THE EFFECTIVENESS OF AN ICT BASED TEACHING SCENARIO OF TSUNAMI ON STUDENTS' LEARNING: A CASE STUDY

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ABSTRACT

This study aims to present an ICT-based teaching scenario, which was implemented in 21 students (10 boys and 11 girls) of the 7th grade of a Junior High School on Lesvos Island, Greece. Intervention was applied to the Geography course, and it lasted 8 hours. The main characteristic of this class was that one-third of the students were non-native Greek speaking. Teaching tools used were: simulations, online quiz, movie maker software, QGIS software and power point for students activities. To check the effectiveness of this intervention, tools were distributed to students through 2 (pre-and post) questionnaires that were anonymous, but they had a code to identify and compare the same students' answers to pre-and post-intervention. Main results showed that all students had better achievements after the intervention was completed, and the greatest difference laid in those students who were not native speakers of Greek. The students' creations also indicated that they changed or completed their prior knowledge and, more specifically, of those concepts that they had misconceived earlier.

KEYWORDS

Geohazards; tsunami; earthquakes; geography; ICT

1. INTRODUCTION

Many natural phenomena may suddenly become a 'natural disaster' or a 'disaster of natural origin' if they encounter a vulnerable and poorly prepared society [4, 5, 6]. One of the natural disasters that many areas, such as Greece, often face with are earthquakes that are considered one of the most catastrophic geological phenomena that have primary ephemeral and secondary effects on the natural and human-made environment [7]. The inability to stop natural geological and climatic procedures should be focused on the process of prevention and mitigation of natural hazards effects. The key to reducing loss of lives, personal injuries, and damage from natural disasters is widespread in public awareness and education. According to the National Academy of Sciences [8: 19] Educational materials about preparedness, warnings, and self-protection should be distributed to schools for use in kindergarten through the 12th grade. Teachers should be trained in integrating the relevant materials into the regular curricula so that children receive the information they need to protect themselves from disasters. Moreover, the goal is to increase a community's capacity to be prepared for, respond to and recover from any type of threat or hazard effectively [9]. Students are part of communities and are the most vulnerable to natural disasters. The knowledge of a kind of disaster is an important background to prepare students, and should be provided as early as possible [10]. An individual's level of knowledge can affect the level of preparedness in dealing with disasters [11]. To do this, students have to develop correct ideas they can use them in order to advance their knowledge. However, many students have not developed an appropriate understanding of fundamental concepts from the beginning of their studies, and this shortcoming can interfere with subsequent learning. If the original idea is

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wrong, then students will have difficulty in understanding scientific concepts, and it is possible that these misconceptions they may carry them into their adult lives [12]. But in the case of natural hazards, knowledge alone is not enough. Knowledge must become action [13], so that school communities are prepared to face a strong natural phenomenon. Educating children can be a path to growth readiness inside and outside school. In Greece, the current curricula do not emphasize natural hazards and disaster risk reduction, so there are a few units referring to in these concepts. One of the sciences that studies natural disasters, such as earthquakes, is physical geography [14]. Physical geography tends to study the natural features of the earth's crust. It studies the spatial processes and patterns in the natural environment [15]. Therefore, teaching geography in schools is very important. In the process of teaching Geography by the traditional method, teachers often encounter inconveniences, such as outdated maps, cumbersome use, and large space occupation [16]. Moreover, the major problem with the traditional teaching method of Geography is that many students either underperform in or are bored with it. This is due to the fact that the traditional teaching method (teacher-centered) dominates [17], and is based on blind memorization (or verbatim). Current technological and pedagogical developments in educational applications of ICT have led to an increased interest in the development of digital educational resources [18]. ICT promises to help jump over series of obstacles of the traditional order [19], and are widely regarded not only as a means of significant innovations in school practice but also as factors that can contribute to educational change [20]. According to Pernada et al. [21], the computer can be used as an interactive cognitive tool with the student, therefore, it is one of the dynamic tools of exploratory and experimental modeling of phenomena and problems. Additionally, the use of ICT is very important in multicultural education nowadays because it can affect students' learning and make educational material more understandable and effective [22, 23]. A software that can be used as a teaching tool in teaching geography is the Geographic Information Systems (GIS). In recent years, GIS has become very well known in the field of education [24]. GIS is not only able to collect, edit and process geographic data but also create maps and visualize functions [25]. This is a powerful advantage for teaching geography as many studies have demonstrated the benefits of visualizing educational concepts [16, 26].

