PROFF
Protection against flash floods

Applying STEAM methodology and using AR for learning against climate change

Guide for VET teachers

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About the guide

This is a guide on how to apply the STEAM methodology in the classroom. It was created in the framework of the project "Protection against flash floods (PROFF)", an Erasmus+ programme whose aim it to address climate change and related natural hazards, focusing on flash floods.

The project is addressed to Vocational Education and Training (VET) classrooms, both students and teachers, and aims to incorporate the STEAM methodology in the classroom, as an educational method to teach about climate change and related issues.

In this guide, we will delineate some aspects of the STEAM methodology in order to propose a concrete and concise definition of the STEAM approach. The purposes of the guide are:

(i) to define the term "STEAM" and address its main characteristics;

(ii) to point out the benefits of the STEAM methodology compared to conventional teaching methods.

(iii) to indicate examples of how to apply the STEAM methodology in the classroom in order to address several climate change-related issues.

(iv) to make a guidebook for VET teachers, so that they can comprehend the methodology of STEAM and how to apply it in the classroom. In this way, STEAM can be incorporated into the educational system not only to teach about climate change, but other aspects as well.

This guide is divided into three distinct parts. In the Introduction section, the STEAM methodology is briefly presented. More specifically, we define the term and analyse its components. We also discuss on the advantages and benefits of applying this methodology in the classroom. In the second section (STEAM tools), we mention the general categories of the available STEAM tools, also addressing some examples. We make a separate description of the Augmented and Virtual Reality as teaching tools. Finally, in the third section (Learning about climate change), we briefly describe twelve workshops, which were developed in the framework of the project and are related to climate change, with a focus on flash floods. In this section, we describe the tools to be used, the activities themselves and in the end of each workshop, we describe how the components of STEAM have been addressed.

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1. Introduction

1.1. What is STEAM?

STEAM is an educational approach, derived from the terms: Science, Technology, Engineering, Arts and Mathematics. The STEAM approach is used for teaching and learning in an interactive and engaging way, fostering critical thinking. It was developed in order to substitute the traditional teaching method, due to its benefits, which will be discussed in this section.

Through STEAM, students become ardent researchers, motivated to seek the roots of a problem, identify its causes and find effective, sustainable and innovative solutions. STEAM offers students valuable skills and knowledge, part of which cannot be bestowed through the conventional teaching methods. Moreover, it helps them develop critical thinking, as well as digital skills that are necessary for their future academic and/or professional development.

In a few words, STEAM is a teaching methodology that incorporates these five aspects (science, technology, engineering, arts and mathematics) into the teaching procedure, with the ultimate goal of ensuring that the students will obtain the necessary knowledge, skills and experience and, more importantly, that they will preserve it even after their education has ceased and their academic and/or professional development begins.

1.2. What are the benefits of STEAM?

STEAM has multiple benefits as opposed to conventional teaching methods. The most important ones include:

Proficiency in science, engineering and mathematics. By default, the STEAM method utilises these three fields in education. Therefore, students obtain knowledge, skills and experience regarding these fields which may be proved necessary in their future academic or professional career.

Digital competences. By the use of technology, students obtain additional technological skills. In this way, they learn to utilise the technology in the classroom first, and by extension in a professional way.

Creativity. Students are not asked to perform specific activities and tasks by following specific steps. Instead, they are asked to come up with their own ideas (which could be potential problems caused by a situation, solutions to these problems etc.). In this way, they become more creative, which can motivate them to think of solutions that a teacher might not.

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Increased curiosity. Because students are asked to come up with their own ideas and participate actively in discussions, they realise that they, too, can be active members of the society, regardless of the issue addressed. This results in their becoming more curious and eager to solve even more problems, whether they are related to their course(s) or not.

Team spirit and collaboration. Students do not see their classmates as competitors and they do not struggle to come up with the best solution, in order to achieve the highest grade. On the contrary, all students are treated as being parts of one single group with common needs, problems and goals. Thus, students learn to co-operate with each other in a team spirit.

Exchange of ideas. Through this collaboration, students learn to express themselves, either orally/in writing or through arts, and share their thoughts, ideas and recommendations with their teammates and their tutors.

Increased self-esteem. As they become creative and are in the position to think and propose their own ideas, students become more confident.

Social skills. As a result of the above, students learn to communicate with each other and their superiors (in the class: their teacher, who corresponds to their future employer or supervisor) and thus become more social and socially adaptable, which will facilitate their future development as professionals.

Maintaining of knowledge. The interactive, all-inclusive, creative and collaborative approach of the STEAM methodology can have the outcome without which all the above may not be achieved: the maintaining of the obtained knowledge and skills. Students will not only acquire more knowledge and experience in science, technology, engineering, arts and mathematics, but they will sustain them even after their education has been completed. In this way, they will be able to actually apply them in real life as professionals.

Critical thinking. Students are not passive receivers of knowledge. They are not just introduced to a problem and its solutions. They become actual drivers of solution, as they are required to come up with their own ideas. In this way, their critical thinking is increased, not just for the course(s) to which STEAM is applied, but for other aspects of their life as well.

Teacher-student bonding. Through STEAM, the students do not see school as an obligation, but rather as place of fruitful discussions and unique experiences. Similarly, the teacher does not view teaching as an obligation, but as a way to transfer their knowledge and experience to their students, as well as learn from them. Therefore, the relations between them are improved.

Real problem solving. STEAM is not applied to merely teach about an issue. STEAM is applied to actual problems of the society (not necessarily scientific, engineering or

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technological ones). Therefore, students are summoned to identify the problems of society, their causes and their solutions.

Perpetuation of the STEAM approach. Children tend to imitate their elderly. Similarly to their parents, their teachers usually act as paragons for them. This means that if the teacher regularly applies the STEAM methodology in their classroom, the students will also be motivated to use it when they themselves will need to be teachers. And being a teacher does not require a professional occupation at school, as every piece of advice they may have to give as colleagues, researchers, professors, parents, employers etc. is in fact a teaching process.

1.3. What is the difference between STEM and STEAM?

The difference between these two approaches is the inclusion of "Arts". The aim of STEM is to provide students with skills and experience regarding science, technology, engineering and mathematics, in order for them to be able to apply these skills in real life problems.

The inclusion of A in STEM is a relatively recent approach. This has led to the advancement of the STEM methodology, in the following ways:

- **Design**. Students can use arts to visualise and present their thoughts, ideas, proposals etc., which could be solutions to a potential problem. They can create, for instance, sketches, diagrams etc.
- **Communication**. Arts can be a significant aid in the communication. Many students seem to prefer to express themselves, and therefore their ideas and proposals, through arts. And given that through arts they can visualise their thoughts, this way makes it easier for the other students and for the teachers to better understand their thoughts and ideas.
- **Creative planning**. In general, students prefer an interactive and playful way for the teaching process compared to conventional methods. Therefore, by incorporating arts in the educational procedure, they may become more productive and come up with innovative ideas, which is one of the aims of STE(A)M.

In all cases, the goals of STE(A)M remain unchanged: to address real scientific and/or engineering problems to students and motivate them to come up with solution by utilising skills and knowledge from technology, mathematics and, in case of STEAM, arts.

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1.4. How to apply STEAM in a classroom?

