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Enhancing Education on Protective Measures through Visual Arts and the STEAM Approach in First and Second-Grade Elementary School

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Abstract

This study explores how visual arts, when integrated in the STEAM (Science, Technology, Engineering, Arts, and Mathematics) learning process, could affect seismic safety education among first- and second-grade elementary students. The results of this study show that when varied methods are used in the teaching process, students are able to understand and apply protective measures more effectively. It also shows that traditional rote-based teaching is less effective than interactive, interdisciplinary learning, which seems to significantly promote students' engagement and critical thinking. This study suggests that an expanded use of the STEAM approach in educational curricula can improve young learners' safety awareness and preparedness for seismic events.

Keywords: *Visual Arts, STEAM, protective measures*

ΠΕΡΙΛΗΨΗ

Η μελέτη αυτή διερευνά τον τρόπο με τον οποίο οι εικαστικές τέχνες, όταν ενσωματώνονται στη μαθησιακή διαδικασία STEAM (Επιστήμη, Τεχνολογία, Μηχανική, Τέχνες και Μαθηματικά), μπορούν να επηρεάσουν την εκπαίδευση σε θέματα σεισμικής ασφάλειας στους μαθητές της πρώτης και δεύτερης τάξης του Δημοτικού σχολείου. Τα αποτελέσματα της μελέτης αυτής δείχνουν ότι όταν χρησιμοποιούνται ποικίλες μέθοδοι στη διδακτική διαδικασία, οι μαθητές είναι σε θέση να κατανοήσουν και να εφαρμόσουν τα μέτρα προστασίας με μεγαλύτερη αποτελεσματικότητα. Δείχνουν επίσης ότι η παραδοσιακή διδασκαλία που βασίζεται

στην απομνημόνευση είναι λιγότερο αποτελεσματική από τη διαδραστική, διεπιστημονική μάθηση, η οποία φαίνεται να προάγει σημαντικά την ενεργοποίηση και την κριτική σκέψη των μαθητών. Η μελέτη αυτή υποδηλώνει ότι η ευρύτερη χρήση της προσέγγισης STEAM στα εκπαιδευτικά προγράμματα μπορεί να βελτιώσει την ευαισθητοποίηση των νεαρών μαθητών σε θέματα ασφάλειας και την ετοιμότητα τους για την αντιμετώπιση σεισμικών φαινομένων.

Λέξεις-κλειδιά: Εικαστικές τέχνες, STEAM, μέτρα προστασίας

1 Introduction

Many children who live in seismic regions do not have a clear image of possible protective measures towards earthquakes (Chongbang, 2022; Korkmaz, 2023; Muttarak & Pothisiri, 2013; Nuraeni et al., 2023; Save the Children, 2016; Subedi et al., 2020). It is therefore important that children acquire a better knowledge of seismic phenomena at an early age in order to develop safety awareness and response skills (Yilmaz & Yildirim, 2021). Unfortunately, many children, because of educational methods still reliant on rote learning and passive instruction, have little meaningful engagement or development of thinking for natural disaster preparedness (Çoban & Göktaş, 2022; Feng et al., 2020; Kurt et al., 2024; Mitsuhara et al., 2013; Parham et al., 2021; Rowland et al., 2020). This shortcoming is critical and points out the necessity of developing innovative and interdisciplinary pedagogies that will encourage children's active engagement and increase their ability to respond effectively in emergencies. Recent studies show that children in elementary schools have poor knowledge of seismic events, and this is mainly attributed to the lack of focus on earthquake preparedness in early education (Mote et al., 2019; Muzani et al., 2022; Septikasari et al., 2024). For instance, in Greece, information about earthquakes is first taught to students in 4th grade, and children at younger ages haven't been educated on how to deal with an earthquake until then. This delay results in a knowledge gap and could influence the ability of these young students to react in an earthquake. Thus, dealing with this question demands appealing to educational practices at a particular developmental stage of early childhood.

Combining the visual arts with educational methods based on the STEAM (Science, Technology, Engineering, Arts, and Mathematics) can have very positive results. Various studies show that artistic elements integrated into science education have a positive effect on student's engagement, empathy, and have led to more holistic thinking of complex phenomena. The STEAM approach has the potential to create more

meaningful educational experiences by utilizing creativity and engaging learning experiences to provide an overall more integrated educational experience of learning in scientific disciplines, particularly for those associated with reasoning through conceptual understanding and application, such as earthquake preparedness. This study investigates the effectiveness of visual arts incorporated into a STEAM-based approach in terms of raising students' awareness about earthquakes and safety measures. This study will focus on how students' understanding, engagement, and application of safety measures were influenced by a mixed-methods approach. This mixed-methodological research approach intends to provide evidence of the effectiveness to support policy towards STEAM-based interventions in emergency preparedness education. By examining the existing gaps in earthquake education in the early stages, this research aims to develop innovative teaching methods that enhance scientific knowledge and equip young learners with essential life-saving skills.

