting these statistical data, as well as the information each shape or chart conveyed (Ozmen et al. 2020). From there students revisited their responses, putting more emphasis this time on the meaning behind the presented and visualized information, eventually boasting that they felt much more confident about answering where they can find Statistics in the real world. On the matter of Geography, we noted a notable expansion of their apprehension regarding the versatility of maps and the many different situations these may be put into use. Additionally, the students' skill to interpret graphs and

charts was honed as they became more competent to read the information contained in each method of representation as well as decide which one was more suitable in each case. Overall, a development of the students' statistical, geospatial and visual literacy was observed.

At the end of the 4-hour course students could identify and interpret population patterns such as demographic shifts in certain regions. Further on, they were able to define the factors which affected these shifts with the aid of simple statistical functions, aiming at comprehending the social phenomena of birth deficiency, urbanization and immigration. Through their participation in this experimental teaching scenario, students were introduced to a variety of social processes (e.g. demographic issues, pandemics, unemployment etc.). Owing to the team-collaborative teaching they learned to function creatively, applying critical thinking when searching for the substance of the matter. At the same time, the elusive part of Statistics became attractive and approachable, through ICT, piquing their interest and curiosity.

Ultimately, 87.80% of the students considered charts to have offered a great aid in their understanding the various statistical concepts, by (them) being an established and familiar form of visualization. Additionally, 78.04% felt that the geographical background further assisted in their efforts to sort through the data sets and draw conclusions. In their opinion, this was owed to the fact that the familiar background allowed them to create mental representations and link these to the demographic events, in such a manner that placed emphasis on the parameter of time and the way(s) it affects growth factors. Thus, it became clear to them that the spatial distribution of population relates to the geographical variation between different places. This, in turn sparkled the offering of opinions and ideas regarding spatial information and ways in which it supports inferring of conclusions, based on statistical data.

The world is changing rapidly, perhaps at greater paces today than ever before in human history. A peaceful revolution is taking place, graced and fueled by Big Data and the velocity and scope of the Internet of Things (IoT), pervading and altering, in a good way, every aspect of our society - social, economic, scientific and political (WEF 2016). Building upon the 3rd Industrial Revolution, the common denominator across all advancements is statistical data and the information derived from these. From global environment change talks to famine and water supply scarcity, from planning for the sustainable future to dealing with ongoing crises, Statistics is at the core of all educated decision making (Lipic & Ovsenik, 2020; Muñiz-Rodríguez et al. 2020; Rasmussen et al. 2020; Spiegelhalter 2020).

Having identified this fact (Hande 2020; Risqi & Setianingsih 2021) but also the deficient literacy of the majority of people (Cazorla et al. 2020; Elfitra & Siregar 2020; Muñiz-Rodríguez et al. 2020), countries all around the world have begun taking steps towards creating statistically literate citizens who will be able to stand in the front line and advance the progress of this 4th Revolution. These steps vary from educating teachers on how to best teach Statistics and familiarizing students to its manifold applications, to changing the way Statistics is presented in the classroom, entirely (Casey et al. 2020; Souza et al. 2020). A variety of approaches have been proposed and put to the test, aiming at creating a reversal of the negative aura that haunts both teachers and students regarding Statistics and also making it more approachable and comprehensible to all (Hassan et al. 2020; Rohayati et al. 2020; Rohita 2020).

On the other hand, Geography has evolved from cartography to geovisualization. In this new form it permeates nearly all aspects of modern life – be it travel and goods transportation, to global climate monitoring to surveying and managing natural resources and the many ways human activities impact the environment. The ancient yet intricately crafted and detailed atlases of the old have been replaced by elaborate representations of the Earth and Cosmos, enhanced with high definition images and sophisticated features which allow for various types of interaction and real-time 3D navigation. Students are no longer, or should no longer, be trained to merely read from a flat map crammed with static information. Place names and legends mean nothing if they are not associated with dynamically updated information, in such

a way that will allow for instant usability, in a few clicks or a couple of swipes of the thumb or index fingers. Modern citizens need to take the leap from being able to find their current & target location (absolute and relative positions) to knowing the relations and connections between these two places and make safe and quick decisions about them when planning out a course of action.