Even though each course or issue will require a different approach in order to match the STEAM criteria, there are several steps that must be taken in order for a teacher to apply the method in their classroom. These steps include:

- **A clear focus.** STEAM is not to be used as a general teaching method, but instead it must be aim-oriented. This means that before attempting to apply this methodology, teachers need to have a specific issue to address. For example, as regards the climate change in general, the teachers mwill have to define the focus first, which could be for example the causes, the effects of climate change, the human interventions, potential solutions etc. These issues should be addressed separately and using different STEAM tools.
- **Details and background.** Regardless of the subject to be addressed through the STEAM approach, it is of vital importance that the necessary theoretical background be properly presented to the students. This should not predate the application of STEAM, but instead be a part of it. Students need to become familiar with the necessary information about an issue before they are able to actually comprehend it and participate in any activities.
- **Active participation.** This is among the most important aspects of STEAM. Any non-participatory teaching methods, including the most impressive or innovative ones, can only rarely induce all the learning outcomes. Students need to participate actively in several actions, so that the class become as interactive as possible.
- **Practical applications.** The class must not be limited to the theoretical part. Students need to think (or search) and find actual solutions to the addressed issues.
- **Sharing of results.** As students have actively participated in the overall approach, they also need to share the results with each other and the teacher. They need to discuss about their own thoughts, opinions, or even searching results, if the teacher has asked them to search information for a specific issue.
- **Linkage to other issues.** Each course or issue addressed should be linked to other similar issues as well. For example, a course related to the causes of the climate crisis must be linked to its impacts, to potential solutions etc.
- **Creativity.** Teachers should not give their students fixed results (e.g. solutions, causes, effects of climate change etc.), but instead ask them to come up with their own. Students need to be given the opportunity to express themselves (through words, through activities, through art etc.). This will have a twofold result; on the one hand, the desired teaching results (obtainment of knowledge and skills, critical thinking development etc.) will be better achieved. On the other hand, students have a different perspective and

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different experiences than the teachers, which means that potentially, students can come up with issues that the teachers could not have thought of. Thus, learning is facilitated for the students, but for the teachers as well.

1.5. Can I teach STEAM?

Based on the above, one would think that the STEAM approach requires specific and integrated knowledge about scientific and/or engineering issues, familiarity with technology, an artistic vein or proficiency in mathematics.

However, the usage of the STEAM methodology in the classroom does not require any of these. Every teacher can teach STEAM. One does not need, for example, to be a science or art teacher, or even have the corresponding background. The key to apply STEAM in your classroom is to have in mind that its five aspects are not individual, but should be strongly interlinked.

Of fundamental importance is the teacher's eagerness to apply the STEAM approach in their classroom. To begin with the application of this methodology, the teacher must be exempt from the – common, unfortunately – attitude of profession, but stick to the attitude of vocation. The difference between is simple: The professional teacher only sees education as a job, as a means of payment. The vocational teacher sees education not only as a pleasure, but also considers their role of high importance.

Therefore, provided that the teacher is intent on providing their students with the necessary knowledge and – why not? – even more knowledge besides the curriculum, they can easily become STEAM teachers.

On the other hand, applying STEAM in the classroom is not a simple task. Every teacher needs to have a special professional development before they can successfully apply it. They can attend seminars or webinars, they can read about STEAM, they can consult STEAM experts etc. This is the exact purpose of the PROFF project, including this guide: to provide teachers with the necessary skills and knowledge in order to aid them in incorporating STEAM into their teaching process, first regarding climate change and natural disasters, and by extension to each and every course and classroom.

1.6. Do I need a special equipment to teach STEAM?

Exactly like in scientific research and many other aspects of our life, how we can apply STEAM is a function of the materials that are available to us. If we have the ability (and experience) to use complex technological equipment, devices etc., then they can have a significant contribution for our classroom.

However, one does not need to possess a scientific laboratory or a super-device to teach STEAM. STEAM can be applied by even using simple materials that are available

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to moss classes, such as papers and pencils. In its simplest form, STEAM can be even applied by taking the students out in the nature, or even in the school yard.

What is important is to have the willingness to apply this methodology. Once this is ensured, teachers need to have the necessary theoretical background of the issue they are addressing. Regarding climate change and natural disasters, particularly floods, the outcomes of the PROFF project are to supplement the teachers' knowledge, so that they can apply the STEAM methodology in their classrooms.

But if you can use photos, videos, presentations or perform activities (e.g. experiments) that require specific materials, you should try to incorporate some of them in the teaching process.

1.7. For which courses should I choose the STEAM approach?

The answer to this question is rather simple. Despite it is made up of five specific components, namely science, technology, engineering, arts and mathematics, the STEAM methodology was not designed only for courses related to these. Ideally, it can – or better, should – be used for each and every course, regardless of its subject.

A similar question would be: In which courses do we need a whiteboard? For courses like mathematics or history, the whiteboard is necessary. But for gymnastics, for example, one could say that it is not necessary. But gymnastics too have a theoretical part in their main body, besides the exercises, so practically, the whiteboard can facilitate every course.

For example, STEAM perfectly matches a linguistic course, which *prima facie* does not match with any of these five aspects. If one examines the course in detail, and reflect on what the students need to learn and how they can learn it, one will realise that even this course can be taught through STEAM.

It is also important to bear in mind that in some courses, not all five aspects of STEAM can be simultaneously applied. For example, for a specific course, the teacher may be able to use only science, technology and arts. This limitation is not owed to the nature of any course, as all five components can be applied to all issues and in all cases. Which of the aspects will be used depends only on the available time and the experience, knowledge and skills of the teacher.

In conclusion, the STEAM approach can be used in all courses. In fact, considering its multiple benefits, it should be used instead of the traditional and conventional teaching method in all cases possible.

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2. STEAM tools

STEAM utilises many tools, many of which can be applied to almost any classroom. The STEAM tools are grouped into two broad categories, the unplugged and the plugged tools. In this section, we will make a brief description of both categories and add examples of tools that can be used to teach about climate change-related natural disasters, with a focus on flash floods.

2.1. Unplugged STEAM tools

Unplugged tools include tools that can be created and/or used without electrical supply. They range from very simple ones to more complicated ones. Their main advantage is that generally, they can be applied to any classroom without any special needs, save the necessary equipment. The most common unplugged tools that can be used to teach about climate change and flash floods include:

1. **Paper and stationery.** This is the simplest STEAM tool a teacher can utilise. At the same time, it is one of the most effective methods of teaching, when someone wants to take their first steps in using STEAM as a method of teaching. The simplest action would be to ask students to make a list of potential effects, causes or solutions of floods. As a more complicated activity, students can be asked to draw an imaginary drainage basin, a town, an industry, an agricultural area etc., and assess the impacts of a flash flood.
2. **Complex/Advanced stationery.** More complicated stationery could include markers, paperboards, watercolours, scissors, strings, brushes, glue, rulers, rice papers etc. Students can, for instance, create a more complex drainage system and visualise the impacts of a flash flood or other disaster (e.g. landslide, soil erosion, coastal erosion etc.) or protective measures against it in a better way.
3. **Play dough.** Play dough can be used similarly to the complex stationery, but it is easier to acquire, to use and to visualise climate-change related natural disasters.
4. **Building blocks, Playmobil etc.** Despite these tools are mainly addressed to younger pupils, they can simulate real human activities (e.g. a settlement with roads, bridges etc.). Thus, students can visualise an actual city and examine the impacts of several natural disasters.
5. **Sketches, diagrams and photos.** Instead of simply explaining to students what a flood is, it would be better for them, regardless of age, if they could actually see it. Visualisation plays a vital role in education. These visualisation tools are usually found in an online form nowadays, but they can always be in paper form if the teacher considers this a better option, or if there are technological issues.

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6. **Natural materials.** Teachers can always use natural materials to simulate a flood, a landslide, a soil erosion phenomenon, a coastal flood etc. Such materials are very easy to find and use, but usually they require an open space. They could be cobbles, soil, sand, leaves, wood etc.
7. **Field trips.** They are one of the most important tools when educating people (regardless of age, education type or background) on nature-related aspects. They can contribute to this education to the maximum extent compared to most other educational techniques. When in the field, students can observe nature and comprehend the natural processes that have always been present and have long affected the human activities, as well as affected by them. In the field, they can understand the relationship/interaction between different natural processes, landforms or other characteristics, as well as between nature and man. Moreover, through field trips, students come closer to each other and their educators, thus creating long-lasting bonds. Furthermore, the highly interactive and experiential character of field trips render them a perfect means of education, capable of offering knowledge to all students.

2.1.1. Stream table

Besides the above, there are also unplugged tools that are more complex to acquire or create. The stream table is one of them. The stream table is a necessary component of several workshops described in this guide. Thus, in this section, we will make a brief description of how to create it and use it in the classroom.