2 Theoretical Literature Review

2.1 Theoretical Framework

The use of creative teaching strategies in education has recently caught the attention of many academics. Inquiry-based methods to teach on a topic such as seismicity, which are grounded in the philosophy of constructivist learning (Knoll et al., 2020), represent an improvement over traditional memorization and passive learning, which cannot help students deepen engagement or facilitate conceptual understanding (Baptista & Molina-Anrade, 2023; Çoban & Goktas, 2022; Urdanivia et al., 2023). Given these considerations, educational institutions need a theoretical background of constructivist learning when designing interventions in order to form tomorrow's active citizens.

Social constructivism (Vygotsky, 1928) points out the importance of active and collaborative teaching methods, that transmit knowledge through interaction, meaning, and connectedness. Likewise, Piaget's (1971) cognitive constructivism points out the importance of active exploration in deepening concepts. These approaches can be valuable when applied in a seismic education that is STEAM (science, technology, engineering, arts, and math)-oriented, as students experience empirical and cross-curricular learning that links rigid science content to authentic real-world problems.

Modern research shows that visual arts significantly contribute to a STEAM-based educational process. Studies have shown that including arts in a STEAM educational system can promote creativity and engagement in learning while developing students' design thinking and problem-solving ability (Zhang & Jia, 2024). Further, research

indicates that the arts as a discipline should be preserved within STEAM education and not simply incorporated as an additional subject (Sanz-Camarero et al., 2023). Such views support that visual arts education can effectively improve preparedness both academically and socially for scientific literacy and disaster preparedness.

2.2. Challenges in Traditional Earthquake Education

In many cases, elementary education provides students with insufficient exposure to earthquake hazards and little understanding of how to be prepared for the risk of seismic events (Widowati, et al., 2023). Traditional teaching methods are often based on lecturing and memorization from textbooks, both of which do not encourage students' engagement (Franklyn & Sayre, 2014). The literature on earthquake preparedness in elementary schools indicates that earthquake preparedness can be raised through an increasing number of drills and psychological support to students increases, while at the same time students' anxieties around earthquakes can be reduced (Kaya et al., 2023). Furthermore, the literature suggests that when students receive hands-on, experiential learning early in elementary school, they remain alert in terms of taking safety measures for a longer period. In Greece, the education system provides earthquake preparedness in the context of fourth-grade education, and all prior years of education go without any consideration for preparedness. There is a clear gap in early education and modern pedagogy should insert seismic discussion and preparedness more officially into earlier education that is engaging and developmentally appropriate. All this considered, STEAM is an appropriate basis for the inclusion of innovative, creative, and student-centered teaching techniques in elementary education classes about earthquake preparedness.

2.3. The Role of STEAM in Enhancing Seismic Education

The STEAM model is a pedagogical model that unites the arts with science, technology, engineering and mathematics in order to provide a more holistic and dynamic learning experience for students (Beers, 2011; Halverson et al., 2022; Huser et al., 2020). Previous research suggests that including arts in the teaching process can fortify academic achievement, problem-solving skills and critical thinking (Bolwerk et al., 2014; Bowen et al., 2014; Han et al., 2016; Kim et al., 2013; Mater et al., 2020; Nilrat et al.,2024; Phonchaiya, 2014; Oonsim & Chanprasert, 2017; Smith et al., 2018; Sumarni& Kadarwati, 2020; Wan et al., 2018; Yaki, 2022).

A recent study explored how visual art works when included in a STEAM-based educational plan and it was shown that a structured framework would allow the arts and sciences to coexist and lead to richer learning experiences for students (Zhang & Zhia, 2024). Another study also supported that learning through STEAM can lead to greater engagement and retention of knowledge when hands-on, interactive methods are applied (Sanz-Camarero et al., 2023). It is therefore concluded that using the arts to address seismic education can promote both a cognitive understanding of the complexities of disaster preparedness and emotional resiliency, which may underpin young learners' ability to access and retain difficult concepts.

However, challenges remain. Some teachers have expressed concerns about having to balance a structured scientific inquisition with creativity (Halverson & Sheridan, 2014). Further investigation of how students' unique learning styles may or may not lead to effectiveness with STEAM-based education will still be needed.