Taking into account the need to improve the proficiency of Greek students' statistical and geospatial literacy, the desire to integrate ICT with school practices, the demand to have future citizens actively and efficiently participate in decision making without misconceptions and the cultivation of critical thinking, we can see that it is inevitable to rise to the challenge of change in order to make the best use of statistics in our daily lives. The approach we proposed and tested here, is based upon such practices as interdisciplinarity and non-assisted, exploratory teaching while centered around and guided by a teaching scenario augmented with ICT activities. It makes use of a web-based platform (*statistics4school.eu*), which was created specifically for this purpose. This online tool is aimed at both teachers and students and can be used as a complement to existing databases (e.g. ELSTAT, World Data Bank) and educational material Greek repositories (e.g. e-class, Aesop, photodentro). Initial results of this experimental teaching method are very encouraging, showing an increase to students' statistical, digital and geospatial literacy as well as a well-received educational approach to learning Statistics and Geography.

It must be noted that our sample was particularly small, owed to limitations described. Arguably, further investigation should be made before we are in a position to generalize and derive more solid and well established conclusions. However, initial results are supported by similar studies carried out in various degrees of education in many countries (Martin 2020; Suhermi & Widjajanti 2020). It is our firm believe that the proposed approach, based on the inter-disciplinary teaching of 'complex' subjects, based on scenarios that incorporate ICT and STEM activities, may be an invaluable aid to increasing a multitude of literacies (Hourigan & Leavy 2020).

REFERENCES

Akshay, N., Minces, V., Vazhayil, A., Gopalasamy, V. & Bhavani, R. R. (2020). There's Data all around you: Improving data literacy in high schools through STEAM based activities. *Fablean Asia 2020*. Retrieved from, https://par.nsf.gov/biblio/10166600-data-all-around-you-improving-data-literacy-high-schools-through-steam-based-activities

Alajmi, M. M. (2021). The Effect of Blended Learning on the Degree of Students' Acquisition of Geography Skills for the Eleventh Level at the Secondary Stage in Kuwait. *Journal of Social Studies Education Research (JSSER), 12*(4), 93-120. Retrieved from, https://jsser.org/index.php/jsser/article/view/3625

Almašiová, A., Kohútová, K. & Fričová, J. (2021). The level of statistical literacy in future teachers and the use of available technology with the aim to increase it. *AIP Conference Proceedings*, 2343(1). https://doi.org/10.1063/5.0048211

Bikar, S. S., Rathakrishnan, B., Rabe, Z., Mahat, H., Sharif, S. & Talin, R. (2022). The impact of geography information system integrated teaching on underachieving students' intrinsic motivation. *International Research in Geographical and Environmental Education, (1),* 1-17. https://doi.org/10.1080/10382046.2021.2001983

Campos, C. R. & Perin A. P. (2020). About critical and behavioral competences in Statistics Education. *Zetetiké, Campinas, SP, 2020*, 28, 1-18. https://doi.org/10.20396/zet.v28i0.8656795

Casey, S., Hudson, R., Harrison, T., Barker, H. & Draper, J. (2020). Preservice teachers' design of technology-enhanced statistical tasks. *Contemporary Issues in Technology and Teacher Education, 20*(2), 269-292. Retrieved from, https://citejournal.org/volume-20/issue-2-20/mathematics/preservice-teachers-design-of-technology-enhanced-statistical-tasks/

Cazorla, I. M., Utsumi, M. C. & Santana E. (2020). Statistics performance of elementary and middle school students in the context of D-Estat. *Zetetiké, Campinas, SP, 2020,* 28, 1-25. https://doi.org/10.20396/zet.v28i0.8656917

Cresswell, J. W. & Cresswell, D. J. (2018). Research design: Qualitative, quantitative, and mixed methods approaches. In Research design: Qualitative, quantitative, and mixed methods approaches, Cresswell, J. W., Cresswell, D. J. Eds: SAGE-Publications Inc. Retrieved from, https://www.yumpu.com/en/document/read/63191620/creswell-john-w-creswell-j-david-research-design-qualitative-quantitative-and-mixed-methods-approaches-sage-publications-2018

Cross Thematic Curriculum Framework (CTCF) & Subjects Curricula For Compulsory Education (2003). *Translated from the Official Gazette issue B, nr 303/13-03-03 and issue B, nr 304/13-03-03 by members of the P.I.* Retrieved from, http://www.pi-schools.gr/programs/depps/index_eng.php

Dolan, A. M. (2019). Geoliteracy: an approach to enquiry-based learning for Junior Cycle Geography students in Ireland. *Teaching Geography, Springer 2019, 44*(1), 24-27.