By using the stream table, several aspects of STEAM are addressed. Students can understand the scientific part of flash floods (e.g. causes and factors affecting them), and also the efficiency of protection measures (engineering). Arts is applied in one sense, given that students create their own relief and city according to their imagination and, of course, some facts that need to be taken into account and described in the following sections. Mathematics could be applied, at an advanced level, if one would like to make a rough quantitative estimation of the floods' damages (e.g. the damage costs).

For the creation of the table, you will need:

1. a stream table;
2. sediments;
3. simulations of people, cars, buildings, roads, trees etc. (such as Playmobil or Lego); and
4. a source of water;
5. *(Optional)* Google Earth.

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Stream table

The stream table is a tub which can be used to simulate the behaviour of water flowing in a drainage basin. It simulates a drainage basin, whose flood regime we wish to study (Figure 2.1.1). Even though in the market, one can find a full set for a stream table, any tub could be adequate for the workshop. The dimensions of the tub should ideally be around 1.2 m x 35 cm. Keep in mind that larger tubs will require a larger amount of sediments.

Figure 2.1.1: Preparation of a stream table.

Sediments

The sediments you can use for the workshop include cobbles, sand and clay. You can use either of these three, or even any combinations. These sediments simulate the geological regime of the drainage basin. You can choose the material(s) that best suit the case you want to study, bearing in mind that:

- Cobbles are highly porous, which means that the flowing water will infiltrate them more easily and thus, less water will eventually become surface runoff; the amount of the flooding water is thus reduced; sand has intermediate porosity and clay (soil) has even less. The flooding water will hence be more.
- If you use two types of materials mixed, e.g. cobbles and clay, the clay particles will cover the pores between the cobbles, preventing water infiltration.
- If you use two or three material types, but in separate reaches within the stream table, you create zones of different porosity, which would correspond to areas of different lithologies across the drainage basin (which is the case in almost all basins).

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Once you have collected the material you want to use, you can put it into the tub. You will have to create the morphology of your basin, using this material. To simulate an actual catchment, you need to have a "high"-relief area in one edge of the stream table, whose inclination will be reduced (or, in some reaches, remain stable) as you move to the other edge (in actual catchments, the high-relief part are the mountains and the low-relief part are the estuaries of the river; the inclination between these two reaches is reduced, either homogenously or stepwise).

You may choose to create a deep and narrow gorge, a cascade, a plain etc. and you can also create a major river straight, meandering etc. You may also create more lesser streams in the "high"-relief part of the catchment.

Lego/Playmobil figurines

Use them to simulate the human interventions within your drainage basin. You can place roads, buildings, bridges, parks, trees, carts or even people, as well as flood proofing measures. This will simulate the land cover factor affecting floods.

Source of water

As a source of water, you can use a common hose or a large bucket filled with water. This will simulate the rainfall. So, to start the experiment, you can just open the tap or start throwing the water.

If the discharge of the water is small, it simulates low-intensity rainfall. If it large, it will simulate a storm. You may also change the intensity constantly, stepwise or gradually. Also, you can move the source of water from the estuaries to the mountainous part or vice versa, to simulate a different direction of the storm relatively to the catchment (which would cause different types of floods).

Google Earth

Optionally, you can use the common Google Earth to view your region. Observe the drainage basin it is located in and record its morphology, its lithologies (if possible) and its drainage network (torrents, streams and rivers).

Then, try to create this basin using the stream table. Also, simulate the human interventions as they exist in your area (e.g. towns, roads, parks etc.).

Then, perform the experiments proposed in this guide (or any other experiments you may think of) and see which parts of your area are more prone to flash floods. Discuss with the students why that is.

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2.1.2. Soil experiments

Soil experiments share the same philosophy as in the case of the stream table, but they are simpler to construct and apply. You will need the following materials:

1. a transparent plastic or glass container;
2. water;
3. soil and/or sand.

Sand (or gravel) - absorbs water and slowly begins to slide - surface erosion occurs. In case of clayey soil, water flows over the surface and erosion occurs gradually.

Taking this into account, you can choose the material you will use. Insert it into the container and give it an inclination (Figure 2.1.2a). Then, spill water gradually and slowly to observe the movement of the soil or sand (Figure 2.1.2b). In this way, you can simulate both soil erosion and landslides. You can also examine the effects of climate change on these phenomena, by increasing the discharge with which you spill the water. This will reflect, as in the stream table, an increase in rainfall duration and/or intensity as a result of the climate change.

(a)

(b)

Figure 2.1.2: (a) The soil experiment; (b) Performing the experiment

2.2. Plugged tools

Plugged tools are tools that require electrical power supply. These tools are generally more complex than the previous category and have more limitations as to when, where and how they can be utilised, as well as by whom they can be properly used. On the other hand, they can offer more visual, audio, or even augmented reality-based experiences to the students and can also familiarise them with the usage of such methods, not only for education, but their future work as well, as such tools are broadly used for several other activities besides education. Some of them include:

1. **Web platforms.** The internet is being more and more frequently used, *inter alia*, in education. Students can be asked to search in the internet about the climate change, its causes, its effects, about related natural hazards such as floods, as well as draw ideas for potential solutions to real life problems. More

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specific examples about how to use web platforms to teach about climate change and flash floods are included in section 3 of this guide.

2. **Satellite images.** They are a very powerful tool in many aspects of education, as well as work/carrier. Through them, one can obtain many different types of information, such as area, length and altitude measurements, cartography or identification of areas of interest (either regarding a scientific field such as geomorphology, stratigraphy etc., or even in the simplest sense, e.g. identification of the best route to be followed in order to reach a specific point). Additionally, one can observe the recent evolution of a dynamic area (such as a deltaic plain, a beach, a dune field etc.) over the years and examine the factors that have caused potential differentiations. Moreover, they can view any area panoramically, observe its relief and morphological features, its land cover etc., as well as observe it from any optical aspect. As for natural hazards such as flash floods, soil erosion, landslides etc., students can observe an area (preferably, their own area of residence) and estimate its vulnerability, based on these hazards' primary drivers and factors.
3. **Virtual field trips.** They are a very experiential way of studying an area. Through them, one can achieve combined learning outcomes resulted from the usage of the previous two tools. Several studies have shown that, at least when it comes to learning and teaching, virtual field trips cannot substitute actual field trips, but they are still among the best educational tools, as they can offer the students many ways of learning. Virtual field trips can be conducted through various platforms (e.g., Google Earth, ArcGIS Story Map, Virtual Reality, Augmented Reality). Virtual field trips can address any climate change-related issue, concerning causes, impacts, as well as solutions.
4. **Sensors.** Through sensors, we can examine issues relevant to the climate change. Sensors can be used in order platforms like Arduino etc. Specific examples of how sensors can be applied in the study of climate change include: (a) the impact of CO_2 to the global temperature; (b) observing the vegetation after a fire using the normalised difference vegetation index (NDVI); students can be engaged in the process of taking measurements and data from satellite that will make them to act as scientists; and (c) study of soil erosion. However, the use of sensors is very complicated, as it requires specialised personnel and experience. Therefore, we have not proposed any sensor-based activities in this guide.
5. **Virtual Reality (VR) tools.** VR is a simulation of a 3D (virtual) world, which gives the users the feeling that they are located in this world. They are secluded from the real world and are immersed in the virtual one. VR can be used in the teaching of floods, as one can simulate the phenomenon as if they were actually where it occurred. On the other hand, these tools are very complicated and therefore, we have not applied them through this project.

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2.2.1. Augmented Reality application

Augmented reality (AR) is an interactive simulative experience that combines real and virtual world. Users witness the real world, but also computer-generated images, animations etc. AR combines real-time 3D interactions with virtual visualisations and is perfect for simulating floods and other natural phenomena. Contrary to VR, AR is relatively simple to develop and use. Through the PROFF project, we have developed an AR application that can be used to simulate floods within a room (e.g. a classroom).