In Greek High school, some of the main objectives set are for students to be able to define and distinguish endogenic and exogenic forces and describe the changes in the earth's surface and how they originate. Additionally, to describe interactions of endogenic and exogenic factors and to explain the impacts of these forces on lives and properties. In this study, in addition to the above objectives, it was attempted, through activities, (1) to make students understand that Greece is one of the most geologically complex regions in the world, as it is wedged between the zone where the African, Eurasian, and Arabian plates meet up, and a large number of earthquakes may occur in this area yearly; (2) to improve their understanding of the risks around the Aegean Sea; (3) to recognize the effects of an earthquake on people's lives and properties. That teaching scenario was based on multimedia (video, animations, etc.) and the use of GIS, and its aim was both to understand the level of student's knowledge of geohazards and, more specifically, of tsunamigenic earthquakes and to improve their knowledge while using GIS and other digital resources.

2. METHODS

2.1. Participants

This research was conducted in a public Junior High School on Lesvos Island, Greece, and lasted 8 weeks, starting from February to March 2016. Participants were 21 (10 boys and 11 girls) students of the 7th grade, who were 13 years old. 7 (33.3 %) from 21 (67.7 %) were not native users of Greek. One of the participants, who was native speaker of Greek, had behavioral problems though, and sometimes he could not participate in the course. Moreover, the grades that students had received in Geography course (in the previous semester) were: 23.80% 10-12 [out of 20] (low performance), 19.10% had got 13-15 [out of 20] (medium performance),14.30% had received 16-18 [out of 20] (high performance), and 42.80 % of the students had been awarded with 19-20 [out of 20] (excellent performance).

2.2. Research Questions

i) Can the implementation of an ICT based scenario (mini project) have positive learning benefits on native and non-native Greek speaking students in the Geography course?"
ii) Can the implementation of an ICT based scenario (mini project) help students to perform better and to be more confident so to make correct decisions in case of a geohazard like a tsunami?"

2.3. Survey Instrument

This research used a quantitative descriptive method. An empirical research implemented the strategy of a case study to answer the research questions. Collection of data through the use of the two questionnaire method (pre-test and post-test) must have been completed by the respondents. Moreover, the tools used were students' video, maps, and presentations, as well as their worksheets.

- Pre-questionnaire consisted of two parts:

  First part: 15 questions about the student's data.

  Second part: 8 questions (7 open-ended and one closed) about earthquakes and tsunami (e.g. how do earthquakes originate? What are the 3 causes of plate movement? How is tsunami created? etc.).

- Post-questionnaire consisted of two parts:

  First part: included the same questions as the second part of the pre-test to compare students' answers to pre- and post-intervention, evaluate the effectiveness of this intervention and examine the achievements of the objective set.

  Second part: 13 questions (10 closed and 3 open-ended) about new technologies used during that intervention and students' satisfaction with the whole teaching process.

2.4. Procedure

The teaching scenario was based on guided exploratory learning, student-centered teamwork. The teaching was conducted in a computer lab by the researchers (PhD candidate student and her supervisor) during the Geography course, which is usually taught for one hour once a week. The completion of the teaching scenario took 8 hours; that is, one hour per week for eight weeks.

First teaching hour: The students answered a questionnaire (pre-), whose aim was to investigate their knowledge of earthquakes and tsunami. Subsequently, the students were divided into 10 teams, 9 teams of 2 students and one team of three students, because the computer lab was equipped with 10 PCs.

Second teaching hour: To motivate students’ interest, engage and challenge them, the teacher presented part of a video (from 0:25 to 3:00) of the 2004 Indonesian tsunami (https://www.youtube.com/watch?v=DgvyC8lctcc). Then, the worksheets were distributed to the student teams. In the first worksheet, there was information where they could find the folder (folder name on their PC desktop) with the digital material they needed to accomplish the activities. First, they had to hypothesize on how that tsunami was created (activity 1- to check prior knowledge and understanding). Afterwards (activity 2), the students should open the file and attend to two simulations (in the Greek language) on the earthquake, the tectonic plates in the area, and the creation of the tsunami. Subsequently, they had to check whether their previous hypotheses were correct or wrong, write the correct ones and present them to the whole class. Eventually (activity 3), there was an implementation activity (where in the world could another tsunami occur?), and then they had to make generalizations (find the relationships among tectonic plates movements, earthquakes, and tsunamis) and draw conclusions. At the end, they have to complete the evaluation sheet with multiple-choice questions.