2.4. Seismology and the Arts: A New Educational Paradigm

Combining seismology and arts can be an effective approach to earthquake education, which will allow students to experience both the scientific and emotive aspects of natural phenomena. It is generally acknowledged that art can improve emotional expression in education and enhance students' mental processing of earthquakes (Goodman, 2016; Grace et al., 2022; Hertz, 2016; Huser, 2020; Ooms, et al., 2018; Regev et al., 2024; Segarra et al., 2018). Studies on Digital Game-Based Learning suggest that interactive methods based on games improve students' ability to be prepared in the case of an earthquake more significantly than methods based on lectures (Coban & Goktas, 2022) and promote students’ success and engagement. Other studies indicate the importance of AI-based tools, like ChatGPT, in understanding the potential of using AI in seismic education and demonstrate that interactive learning which includes AI tools leads to greater student engagement and acquired knowledge compared to one-way teaching methods (Kotsis & Tsiouri, 2024). More recent research found that visual representations of complex geological contexts within an educational frame led to positive results in terms of students’ ability to learn scientific abstractions (Occhipinti, 2025). These findings agree with constructivist learning principles, which underline the importance of hands-on, interactive and creative learning experiences for young students.

2.5. The Need for a STEAM-Based Approach in Seismic Education

The literature discussed points out that typical earthquake education proves insufficient while STEAM-based interventions seem promising for more meaningful, dynamic learning. When art is integrated in STEAM framework, it provides a valuable tool to help students visualize seismic concepts and realize the emotional aspects of disaster preparedness. As this research progresses, the need for digital and AI driven tools becomes more and more clear, supporting traditional learning methods to provide a more personalized, immersive learning space for students. Nevertheless, further investigations of the long-term impacts on learning outcomes in different educational contexts will be necessary. By including art, technology, and experiential learning into earthquake-preparedness education, educators can provide young learners with tools to anticipate natural disasters as well as the knowledge and emotional fortitude required to bounce back from such disasters.

3. Research Methodology

In this study, a mixed-methods research design is used to investigate the impact of integrating the visual arts within the STEAM framework on primary school students' learning about earthquakes and earthquake safety. The study's methodology is organized in two phases: (a) design and application of the intervention, and (b) data collection and analysis of the results.

3.1 Educational Intervention

The educational intervention was designed using the foundations of constructivist and experiential learning theory, with the intent of actively engaging students through interdisciplinary hands-on experiences. The program integrated visual arts into a STEAM-based teaching process to promote theoretical knowledge and emotional preparedness for earthquakes and other seismic events.

The intervention was conducted over the course of two thoroughly planned learning sessions, during which students progressed from basic knowledge about earthquakes to applying protection strategies. During the first learning session, students engaged in exploratory conversations about basic earthquake principles and exposure to visual representations of earthquakes. Students took part in artistic activities (i.e., drawing and modeling), which gave them another opportunity to assimilate their conceptual understanding, and to further comprehend key scientific principles.

The second session focused on the process of preparing and reacting in case of an earthquake. The hands-on approach involved putting students through simulations,

exploring digital media and role-playing to help them understand how they can protect themselves. The incorporation of the arts enhanced visualization, thus helping students imagine safety routines and apply it in a virtual environment. Critical thinking, collaboration and emotional involvement were particularly stressed out during the intervention in order to achieve a comprehensive, experience-based learning approach.

3.2 Data Collection and Analysis

To ensure the depth and reliability of the results, a three-step approach was applied in the data collection. First, pre- and post-intervention surveys were utilized that included a combination of structured questionnaires with closed and open-ended questions about student knowledge and perceptions of seismic activity. Table 1 presents the specific items used in the questionnaire along with their pedagogical aims and the technique each item employs. The survey responses were then quantitatively analyzed to assess students' improvement in knowledge using students' test scores. Second, qualitative observations of the students during the intervention took place. The researchers observed and recorded students' engagement, participation and discussions during the activities. Observational data were then reported according to students' cognitive, emotional, and behavioral responses to the intervention. Third, students' thoughts and art creations were collected and analyzed. Students illustrated and graphically depicted seismic concepts that were investigated through thematic analysis to understand how students conceptualized and internalized earthquake preparedness through an artistic lens. Quantitative data were analyzed using descriptive statistics, including mean and standard deviation, to evaluate pre- and post-intervention change in student knowledge. Paired t-tests were conducted to statistically assess any significant improvements in student learning. The qualitative analysis utilized thematic analysis to analyze the students' open responses to the survey and the students' art representations to discover recurring continuation of patterns related to students' perceptions, creativity, and understanding. The observational data were evaluated by being separated into three categories to define students' cognitive, emotional and behavioral responses to the intervention, while leaving less space for subjective interpretation.