The application can be accessed here. It is an .apk file that can be downloaded into a mobile phone. To download and install it, teachers and students can follow these steps:

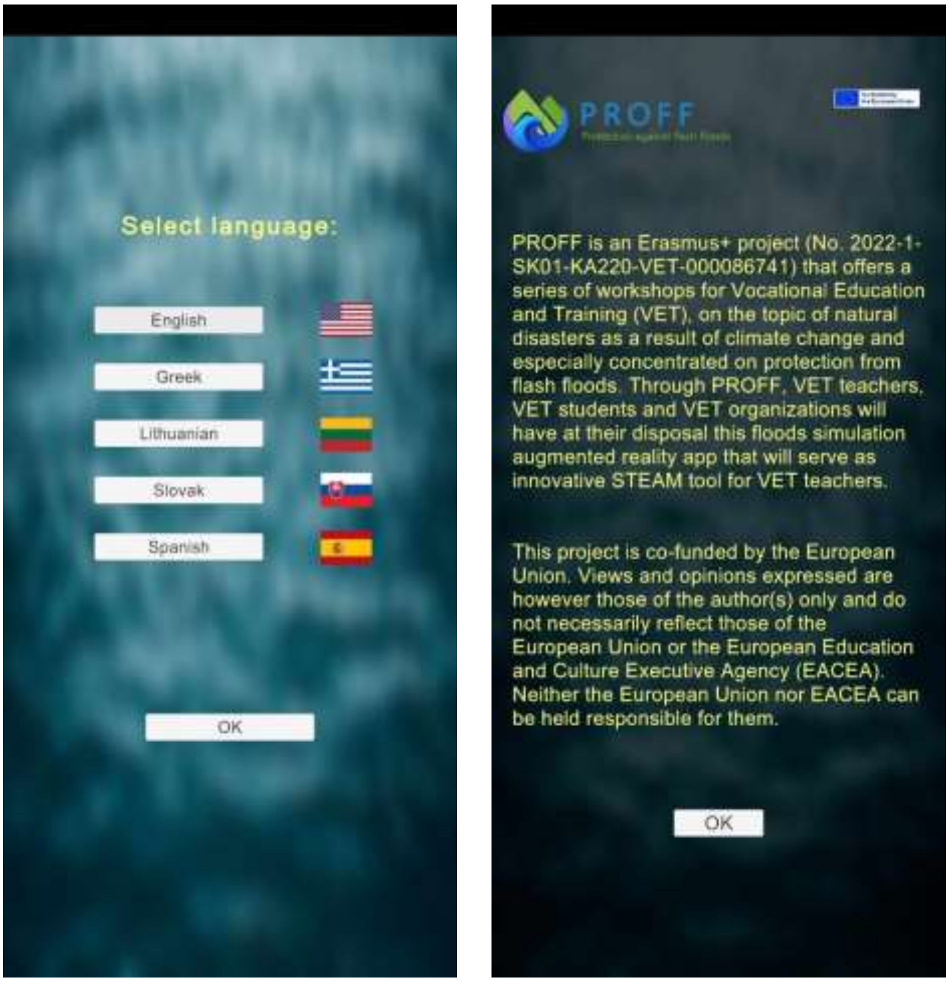
1. Download the PROFF.apk file to your computer or directly to your android mobile phone. If you have downloaded it to your mobile, then go to step 6.
2. Connect your phone with a USB cable to your computer.
3. Set your phone to "USB for files transfer". You will see your phone connected to other drives on your computer.
4. On your computer, copy the PROFF.apk file to your phone's internal memory or SD card.
5. Use your phone's file browser (usually "Files") to find the PROFF.apk file you downloaded or copied.
6. Run the file.
7. If your phone throws a message about not allowing installation from unverified sources, find "allow installation from unverified sources" (or similar - depending on the model, manufacturer and android version) in your phone's settings and turn it on. Repeat steps 5-6.
8. Run the app, confirm permission to use the camera, point the camera inside the room.

The "settings" button allows you to select the language of the interface. You can select between five languages, namely English, Greek, Lithuanian, Slovak and Spanish (Figure 2.2.1a). the "About" button shows a short description of the project (Figure 2.2.1b) and the "Exit" button exits the application.

After these optional steps, you will see the main workspace of the AR application (Figure 2.2.2). In the top, you will see three parameters affecting the flood's characteristics:

1. **Amount of rainfall per area.** This parameter refers to the quantity of rainfall. The more rainwater falls over an area, the more prone it becomes to flooding.

2. **Amount of rainfall per time.** This parameter refers to the intensity of rainfall. The less the time in which a specific amount of rainwater falls, the more possible it will be for a flood to occur, and the more intense the flood will be.
3. **Infiltration Capacity of Rocks.** This parameter refers to the capability of the rock (or soil) formations of the mountainous part of the basin to store part of the rainwater, preventing it from flowing superficially.



(a) (b)

Figure 2.2.1: (a) Language selection; (b) The “About” section.

Each of these parameters has a bar, which the user can drag to change them. Each bar has three options: left (low), centre (medium) and right (high). Setting the first two parameters in “high” and/or the third parameter in “low” leads to an increase in the velocity of the water and thus the time available before the room is fully “inundated”.

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Set the bar of each parameter to the desired position and observe the results. You will see that the room becomes gradually inundated. Below, you can see the water flow velocity (in meters per second) and the water level within the room (in meters) (Figure 2.2.2).

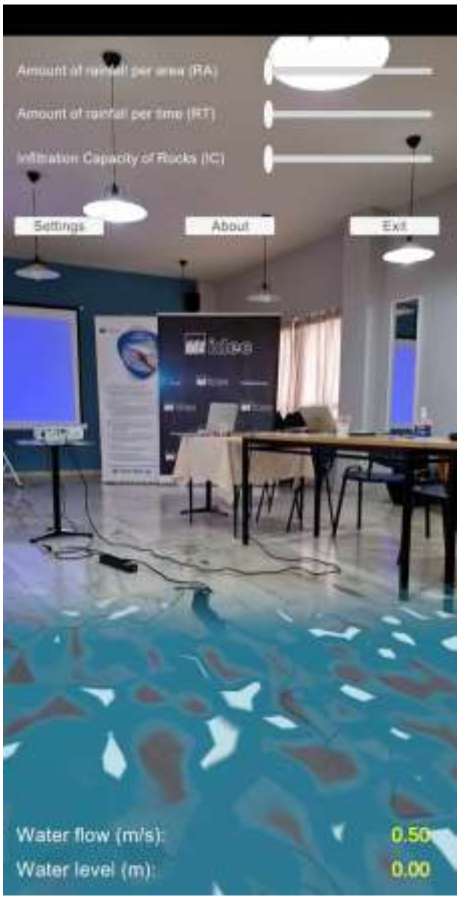

Figure 2.2.2: Simulation of a flood using the AR application.

Augmented Reality Sandbox

The Augmented Reality Sandbox is a valuable tool for teaching students about the relief and the principles of physical geography and geomorphology, before delving into more theoretical details and/or practical applications.

The Augmented Reality Sandbox is a table exhibit that uses augmented reality to visualise the relief into a three-dimensional model, which users can see without the direct usage of a technological device (such as a mobile phone or glasses), besides the sandbox itself (Figure 2.2.3). It is to be noted that this visualisation is dynamical, that is, the relief can change over time.

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The Augmented Reality Sandbox is very easy to operate. Like the stream table, sand is needed, which is placed inside a small bucket or tub. The tutor needs to build a relief (for example a mountain range, a plain, perhaps a river flowing within it, a gorge etc.).

The sandbox itself contains a 3D camera bearing a depth sensor, through which it can sense the topography created by the sand. It is then connected to a computer system, which processes the data and generates colour-coded contours, like the ones created through a Geographic Information System. Through a light projector, these contours are projected over the sand relief.

Figure 2.2.3: An Augmented Reality Sandbox (Source: https://www.topobox.co/order).

Typically, the Augmented Reality Sandbox generates colours that are easy to perceive in association with the relief. For example, plains are usually shown with green colour, rivers with blue, mountains with brown and mountain peaks with white (Figure 2.2.4). Moreover, the water can appear flowing from upstream to downstream, as is its natural course. Additionally, if there is a change in the relief (e.g. either due to a manual change or due to a landslide or similar phenomenon), the contours and the colours will automatically be adjusted to the new relief.