Third and fourth teaching hours: Before the two hours of lab work had started, the researchers downloaded the QGIS software on students' PCs. Each team found a new folder on their desktop, which included a new worksheet with detailed steps how to create theirs map with QGIS software. Additionally, in this folder, there were all data that they had to use for the maps’ creation (tectonic plates and the biggest earthquake in the world for the last 10 years). Some of the maps created by the students are presented below (Figure 1). Furthermore, the students in their worksheet found four links from the educational site to read more information about earthquakes and tsunamis which originated from them. Then, they should have responded to two activities. One of them was an online quiz (http://photodentro.edu.gr/lor/r/8521/3299?locale=el) from Photodentro (a Greek Learning Objects Repository, on Digital School platform).

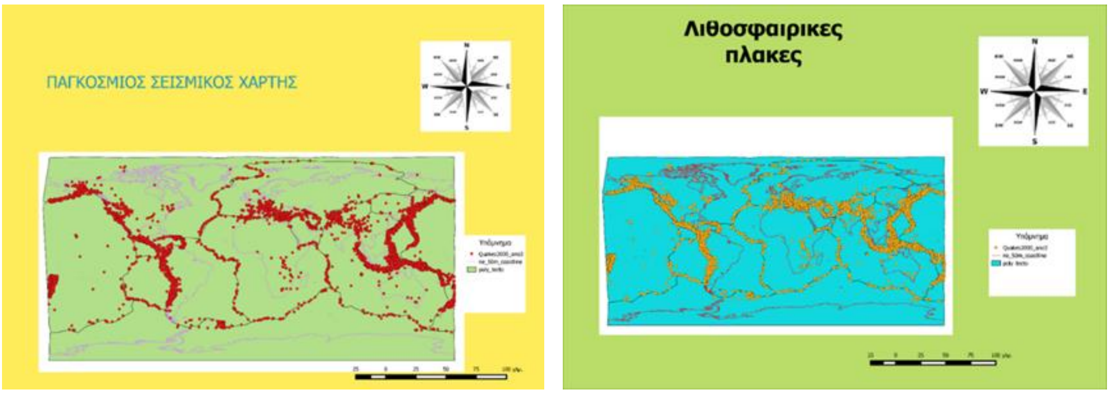

Figure 1, 2: Two of student’s maps, using QGIS software

Fifth teaching hour: The teacher assigned a tsunami-related task to each team; that is, they had to find information about and make a presentation (10 power points each, with specifications) on the following topics:

1. The earth’s interior;
2. Plates Tectonic (name, movements, causes);
3. Earthquakes (How is an earthquake generated? Distribution, Where on Earth do the biggest earthquakes occur?);
4. Tsunami (definition, creation, factors); and
5. Tsunami (biggest tsunami in the world, damages, prevention).

Sixth teaching hour: The students found in their worksheets one translated (by researchers) story from the International Tsunami Information Center (Tsunami Warning Cartoon Book Caribbean - 04.20.10.pdf (uwiseismic.com), and then they create their stories (using storyboard and drawings) about tsunami and how they could protect themselves and their families. Students then completed a quiz on google forms for assessment.

Seventh teaching hour: The previous days the students had learn how to use Microsoft Movie Maker in order to make video (in the course of Informatics). So, during the seventh teaching hour, they created a short (5-minute) movie with theirs stories (adding title pages, pictures, drawings, video sound, etc.) in a movie maker. Finally, students presented their power points and movies to the whole class.

Eighth teaching hour: There was a whole class discussion about the students' points of view on and feelings about the teaching scenario and learning processes. At the end, they answered the post-test questionnaire.

3. RESULTS

The analysis of students' responses to the first part of the pre-test questionnaire indicated that the majority of students (57.1%) were aware of the use of PCs and several programs installed on them. More specifically, 76.2% of them knew how to use a the "Word" processing software, 19.0% could use "Excel", 61.9% used PowerPoint, 90.5 % used movie maker, but no one had ever used QGIS. Subsequently, the researchers analyzed students΄ responses to the questionnaires (pre- and post-) according to the group they belonged; that is, Greek-speaking and non- Greek speaking groups. The first group was the students who were native Greek speakers and the second group were students who are non-native Greek speakers. It was observed that both groups of students had a large difference in the means between pre-test and post-test (Table 1). Another important finding was that from the average of the students of the two categories it seemed that the biggest difference were the students whose Greek was not their mother tongue. Before the intervention, the first group (i.e. the native Greek students) had better knowledge than the second one. But after the teaching intervention, it seemed that the second group improved their knowledge more than the first one.