3.3 Ethical Considerations

This study was strictly based on ethical standards that ensured the rights and anonymity of all people included. The study received ethical approval from the Ethics Committee of the National and Kapodistrian University of Athens. All participants gave written

consent after being thoroughly informed, including parents and legal guardians, teachers and school staff. All the necessary measures were taken to ensure the anonymity and confidentiality of the informants. To anonymize this study, students' written responses, observational notes, and artwork contained no personal identifiers. Students participated voluntarily, and at the beginning of the study they were informed that they could withdraw at any time without consequences.

3.4. Reliability and Validity

Trustworthiness and validity of the study were ensured in several ways. In particular, the clarity and appropriateness of the questionnaire were improved through a preliminary stage with a limited student sample. Inter-rater reliability was improved by more than one researcher independently coding the qualitative information. Additionally, data from different sources, including test scores, observation data and student comments were connected to ensure the study's credibility and contributed to a holistic view of the intervention's outcomes.

4. Results and Discussion

The present study has analyzed and tested how effective the combination of visual arts and STEAM-based methods can be in terms of promoting young students' learning about the phenomena of seismic waves and possible responses. It has been found that this innovative approach leads to much better understanding and emotional involvement. Thus, it can be considered a valuable tool for teaching during the course on disasters. On the one hand, the outcomes have clearly shown that the participants got a far better understanding of the concepts behind the tremors and the protective measures. This goes in line with the research on students using art concepts and methodologies to increase understanding and long-term retention of intricate scientific phenomena. Particularly, as reported by the disaster education literature and filling the gap on it, the children who received hands-on experience of designing an action plan and acting out their proposed procedures felt more confident in their ability to articulate what they had learned. On the other hand, the current intervention has shown pedagogical benefits besides knowledge acquisition. From what I have observed, the students who appeared fearful or unenthusiastic in the presence of the materials and signals rapidly grew in attention and became more gleeful in their participation. This also confirms previous research showing how artistic expressions help students to address their stress and fear during natural catastrophes and demonstrate improved readiness. Therefore, the present study also has some limitations and challenges. I have

also noticed that while almost all the students benefited, some struggled to understand chief correlative concepts, chiefly presented via visual message. This marks the need for possible scaffolding in the future, as the arts can lead to higher engagement but do not necessarily promise a deeper understanding of scientific principles. Thus, from this point of view, it would be interesting to explore how the peculiarities of cognition play into the enhanced approach for children and their utilization of arts for this kind of disaster education.

A further limitation of this study is the sample size and scope. As it focused on one school only, the findings may not be safe for generalized knowledge across varied educational contexts. In addition, as the study examined short-term knowledge gains, it does not make clear whether students retain the material over time. Longitudinal studies that examine knowledge retention and behavioral responses in real-life seismic events would provide important information about the long-term effects of STEAM-based interventions in earthquake education. Nonetheless, the results of this study support STEAM-based strategies in primary education, particularly for topics requiring both cognition and emotion. The use of visual arts in the study of seismic events not only enhanced scientific knowledge but also empowered students by making learning engaging, accessible and emotionally connected.

5. Conclusions

The present research reveals empirical evidence that utilization of visual arts in the STEAM area leads to young learners' increased understanding of earthquakes and readiness in case of an earthquake. The intervention promoted knowledge retention, engagement and emotional response in learning and suggests that interdisciplinary, experiential learning approaches are a useful tool in achieving disaster preparedness. The data indicate that students who engaged in interactive activities involving the arts were better prepared to describe their understanding of earthquakes when discussing safety measures during and after an earthquake. Participating in activities where art was used as part of the learning evidence, and finding better approaches to learning, in general, suggests that learning rote memorization alone is not enough to develop a deep and lasting understanding. This study also underlined the emotional impact of integrating arts, as students expressed increased positive feelings and less anxiety while discussing earthquake preparedness. Responding to research gaps in early education on earthquakes, this study adds to the growing literature which supports the arts as integration learning of arts into STEM (STEAM) learning and enhances the growing body of research available for STEAM strategic and conceptual pedagogical practices.

With the growing emphasis on cross-curricular learning, this research re-emphasizes the need to be innovative in learning and student-centered, beyond a focus on memorization, while simultaneously demonstrating cognitive development related to creative thinking, problem solving and disaster response planning in young people.

6. Recommendations and Future Perspectives

For Educators

i. Integrate arts-based learning in seismic education: Teachers should include drawing, storytelling, and role-playing exercises when teaching students about earthquakes. These creative activities help students embody safety measures while making the learning process more pleasant and interesting.
ii. Use experiential and interactive methods: Simulations and collaborative activities should be used to connect scientific principles with real-world applications.
iii. Adapt teaching strategies to different learning styles: As some students find abstract representations challenging, educators should provide additional opportunities for understanding (e.g., visual, auditory, and kinesthetic learning techniques).