The Augmented Reality Sandbox has several drawbacks, which is why it has not been applied as a teaching method under this guide and the PROFF project. Initially, it is very expensive to obtain. Additionally, it requires a relevant expertise in order to set up. It also requires experts to handle it. Therefore, it is not a tool that can be easily applied in the school classroom.

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Be that as it may, it is an excellent tool to visualise the relief and the terrestrial processes that are associated with natural disasters, such as floods, soil erosion and landslides. Students can get an idea about the relief and the natural processes that shape it and affect its configuration. They can understand topography, drainage basin physiography and relief evolution, even if they do not have any theoretical scientific background. It is a perfect tool even for students attending the first classes of primary education.

Its imperativeness and automatic adjustment to the created relief gives the observers the impression that the relief is "alive", in that it changes dynamically over time. This is of course true, but as natural processes occur over the geological time scale, their direct observation is in many times impossible, even when in the field. Through the Augmented Reality Sandbox, the time for relief evolution can be delimited into a classroom course, or even less, thus allowing students to directly observe them and comprehend them.

An example of the function and capabilities of the Augmented Reality Sandbox can be found in this short video: https://www.youtube.com/watch?v=bA4uvkAStPc.

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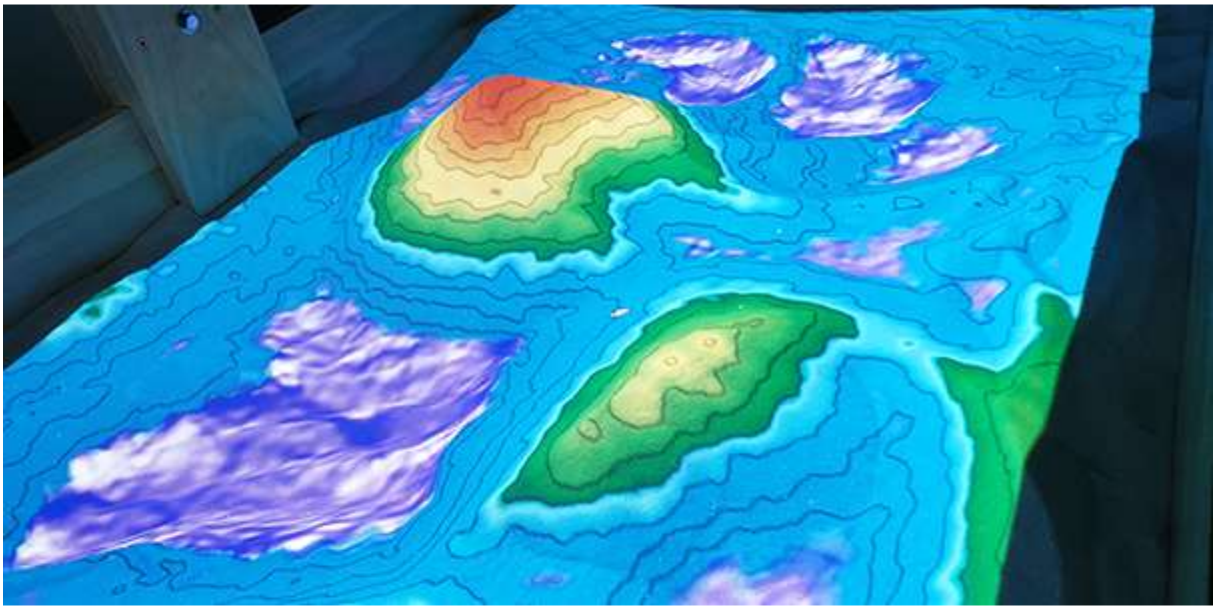
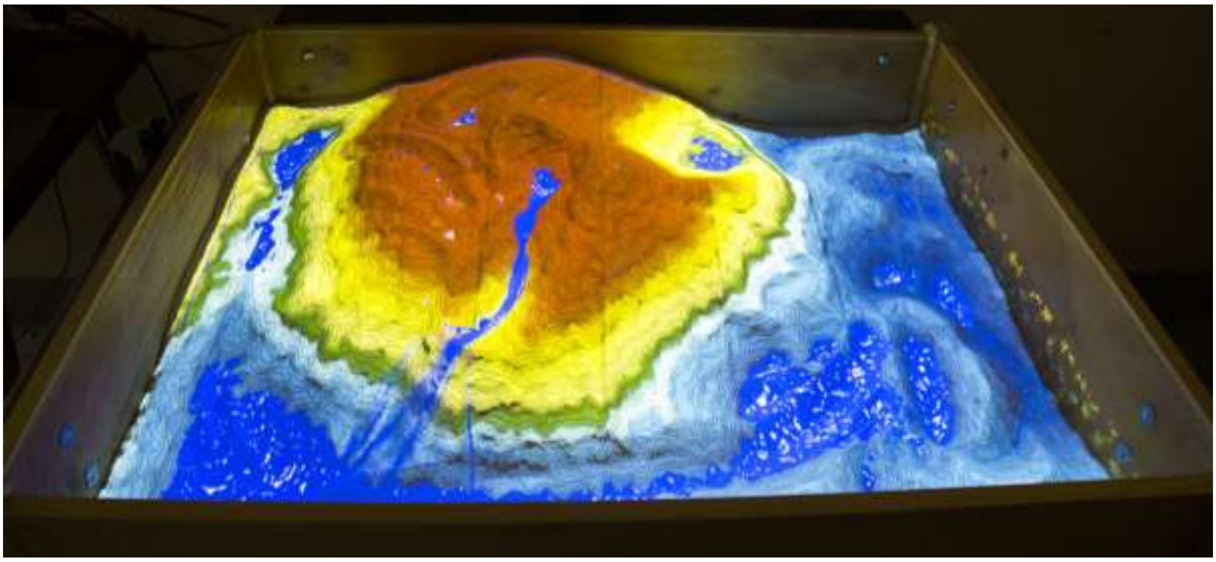


(a)



(b)

Figure 2.2.4: The relief simulated by an Augmented Reality Sandbox: Image sources: (a) https://www.unco.edu/news/articles/augmented-reality-sandbox-earth-sciences.aspx; (b) https://sites.allegheny.edu/news/2015/02/23/students-get-their-hands-dirty-with-new-augmented-reality-sandbox/.

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3. Learning about climate change

3.1. Journey through Climate Change: Origins, Impacts, and Solutions for a Sustainable Future

Introduction

STEAM activities can help engage participants in the science and technology behind climate change, while also incorporating elements of art, engineering and mathematics. By participating in hands-on activities, participants can deepen their understanding of the causes and impacts of climate change and explore strategies for mitigating and adapting to its effects. Here, we propose three activities as an introductory workshop to the concept of climate change, which will be based on **climatic data analysis**.

Tools & Methods

Students will practice on data acquisition and analysis in two steps:

As an introduction to the topic and in order to observe the effects of climate change in different parts of the world, students will access this link.

It provides photos of different places of the planet in the past and today. The tool gives users several options, a very interesting one among them being to view the change in the places provided in time lapse mode.

1. The NASA tool allows students to observe how some of Earth's key climate indicators are changing over time.

The En-ROADS tool is a freely-available online simulator that provides policymakers, educators, businesses, the media and the public with the ability to test and explore cross-sector climate solutions. It is available in various languages. We can modify several aspects that directly influence greenhouse gas emissions. The modifications can be seen in real time on the graphs provided at the top of the screen, making it relatively easy to reach conclusions.

Activities

To use the simulators during the workshops, teachers can carry out the following activities:

1. **NASA Image Gallery**, available here. Students have to:
    1.1. Find an image of the following processes/places: Glaciers, Poles, Floods, Tornadoes and Droughts.