Douglas, E. P., Miller, M. D., Koro-Ljungberg, M., Wells, T., Raymond, T., Waters, C. & Hughes, W. Y. (2018). Guided inquiry learning across educational contexts. *The International Journal of Engineering Education, 34*(1), pp. 171-186. Retrieved from: https://asu.pure.elsevier.com/en/publications/guided-inquiry-learning-across-educational-contexts

Elfitra & Siregar, T. M. (2020). Statistical Literacy Analysis of Mathematics Education Students Through KKNI Assignments. *Journal of Physics: Conference Series,* 1462. The 6th Annual International Seminar on Trends in Science and Science Education. http://dx.doi.org/10.1088/1742-6596/1462/1/012028

Frischemeier, D. (2020). Building statisticians at an early age-statistical projects exploring meaningful data in primary school. *Statistics Education Research Journal,* 19(1), 39-56.

Gholam, A. (2019). Inquiry-Based Learning: Student Teachers' Challenges and Perceptions. *Journal of Inquiry & Action in Education, 10*(2), pp. 112-133. Retrived from: https://eric.ed.gov/?id=EJ1241559

Grando, R. C. & Lopes, C. E. (2020). Creative insubordination of teachers proposing statistics and probability problems to children. *ZDM – Mathematics Education,* 52, 621–635. https://doi.org/10.1007/s11858-020-01166-6

Gomez-Trigueros, I. M. (2019). The Geospace Competences with the TPACK Model and Outdoor Educationautor. *European Journal of Geography, 10*(3), 33-45. ISSN 1792-1341

Hajjaji, Y., Boulila, W., Farah, I. R., Romdhani, I. & Hussain, A. (2021). Big Data and IoT-based Applications in Smart Environments: A Systematic Review. Computer Science Review, 39. https://doi.org/10.1016/j.cosrev.2020.100318

Hande, R. D. (2020). A Geographical Analysis Of Literacy In Pune Administrative Division Of Maharashtra, India. *Juni Khyat (UGC Care Group I Listed Journal), 10*(5), 91-100. ISSN: 2278-4632

Hassan, A., Ghaffar, A. & Zaman, A. (2020). An Investigative Study on University Students' Statistical Literacy in Pakistan. *Sir Syed Journal of Education & Social Research,* 3(1), 159-165. https://doi.org/10.36902/sjesr-vol3-iss1-2020

Hidayati, N. A., Waluya, S. B., Rochmad & Wardono (2020). Statistics literacy: what, why and how? *Journal of Physics: Conference Series,* 1613, Ahmad Dahlan International Conference on Mathematics and Mathematics Education 8-9 November 2019, Yogyakarta, Indonesia. https://doi.org/10.1088/1742-6596/1613/1/012080

Hood, J. C., Graber, C. & Brase, G. L. (2020). Comparing the Efficacy of Static and Dynamic Graph Types in Communicating Complex Statistical Relationships. *Frontiers in Psychology,* 10, 1-7. https://doi.org/10.3389/fpsyg.2019.02986

Hourigan, M. & Leavy, A. M. (2020). Using integrated STEM as a stimulus to develop elementary students' statistical literacy. *Teaching Statistics,* 42, 77-86. https://doi.org/10.1111/test.12229

Johannssen, A., Chukhrova, N., Schmal, F. & Stabenow, K. (2021). Statistical Literacy—Misuse of Statistics and Its Consequences. *Journal of Statistics and Data Science Education,* 00(0), 1-9. https://doi.org/10.1080/10691898.2020.1860727.

Klonari, A., & Passadelli, S.A. (2019). Differences between dyslexic and non-dyslexic students in the performance of spatial and geographical thinking. *Review of International Geographical Education Online*, *9*(2), 284-303. https://doi.org/10.33403/rigeo.510360

Komiljonovna, D. S. (2022). Methods Of Using Statistical Data In The Lessons Of Economic And Social Geography. *Eurasian Research Bulletin, (4)*, 60-62. ISSN: 2795-7365

Legaki, N. Z., & Hamari, J. (2020). Gamification in statistics education: A literature review. In J. Koivisto, M. Buji, & J. Hamari (Eds.), *GamiFIN Conference 2020: Proceedings of the 4th International GamiFIN Conference*, 41-51.