Table 1: Native and not native speakers' means and Std. Deviations in total performance at pre- and post-test

Students	Test	N	Mean	Std. Deviation
Native Greek speaking students	Pre-test	14	17.8571	9.60655
	Post-test	14	30.2143	8.58602
Non-native Greek speaking students	Pre-test	7	16.7143	10.19337
	Post-test	7	34.0000	4.61880

More detailed performances of the 14 native Greek students in 8 questions in the pre-test and post-test are shown in Figure 3, whereas the performances of 7 non-native Greek students is shown in Figure 4. The maximum score that students could get was 40 points. From the first group, 8 out of 14 students (57.1%) had less than 20 points during the pre-test, which is the basis of students' achievement, and from the second group, 5 out of 7 (71.4%) had less than 20 points. After teaching intervention, all students of the first group, except one - that is, 92.8% -had more than 20 points. Moreover, 8 out of 14 students (57.1%) had very high grading (more than 30 points). From the second group, all students had more than 20 points after the teaching intervention, and 6 out of 7 (85.7%) had very high grading (more than 30 points).

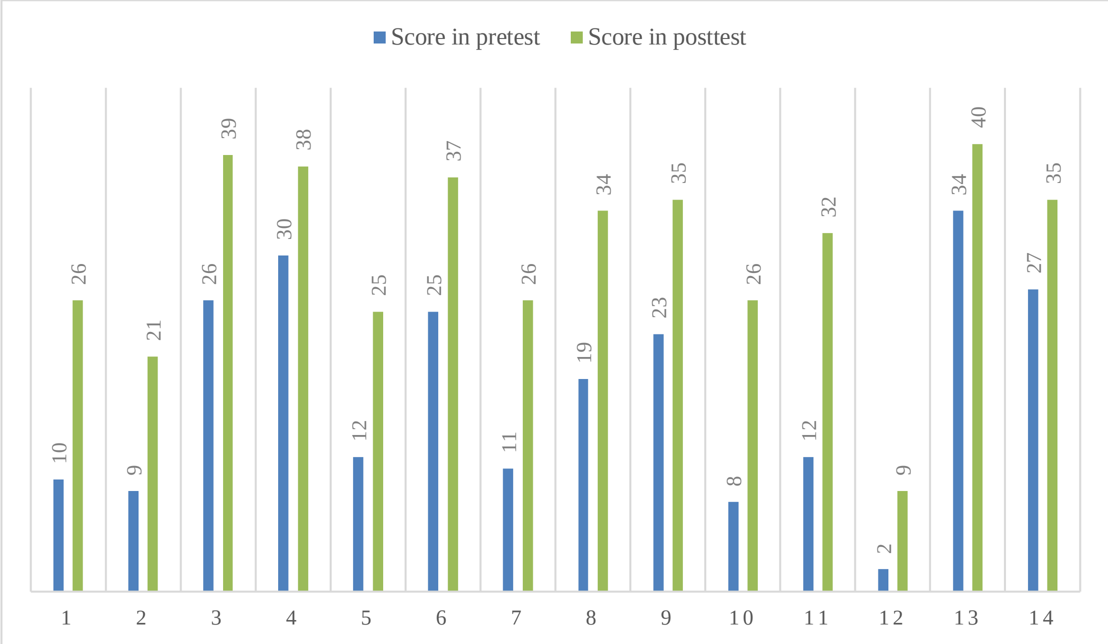

Figure 3: Native Greek speaking students' scores in pre- and post-test

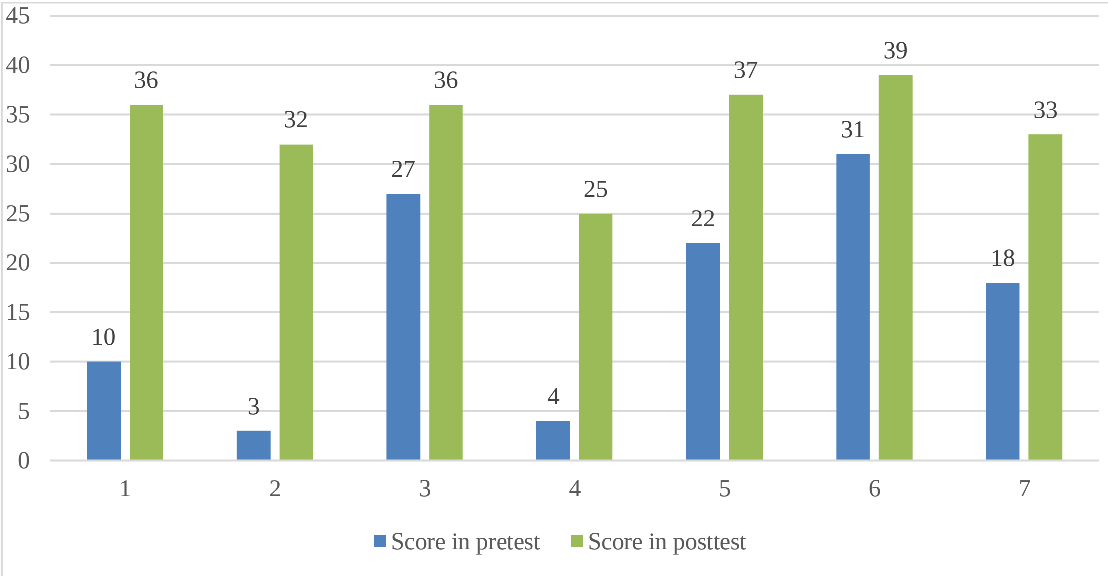

Figure 4: Non-native Greek speaking students' scores in pre- and post-test

From the analysis of students' responses to the second part of the post-questionnaire which was about the evaluation of the project and the activities carried out by the students, positive results were also extracted. The great majority of students (71%) believed that the lesson was more interesting with the use of computers, and 66.6% of students claimed that they liked to participate in the activities very much. In addition, from the Pearson correlation between their marks in the Geography lesson and how much they participated in the activities, a positive correlation emerged, and it is statistically significant (r= 0.863, p= 0.00). The students with low marks in the Geography lesson participated less. The students with 19-20 marks participated less than those students with 13-18 marks (Table 2). However, students