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1.2. Take screenshots of these processes/places.
1.3. Observe the images with the time lapse option.
1.4. Select one of them and observe how the trend has been over the years (e.g. linear, changing, cyclical etc.).
1.5. Try to represent it through a graph.
1.6. Go to the Beautiful Photos section, select on photo, and discuss on what caught their attention about it and why they chose it.

2. **NASA Image Gallery**, available here. Students have to:
   2.1. Visualize how the ground temperature has changed over the past two hundred years. What were the warmest locations in 1886, and where are they today?
   2.2. Visualize the layer related to ice blocks. What does each color refer to; blue, orange-red, black, and gray?
   2.3. Compare the flooded surfaces in the four geographic areas. Which of them is most affected by sea-level rise?
   2.4. Indicate historically which coasts have been the warmest (note the year when this is clearly evident) and discuss on which ocean is the warmest and the coldest today.
3. Use the En-ROADS tool, available here. This will be a role-playing game. Students and teachers are at a climate summit organized by the UN. Students have to:
   3.1. Organize themselves into groups of 3. Each group will be a country and represents the interests of a lobby related to these sectors: energy, transportation, construction, agriculture.
   3.2. Analyze the information found on the web.
   3.3. Note how each of the variables influences climate change: both those that affect your sector and the key variables of the rest of the sectors.
   3.4. Take notes and prepare the speech for the summit.
   3.5. Organize a roundtable where each country must defend its private interests, but they must also make a joint decision that allows us to progress as a society and address the climate crisis.

How is STEAM approached in this workshop?

This workshop addresses the following aspects of STEAM education:

- **Science:** Students will be introduced to the general concept of climate change and they will become familiar with its primary effects on various environments and locations.

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- **Technology:** Students will use several online platforms to perform this workshop, which will contribute to the increase in their digital competence and skills.
- **Arts:** Students will observe several pictures, diagrams, photos and sketches during this workshop, which might inspire them to record their thoughts in an artistic way, when they will be asked to take their own notes (to prepare themselves for the roundtable).

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3.2. From Waste to Wisdom: Exploring Human Waste and Pollution

Introduction

This workshop will provide participants with a deeper understanding of the environmental impact of human activities and the types of waste and pollutants generated by various sectors such as transportation, manufacturing and agriculture. This knowledge can help them identify and quantify the impact of their actions on the environment, and to take steps towards reducing their waste and pollution footprint.

Tools & Methods

Students will use the following tools:

1. **Carbon field calculator**. A web platform through which students will become active participants in the fight against climate change. It will motivate them to take ownership of their environmental impact; it will teach them sustainability, it will empower them to make informed choices and it will encourage collaboration and collective action.

   The process of using a carbon footprint calculator encourages students to set goals for reducing their carbon emissions. It provides a benchmark for measuring progress and tracking improvements over time. By setting achievable targets and monitoring their progress, students can experience a sense of accomplishment and motivation as they witness the positive impact of their behaviour changes.

2. **Climate art**. An art-based activity that can be used as a means to communicate scientific concepts and data related to climate change. Students can create artwork that visually represents climate data, such as temperature trends, sea-level rise or carbon emissions. This exercise allows students to apply scientific knowledge, understand the data's significance and effectively communicate scientific information to a broader audience.

   Through this art exercise, students will explore the intersection of climate change and waste management while fostering creativity, critical thinking, and environmental awareness. They will gain hands-on experience in repurposing waste materials and discover how art can serve as a medium for expressing important environmental messages.

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Activities

The following activities will be included:

1. **Ecological Footprint Calculation**, available here and **only in English**. Students have to:
   1.1. Answer the questions to calculate their footprint.
   1.2. See the facts and figures and reflect on the obtained result.
   1.3. Indicate how they feel and read the advice given by the platform.
   1.4. Compare the results with each other.
   1.5. Take a look at the solutions and choose the one that seems easier to achieve with less effort.
2. Climate art. This will be a non-verbal communication piece of art, such as those shown in Fig. 3.2.1, where students have to:
   2.1. Collect waste specific to their professional field to create.
   2.2. Ensure that their work conveys that collaboration and social connection are non-negotiable.
   2.3. Express urgency or crossroad through their work.

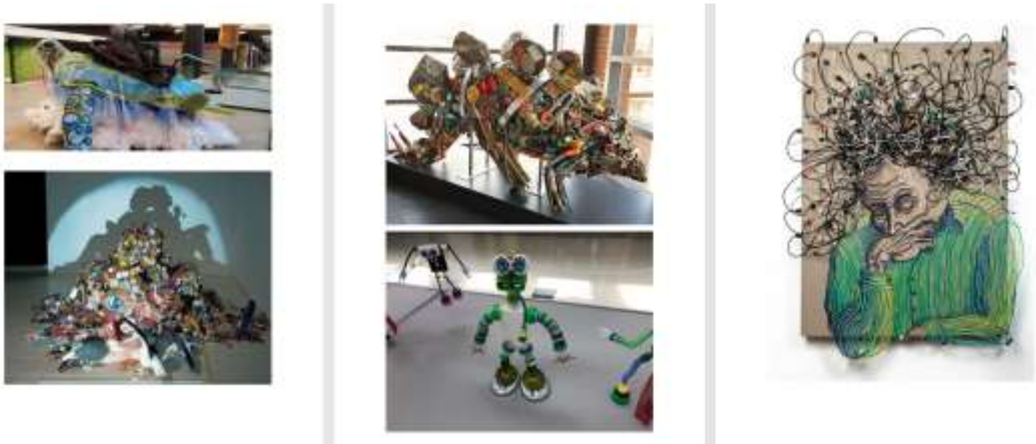

Figure 3.2.1. Examples of Climate art works.

How is STEAM approached in this workshop?

The STEAM educational approach has been ensured during this workshop in the following ways:

- **Science:** Students will become more familiar with the human interventions that cause or deteriorate the climate crisis, including their own, individual activities. Thus, they will be introduced to the main causes of the climate change, as well as potential individual solutions.

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- **Technology:** Students will use several platforms, and in fact not as simple observers. Instead, they will be asked to fill in several fields and observe the results. Thus, they will become more familiar with the usage of technology and its utilisation in education, research and/or profession.
- **Engineering:** Students will construct their own objects using waste, which will be a preliminary introduction to some principles of engineering.
- **Arts:** Arts are a single activity of this workshop, where students will construct their own items, according to their own taste, interests, talents etc.

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3.3. Fury of Nature Unleashed: Exploring Extreme Weather Events (Heat Waves, Wildfires, and Windstorms)

Introduction

This workshop will provide participants with a deeper understanding of the environmental impact of human activities and the types of waste and pollutants generated by various sectors such as transportation, manufacturing, and agriculture. This knowledge can help them to identify and quantify the impact of their actions on the environment, and to take steps towards reducing their waste and pollution footprint.

By conducting this activity, students can gain a practical understanding of how wind can impact buildings and the importance of designing structures to withstand varying wind speeds. It allows them to visualise and experience the effects of wind firsthand, promoting engagement and deeper comprehension of architectural and engineering concepts related to wind-resistant building design.

Tools & Methods

The following tools will be used:

1. Global Forest Watch. It is an online platform that promotes engagement, critical thinking, data literacy, environmental awareness, collaboration and career exploration. Ultimately, it empowers students to be environmentally conscious and informed citizens who can contribute to the prevention and management of forest fires.