Lipic, N. & Ovsenik, M. (2020). The Effect of Statistical Literacy on Response to Environmental Change. *Organizacija, 53(2)*, 147-163. https://doi.org/10.2478/orga-2020-0010

Masfigatin, T. & Suprapto, E. (2020). Student's Statistical Literacy skills Based on the Reflective and Impulsive Cognitive Styles. *Al-Jabar: Jurnal Pendidikan Matematika, 2020,* (2), 273-286. http://dx.doi.org/10.24042/ajpm.v11i2.6902

Martin, E. R. (2014). What is Data Literacy? *Journal of eScience Librarianship, 3*(1), 11-2. https://doi.org/10.7191/jeslib.2014.1069

Meisandy, R. R., Sumarmi, S. & Utomo, D. (2021). Exploring the use of blended PBL in Geography for enhancing students' analytical thinking in the "new normal" condition. *GeoEco, 7*(1), 106-120. ISSN: 2460-0768.

Moorman L. (2019). The Evolution and Definition of Geospatial Literacy. In: Balram S., Boxall J. (eds) *GIScience Teaching and Learning Perspectives. Advances in Geographic Information Science.* Springer, Cham. https://doi.org/10.1007/978-3-030-06058-9_2

Mucundanyi, G. & Woodley, X. (2021). Exploring Free Digital Tools in Education. *International Journal of Education and Development using Information and Communication Technology (IJEDICT),17*(2), pp. 96-103. Retrived from, https://files.eric.ed.gov/fulltext/EJ1297885.pdf

Muñiz-Rodríguez, L., Rodríguez-Muñiz, L. J. & Alsina, A. (2020). Deficits in the Statistical and Probabilistic Literacy of Citizens: Effects in a World in Crisis. *Mathematics 2020,* 8, 1-20. https://doi.org/10.3390/math8111872

Muñoz D. E., Esparza, A. C. M., Ciprés, M. C. & Muñoz Macías, M. G. (2020). Comprehension of statistical graphs and tables by primary school teachers in-training. *Zetetiké, Campinas, SP, 2020, 28*, 1-25.

Nielsen, K., & Miraglia, M. (2017). What works for whom in which circumstances? On the need to move beyond the 'what works?'question in organizational intervention research. *Human relations*, *70*(1), 40-62.https://doi.org/10.1177%2F0018726716670226

Oliveira, S., Carvalho, L., Monteiro, C. & Carvalho, C. (2020). Teachers dialoguing about statistical literacy with support of Messenger App for smartphones. In *Proceedings of 16th International Conference Mobile Learning 2020,* 129-132. http://dx.doi.org/10.33965/ml2020_202004R018

Ozmen, Z. M., Guven, B. & Kurak, Y. (2020). Determining the Graphical Literacy Levels of the 8th Grade Students. *Eurasian Journal of Educational Research,* 86, pp. 269-292. https://doi.org/10.14689/ejer.2020.86.13

Pacione, M. (1999). Applied Geography: Principles and Practice. In *Applied Geography*, Pacione, M. Ed: Routledge: London. ISBN: 9780203012512

Prastiyono, H., Utaga, S., Sumarmi, S., Astina, I. K., Amin, S. & Aliman, M. (2021). Development of E-Learning, Mobile Apps, Character Building, and Outdoor Study (EMCO Learning Model) to Improve Geography Outcomes in the 21st Century. *Journal of Interactive Mobile Technologies (iJIM), 15*(7), 107-122. https://doi.org/10.3991/ijim.v15i07.21553

Qais, A. M., Vikas, R. N., Raza. H., Muhammad M. & Karan, A. J. (2019) Digital Education Using Free and Open Source Tools to Enhance Collaborative Learning. *IJAEDU-International E-Journal of Advances in Education*, *V* (13), pp. 50-57. Retrived from, http://ijaedu.ocerintjournals.org/tr/download/article-file/705009

Rasmussen, E., Chawirah, T, Simon, M. & Montiel, F. (2020). The use of hypothesis and critical thinking in statistics. Retrieved from, https://www.researchgate.net/publication/346009582_The_use_of_hypothesis_and_critical_thinking_in_statistics

Risqi, E. N. & Ekawati, R. (2020). How is the Statistical Literacy of Upper Secondary Students Based on Gender Differences? Jurnal Riset Pendidikan dan Inovasi Pembelajaran Matematika, 4(1), 53-67. https://doi.org/10.26740/jrpipm.v4n1.p53-67