with mediocre performance in the Geography lesson were helped more by the use of new technologies during the teaching intervention. Furthermore, 76% of students believed that they understood better the lesson's concepts with ICT than with traditional teaching. The Pearson correlation between students' marks in the Geography lesson and how much they comprehended the lesson's concepts was significantly positive (r= 0.922, p=0.00). The students with the highest scores said that they understood the lesson's concepts better than those students with low scores (Table 3).

Table 2: Means and Std. Deviation between students' grades in Geography course, and according to their participation in the scenario's activities

Students'grades in Geography course	Means	Std. Deviation
10-12	11.833	1.471
13-15	17.000	1.563
16-18	19.500	0.577
19-20	15.666	3.396

Table 3: Means and Std. Deviation between students' grades in Geography course and thecomprehension of the lesson's concepts

Students' grades in Geography course	Means	Std. Deviation
10-12	10.500	0.577
13-15	12.000	0.618
16-18	15.777	1.855
19-20	19.000	0.816

Table 4: Students' scores (grades 1-10), according to their creations after they had used the three softwares

Teams	QGIS	Movie Maker	Power point
Team 1	10	10	10
Team 2	10	9	10
Team 3	10	9	8
Team 4	10	10	9
Team 5	10	7	10
Team 6	10	7	7
Team 7	6	7	8
Team 8	7	6	5
Team 9	6	-	5
Team 10	10	-	5
Mean	8.9	6.5	7.7

Regarding the QGIS software, 71.4% of the students had positive impressions even though it was the first time they used it. Furthermore, the researchers rated the maps that were produced by students with QGIS software (some of them are shown in Figures1 and 2), PowerPoint and the short movie that they produced by movie maker software. The maximum score that each team could get was 10 points in each software, and it was observed that, although students did not use QGIS again, they had better performance in it than in Moviemaker and PowerPoint which they had already learned how to use, as shown in (Table 4). From these findings, we came to the conclusion that they found it very interesting and, with the researchers' guidance, the students did not find it difficult to use it.