   It is a very complete tool with a lot of educational potential, so it may be advisable to invest some time to understand how the tool works. This is the section where the use of the platform is explained step by step. After clarifying the functions and possibilities of the platform, different situations can be set up in which the students can play and investigate.
2. Building activity. This is an experimental activity to simulate the wind effects. This is suitable for learning about extreme weather because it provides a hands-on and practical approach to understanding the impact of severe weather conditions on structures. It fosters experiential learning critical thinking and problem-solving skills. To create the workspace for this activity, teachers will need the following:
   - Small cardboard boxes (to represent buildings)
   - Straws or small fans
   - Lightweight objects (such as paper clips or small pieces of paper)
   - Measuring tape or ruler

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- String or tape (to secure the boxes)
- *(Optional)* Hairdryer or handheld fan (for stronger wind effects)

Activities

The activities of this workshop include:

1. Global Forest Watch, available here. Students need to observe the map and perform the following:
   1.1. LAND COVER Layer: Load the tree cover height layer; specify the height they want to indicate and find which country in Europe has the highest tree cover height.
   1.2. VEGETATION COVER Layer: Load the intact forest landscape layer and check on the map which countries maintain the largest area of intact landscape.
   1.3. CLIMATE Layer: Find which country has the highest carbon sequestration potential.
   1.4. BIODIVERSITY Layer: Identify the countries where biodiversity conservation is most urgent.
   1.5. FOREST CHANGE Layer: Select specific dates to see where the most significant fires have occurred.
   1.6. Choose "Loss of tree cover due to fires" and compare countries that have experienced severe fire periods to observe the evolution. They may need to do a quick internet search to recall the most serious incidents in recent years (Greece, Australia, Italy etc.).
2. Building activity to simulate the wind effects. Students must perform the following, along with the teachers:
   2.1. Set up a designated area for the activity, preferably in a spacious indoor or outdoor location with minimal obstacles.
   2.2. Divide into small groups, each one of which will have a cardboard box, a straw or small fan, lightweight objects, measuring tape or ruler and string or tape.
   2.3. Each group needs to construct a small model building using the cardboard box. They can cut out windows or other architectural features if they want. Make sure the boxes are sealed securely using string or tape to represent a stable structure.
   2.4. Place the model buildings at a designated starting point, ensuring they are evenly spaced.

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2.5. Observe how wind can affect buildings by gently blowing on one of the model buildings using a straw or small fan. Observe how the building responds to the wind.
2.6. Position themselves at different distances from their model buildings, representing varying wind speeds. They can use the measuring tape or ruler to measure the distances accurately.
2.7. Blow air towards their buildings using the straws or small fans. They can experiment with different wind speeds by adjusting the intensity of their blowing.
2.8. Observe swaying, tipping or movement of the buildings. Discuss how different wind speeds affect the stability and structural integrity of the buildings.
2.9. *(Optional)* To simulate stronger wind effects, you can use a hairdryer or handheld fan on a low setting. Experiment with the increased wind speed and observe the amplified impact on the buildings.

How is STEAM approached in this workshop?

The workshop on extreme weather ensures the application of the STEAM methodology in the following ways:

- **Science:** Students will become familiar with some extreme weather conditions, their consequences and impacts, thus increasing their critical thinking considering weather-related scientific issues. By comprehending the extreme weather, students will gain a general comprehension of several principles of climatology and meteorology.
- **Technology:** "Technology" will be achieved through the usage of a web platform, which students will actively use, by shifting between the options of the platform, in order to observe the different results each time.
- **Engineering:** By studying the effects of wind over the buildings, students will become familiar with the principles of civil engineering and architecture, as they will understand that there are always several standards when constructing a building, to protect it against various phenomena (here: the wind, but this is also applicable to earthquakes etc.).
- **Arts:** Students will construct their own city, according to their own taste. They will have the opportunity to express themselves in an artistic way, if they wish so.

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3.4. Geological hazards

Introduction

The Geological Hazards workshop describes in detail the emergence of geological hazards as a consequence, and driver, of climate change. The content of the workshop is designed to provide participants with information on geological hazards that are influenced by climate change, but also those that influence the climate themselves. The knowledge gained will help them navigate the consequences of geological risks and suggestions for mitigation measures.

Through an introductory presentation of the subject by the lecturer and recommended activities to be carried out in groups, participants will get an introduction to the subject and learn the principles of teamwork.

Tools & Methods

Students will use the following tools:

1. Web platforms, where they will search for information. There are no specific web platforms, but some of those that can be used have been quoted here.
2. An experiment on soil erosion and landslides. The workspace to perform this experiment requires the following:
    - 1 or 2 pc glass/plastic container: dimensions (LxWxH)=cca(30x20x15) cm
    - ca 4 kg of soil (sand and clay)
    - 500 to 1000 ml water
    - a small watering jug or plastic cup
3. A different experiment on soil erosion and landslides. The workspace to perform this experiment requires the following:
    - 1 board with a smooth surface, ca 30x20x2 cm
    - 1 board with a slightly rough surface (e.g. with fine sandpaper on the surface, or with small, drilled holes), ca 30x20x2 cm
    - 1 board with a rough surface (e.g. with thicker sandpaper on the surface, or with larger drilled holes), ca 30x20x2 cm
    - container with 500 ml water
    - 2 pc plastic cup
    - pad under the board (to achieve the slope of the boards)
    - cloth
    - glue or pushpins (for attaching the sandpaper to the plate)

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These simple experiments can help participants use the action of water to create erosion and landslides in the production of different types of landscapes. At the same time, it will help them increase their awareness of the impact of water on the Earth's surface, which is made up of different types of land and rocks.

Activities

The following activities are proposed:

1. Information about Katla volcano, Iceland. Students will:
   1.1. Search on the internet, using available websites such as this or this. They need to find why it is risky.
   1.2. Make a 5-minute presentation on the information drawn from the internet.
2. A simple experiment to demonstrate the behaviour of soils under the action of water, i.e. the occurrence of surface erosion and landslides. Upon gathering the necessary material, students need to:
   2.1. Place the soil in the container so that it is tilted (Figure 3.3.1) and gradually pour water.
   2.2. Repeat the experiment, so that the container contains sand.
   2.3. Repeat the experiment, but put the soil in the container in layers alternately (sand, clay, sand, clay, sand). They need to make a pit in the lowest place and pour water there (it represents a water flow).
   2.4. Evaluate the results. Students need to observe/take into account the following:
      2.4.1. If sand absorbs water and slowly begins to slide → surface erosion occurs.
      2.4.2. In case of clayey soil, water flows over the surface and erosion occurs gradually.
      2.4.3. Sand gradually absorbs water, while the clay remains dry. After the sand is saturated with water and the constant pouring of water (rain), the sand begins to slide slowly → a landslide occurs.
3. A simple experiment to demonstrate the influence of water and different shear strength of soils on the occurrence of a landslide. Students need to:
   3.1. Place the boards with different surfaces on the table.
   3.2. Insert a mat between the board and the table so that the board is inclined (Figure 3.3.2).
   3.3. Prepare two glasses, pour water into one and make a small hole in the bottom of the other.
   3.4. Place a glass of water on the prepared board and observe what happens.

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3.5. Then put a glass with a hole in the bottom on the board, hold it with their hand and pour water into it.
3.6. Drop the glass slowly and observe what happens (If the glass will approach the end of the board, it is necessary to catch it, otherwise the water will spill on the table).
3.7. Repeat the procedure for all 3 boards and observe the differences.

Discuss on the results of the experiment.

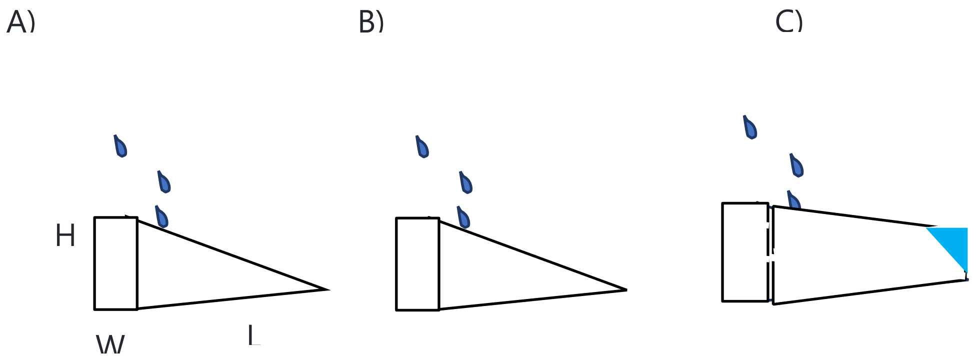

Figure 3.3.1. The first experiment on soil erosion.

Figure 3.3.2. The second experiment on soil erosion.

How is STEAM approached in this workshop?