For Curriculum Developers

i. Incorporate STEAM-based disaster education modules: Curriculum designers should include interdisciplinary approaches that integrate scientific, technological and artistic elements in primary education programs.
ii. Introduce seismic education at an earlier stage: As earthquake preparedness is often introduced too late in elementary education, curriculum developers should design programs that gradually build understanding of seismic phenomena from an early age.
iii. Develop teacher training programs: To ensure that such programs will be effective, educators should be helped through professional development workshops to integrate STEAM- based strategies into disaster preparedness education.

For Policy and Future Research

i. Expand research on the long-term impact of STEAM interventions: Future studies should focus on knowledge retention to determine whether students can

recall and apply earthquake safety measures months or years after the intervention.

ii. Examine cross-cultural applications of STEAM-based seismic education: Since earthquake preparedness varies across different countries and educational systems, comparative studies could suggest best practices for integrating arts and STEAM education globally.

iii. Investigate how different age groups respond to arts-based disaster education: While this study focused on young children, further research could explore how older students, including middle and high schoolers, benefit from STEAM-based learning for disaster preparedness.

iv. Enhance collaboration between schools and emergency management agencies: Policymakers should consider combining school-based earthquake education programs with local initiatives about disaster preparedness, making sure that students receive consistent, practical training in responding to real-world emergency situations.

v. The findings of the current study highlight the importance of creative, interdisciplinary learning approaches in educating children on disaster preparedness. By integrating visual arts within the STEAM framework, educators can not only improve students' scientific awareness and problem-solving abilities but also promote emotional resilience when facing natural disasters. As climate change and increasing urbanization make earthquake preparedness more critical than ever, innovative educational strategies like STEAM can support young learners with essential skills to protect themselves and their communities. Research should continue in the same direction by designating how a combination of art, science, and technology can make disaster education more effective, engaging, and accessible for all students.

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Supplementary material for article: Enhancing Education on Protective Measures through Visual Arts and the STEAM Approach in First and Second-Grade Elementary School

Table 1: Overview of questionnaire items, pedagogical goals, and assessment techniques

Question	Options/Answer	Description	Pedagogical objective
If you had a bag and had to put three things in it that would help you in the event of an earthquake, what would they be? (Circle only 3)	a) Keys to open the door, b) Toy to play with c) Water to quench thirst d) Flashlight to see e) Scissors to cut something if needed f) First aid kit in case I or somebody else gets injured	The technique here is an open-ended question for reflection. The child is asked to make a choice and justify it based on their experience, thus assessing spontaneous knowledge and perception	Investigate children's ability to recognize necessities and associate them with safety in a crisis condition.
Suppose there is an earthquake right now, what will you do	Write what you will do:	This involves scenario-based questioning. The child is placed in a hypothetical situation and describes his or her behavior, which reveals internalized safety strategies.	Recording knowledge of immediate self-protection actions and evaluating the ability to recall correct behavior patterns in unexpected situations.
If you were on the beach and there was an earthquake, where would you go? Choose one of the following and explain why:	- Under the umbrella. Why: ..... - In the sea. Why: ..... - Up the hill. Why:	Structured choice (multiple choice) is used in combination with justification of reasoning. Structured choice shows the initial intuitive preference, and justification reveals the reason why.	Understanding children's perception of danger in outdoor environments and the connection between earthquakes and tsunamis. The reasoning shows their way of thinking and possible misconceptions.

Where would you go in case of an earthquake? (Draw yourself in the picture).	Draw:	A drawing-based assessment is a technique often used in preschool to uncover ideas that children cannot express in words.	Identifying children's ability to recognize safe spaces and their perception of self-protection through visual representation.
If you were on this beach in Japan, where there was this tsunami warning sign  , where would you go in the event of an earthquake?	Draw in the picture: 	Here, we have knowledge transfer to a new environment through the use of drawing. The image allows us to see whether the knowledge can be applied in an unfamiliar context.	Assessment of knowledge transfer to a new environment and understanding of the need to move to safer, elevated locations.
Look at these items we have in the room. Which ones do you think should stay close to us when there is an earthquake? Put a sticker on the correct ones.	Put a sticker ✅	Motor-based assessment. Children see real objects or pictures in the room and do not respond mentally.	Assessment of children's ability to identify useful items in an earthquake situation through a hands-on activity that requires sorting and decision-making in a real-life environment