4. RESEARCH LIMITATIONS

However, there are some limitations. First of all, the research sample was small, convenient and, therefore, not representative of the whole population. Consequently, there is a need for further research in the future, including random sampling from a larger geographical area (e.g., a nationwide study). In addition, the teaching intervention was applied by the researcher, who could influence the whole process, as she was not the class teacher. It will be interesting to help teachers become researchers in their schools and their own classrooms, so that there can be a representative sample from all over Greece. Although our findings are rather indicative and cannot be generalized, they still agree with the results of other studies [22, 23].

5. DISCUSSION AND CONCLUSIONS

In conclusion, although the results of our research are indicative and cannot be generalized, they are nevertheless supported by the results of international research [26, 27]. Thus, we can argue that, although the limitations shown in the implementation of the ICT based instruction by teachers are enough, nevertheless the results allow us to propose that it is worthwhile for teachers being supported (by training and creating appropriate educational materials, etc.) to have a positive attitude towards the implementation of this kind of teaching, as students' improvement of performance at all levels is positive and, undoubtedly, helps in an effective learning.

More specifically, the effectiveness of implementation of the educational material that was shown earlier was high, both at competence and emotional levels. Studying the results of project evaluation by the students, their positive attitude towards ICT is obvious. Of course, it is known that one of the dangers that threaten the validity of the research is the Hawthorne phenomenon, according to which the answers to questions do not reflect people's real views but rather what people guess that the researcher wants to hear [28]. In this case, however, this risk of validity is minimized due to the students' work, the good cooperation between groups, the positive relationships between students and teachers, the positive atmosphere in the class, and students' engagement and enthusiasm, which showed that teaching intervention improved educational outcomes.

In this study almost all students improved their initial level of knowledge and enhanced their academic skills, while equity in teaching of this mixed ability class was being promoted, the students' learning abilities and interests were being taken into account, and, thus, effective pairs and teams were created [29]. Karatza [30] states that traditional and undifferentiated teaching approaches do not facilitate the construction of knowledge of all students in mixed ability classes. On the contrary, ICT teaching enables differentiated teaching, stimulates students' participation and interest, and ensures the effectiveness of learning [31]. ICT helps to develop many methods for differentiated teaching in Geography. This will create new learning environments that will improve both the equity of learning and the knowledge of all practitioners in Geography [32]. New technologies can help students regardless of whether they have learning difficulties or they are non-native speakers of a given language [33, 34, 35]. Furthermore, according to Uchida's et al. [36], the students have a positive attitude towards ICT-based disaster education. This is proven by the present research since, according to the scores in the pre-test and post-test, all students improved their knowledge. In addition, a greater difference in the two pre- and post-questionnaires was observed in students who were non-native Greek speaking, and this means that the multimedia, software, etc. provided by ICTs, helped them to understand concepts that they could not understand before.

The application of GIS software can promote the development of geographical thinking by introducing innovative teaching methods in secondary education geography courses [37]. On the one hand, it can greatly increase the amount of information content, and, on the other hand, geography teaching will become more intuitive, vivid, and flexible [38]. In this study, students had the opportunity, under the guidance of researchers/teachers, to use Geographic Information Systems (GIS). So, it was observed that the majority of students created the maps successfully and enthusiastically regardless of their level of knowledge. Data visualization helped students understand better the role of plate tectonics on the earth, that most earthquakes occur along the margins of plates and that most of them are associated with the plate boundaries, the distribution of earthquakes in the world; they were also able to identify which areas are at risk of being hit by an earthquake or tsunami. Even though Greece is the most seismically active region in Europe and is ranked high (sixth position) on a global scale, the school-based disaster education through Greek Curricula and, mainly Geography curriculum, is minimum; i.e. disaster-related issues (except for the basic content for plate tectonics, earthquakes, and volcanoes) like preparedness and mitigation measures, etc. are missing. Moreover, there are missing activities that could raise students' awareness and build their capacity of preventing and responding appropriately to geo-disasters. Although safety cannot be guaranteed during an earthquake, attitudes about risks, education about hazards, and preparatory activities can surely save lives, while injuries and protecting property can drastically be reduced [39]. Therefore, the curriculum of Greek high school courses should be designed with a more interdisciplinary content [40, 41], as it has already been the case in other seismogenic countries.

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