Risqi, E. N. & Setianingsih, R. (2021). Statistical Literacy of Secondary School Students in solving contextual problems taking into account the initial statistical ability. *Pi: Mathematics Education Journal*, 4(1), 43-54. http://dx.doi.org/10.21067/pmej.v4i1.5285

Rizou, O. & Klonari, A. (2016). Introducing 3D Visualization of Statistical Data in Education Using the i-Use Platform: Examples from Greece. *Review of International Geographical*

Education Online, 6(3), 253-270. Retrieved from, https://rigeo.org/wp-content/uploads/2021/05/RIGEO-V6-N3-3.pdf

Rizou, O., & Klonari, A. (2019). Using Web 2.0 Tools in Teaching Spatial Statistics: Secondary Teachers' Views from Greece. In *Smart Geography, 100 Years of the Bulgarian Geographical Society*, Nedkov, S., Zelezov, G., Ilieva, N., Nikolova, M., Koulov, B., Naydemov, K., Dimitrov, S. Eds.; Springer: Switzerland, 55-63. https://doi.org/10.1007/978-3-030-28191-5_5

Rizou O., Klonari, A. & Kavroudakis, D. (2021). Supporting Statistical Literacy with ICT-based teaching scenario. *International Journal of Education (IJE), 9*(4), 59-78. https://doi.org/10.5121/ije.2021.9405

Rizou, O., Klonari, A. & Kavroudakis, D. (2022). "statistics4school.eu": A Novel Educational Web Platform for Statistical and Geospatial Learning. *Journal of Education, Society and Behavioural Science, 35*(4), 1-13. https://doi.org/10.9734/jesbs/2022/v35i430414

Robinson, A. C., Demšar, U., Moore, A. B., Buckley, A., Jiang, B., Field, K., Kraak, M., Camboim, S. P. & Sluter, C. R. (2017). Geospatial big data and cartography: research challenges and opportunities for making maps that matter. *International Journal of Cartography, 3*(S1), 32-60. https://doi.org/10.1080/23729333.2016.1278151

Rohayati, S., Agustini, A., & Abdullah, A. A. (2020). Teaching an Undergraduate Statistics Class in Digital Era. *Proceeding International Conference on Science and Engineering,* 3, 371-373. https://doi.org/10.14421/icse.v3.530

Rohita R. (2020). The Ability of Ece Teachers To Use ICT in The Industrial Revolution 4.0. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini,* 4(2), 502-511. https://doi.org/10.31004/obsesi.v4i2.339

Setiawan, E. P. (2020). Introducing statistical inference to senior high school students: a textbook analysis. *5th Seminar Nasional Matematika dan Pendidikan Matematika (SENATIK) 2020. Journal of Physics: Conference Series,* 1663, 1-10. https://doi.org/10.1088/1742-6596/1663/1/012014

Souza, L. D., Lopes, C. E. & Fitzallen, N. (2020). Creative Insubordination in Statistics Teaching Possibilities to Go Beyond Statistical Literacy. *Statistics Education Research Journal,* 19(1), 73–91.

Spiegelhalter, D. (2020). No more damned lies…. *New Scientist, 247* (3295), 48-51. https://doi.org/10.1016/S0262-4079(20)31419-6

Suhermi & Widjajanti D. B. (2020). What are the roles of technology in improving student statistical literacy? *Journal of Physics: Conference Series,* 1581, 1-19. https://doi.org/10.1088/1742-6596/1581/1/012067

Wang, H., Hong, Z., She, H., Smith, T. J., Fielding, J. & Lin, H. (2022). The role of structured inquiry, open inquiry, and epistemological beliefs in developing secondary students' scientific and mathematical literacies. *International Journal of STEM Education, 9*(14), pp. 1-17. https://doi.org/10.1186/s40594-022-00329-z

World Economic Forum (2016). Retrieved from, https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/ in 12-12-021.

Yahaya, A. M, Dutsinma, A. L., Suleiman, S. & Ahmed A. (2021). Geography is one of the oldest disciplines with a dynamic that is fluid and constantly changing as it is based on the use of a multitude of teaching methods. *Journal of Social, Humanity, and Education (JSHE), 1*(2), 143-155. https://doi.org/10.35912/jshe.v1i2.369

Zakari, I. S. (2020). Linking statistical literacy and data stewardship in Public Universities of Niger: Lessons learned from the collaboration with the national statistics institute. *Statistical Journal of the IAOS,* 36(S1), 63-72. https://doi.org/10.3233/SJI-200708