The essence of the STEAM method is participation in hands-on activities that will help participants to better understand the causes and consequences of geological hazards. STEAM as a tool will be used to apply theoretical knowledge and model a real situation simulating a landslide. More specifically:

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- **Science:** Students will be introduced to some of the most common geological hazards and through the proposed experiments, they will gain insights into their nature, causes and effects.
- **Technology:** Students will become familiar, not only with the use of technology, but also on searching information, as they will be asked to select among various web platforms in order to gather information and present it.
- **Engineering:** Students will become familiar with the primary causes and results of landslides, which can motivate them to think of potential solutions or mitigation strategies, which will be engineering-based.
- **Arts:** “Arts” will be indirectly addressed, as students will construct a soil slope in their own way, always according to the instructions of the teacher.

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3.5. Will we have our coasts in the future?

Introduction

Coastal erosion and flooding are an important aspect that can be covered by tools for STEAM education. Many students may have experienced waves in a shore, but only a few of them can imagine that the beaches they see are not stable. Educators can encourage interdisciplinary learning, critical thinking and problem-solving abilities in learners by including coastal erosion and flooding into the curriculum.

Tools & Methods

1. Coastal flooding experiment. This will help students visualise the impacts of storm surges on coastal communities and the efficiency of the most common protection measures.
2. Coastal erosion experiment. This will help students visualise the effects and causes of coastal erosion and the efficiency of the most common protection measures.

Both experiments are performed through an experiment, based on a wave tank. The wave tank is used to simulate the seawater's behaviour regarding waves (Figure 3.5.1).

Figure 3.5.1. A professional wave tank, that can be found here.

A very simple wave tank can be created using the following:

- a relatively deep tab, preferably (but not necessarily) transparent
- items simulating the coast (e.g., sand or a rock)

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- items simulating protection measures (e.g., breakwaters, sea walls etc. – for a very simplified version of the wave tank, you could use rocks to simulate them).
- light plate to generate waves (which could be the lid of the tab).
- water (to fill the tank)

Activities

Two different experiments will be performed with the wave tank:

1. Experiment on coastal flooding. Students will simulate a nearly flat coastal zone, which will remain stable, and simulate different cases:
   1.1. Generate relatively small waves and observe how this zone is inundated.
   1.2. Repeat the experiment, but with increased wave height, which reflects a similar increase in nature, as a result of climate change.
   1.3. Repeat the experiment, but using a sea wall to protect their coast.
   1.4. Discuss on the results of the experiment.
2. Experiment on coastal erosion. Students will simulate different coastal zones and case scenarios:
   2.1. Simulate a sandy beach (i.e. a nearly flat coastal zone which they will fill with sand); generate relatively small waves, then observe how this zone is eroded.
   2.2. Repeat this experiment, with increased wave height, which reflects a similar increase in nature, as a result of climate change.
   2.3. Repeat the second experiment, but adding sea walls to protect their coast.
   2.4. Repeat the second experiment, but adding submerged breakwaters far from the coast to protect it.
   2.5. Repeat the second experiment, but adding submerged breakwaters close to the coast to protect it.
   2.6. Discuss on the results of the experiment.
   2.7. Discuss on the efficiency and other pros and cons of the protection measures addressed above.

How is STEAM approached in this workshop?

The wave tank, as a STEAM methodology, can assist students in developing a deeper understanding of the scientific and engineering principles underlying the phenomena of coastal erosion and flooding, as well as allowing them to critically evaluate

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different mitigation measures based on their efficiency, cost, and other benefits and drawbacks. More specifically:

- **Science:** Students will obtain a better understanding of the underlying processes that impact the coastal zone and how these processes interact with human interventions and natural causes. This hands-on learning exercise may help students build critical thinking skills and equip them to face real-world coastal erosion and flooding concerns.
- **Engineering:** Students will get to know the most common engineering measures for coastal protection and the way in which they function, but they will also assess their efficiency compared to other characteristics (e.g. construction cost).
- **Arts:** In this case too, “arts” will be indirectly addressed, as students will construct their own coast and protective measures, according to their own taste and perception.

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3.6. Hydrological risks (flood-drought)

Introduction

This workshop focusses on flood risk. The main activity in this workshop will focus on using stream table for simulating different flood types, different basins morphology and different human activities. Participants will be able simulate different soil types, flood plains, mountains, agriculture areas, settlements, roads and bridges, as well as some flood protection measures such as alignment of revers, dams, leaves etc.

Tools & Methods

This workshop is based on an experiment considering floods. It will provide students with general insights on the flood risk. Students will use a stream table to learn some terms and explore how different stream characteristics and conditions interact (Figure 3.6.1).

(a) (b)

Figure 3.6.1. The stream table components.

Activities

The students will perform three experiments, whose is as follows:

1. Preparing the experiments. Students, with their teachers, need to:
   - 1.1. Place the stream table with an angle toward the bottom of the table.
   - 1.2. Set up the water supply and gathering area (bucket) for the drainage water.
   - 1.3. Put the soil type (clay, sand etc.) into the stream table to form the ground.
   - 1.4. Create the slopes of the ground (flat, moderate or steep).
   - 1.5. Create the drainage network (streams, rivers etc.).

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2. First experiment. Students, with their teachers, need to:
    2.1. Use a water source (such as a hose) on the upper part of the stream table,
    2.2. Set a time limit for the water's presence as well as the pressure they will apply,
    2.3. Poor water into the tab (e.g. open the hose) and start the experiment.
    2.4. Observe the impact of water flow on the area.
    2.5. As the water moves downstream, observe the properties of the flood and its impacts on the basin.
    2.6. Describe the damages and losses that occurred during the flood.
3. Second experiment (impact of protection measures on the basin). Once the water from the previous experiment has drained, students, with their teachers, need to:
    3.1. Define the flood protection measures of their basin (e.g. dams, retention walls, leaves, channel diversion or clearing) and place them in the basin.
    3.2. Poor water into the tab (e.g. open the hose) and run the experiment.
    3.3. Observe the impact of water flow in the area after the protection measures.
    3.4. Evaluate the impact of protection measure on the basin.
4. Third experiment (changing the used parameters and checking their effect on the basin). Once the water from the previous experiment has drained, students, with their teachers, need to change the experiment's parameters and specifically:
    4.1. the discharge (amount of water released).
    4.2. the slopes of the basin using blocks (1, 2 and 3).
    4.3. the soil type (gravel, sand, clay, etc.).
    4.4. the drainage network (streams, reveres and meandering).
    4.5. the locations and types of human activities.
    4.6. the locations and types of flood protection measures.
5. Results and discussion. Students should discuss with their teachers on the following aspects:
    5.1. How does the watershed and the stream channel change over time and space?
    5.2. How do changes in discharge affect the basin?
    5.3. How do changes in the slope of the stream affect the basin?
    5.4. What is the effect of using different bed materials on the basin?

5.5. Do changes the drainage network (streams, reveres and meandering) affect the basin?
5.6. What is the effect of different human activities on the basin?
5.7. How can using different flood measures protect the basin from flood risks?

How is STEAM approached in this workshop?

STEAM methodology will be applied in this workshop through the use of a stream table that will be used for simulating flood risks and management in urban and rural areas. In addition to other activities that depend on thinking, sharing data and discussions. Specifically:

- **Science:** Participants in this workshop will do a simulation of flooding themselves and apply different scenarios and different cases. Also, they will discuss the results of experiments which will help them for prediction of some phenomena. This will help participants in understanding and analysis of natural phenomena such as flood and drought.
- **Engineering:** Students will become familiar with some of the most common protective measures, not only as terms, but also with the way in which they are applied to a specific drainage basin, as well as their function.
- **Arts:** Students will create their own drainage basins, with the relief and configuration they desire, always according to the recommendations of the teacher.

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3.7. Flood types

Introduction

In the workshop on flood types, the STEAM methodology will be incorporated by the use of Augmented Reality (AR) technology to enhance the workshop's effectiveness and engagement.

Participants will learn about the causes, effects, and characteristics of each type through interactive discussions, case studies, and data analysis. AR technology will play a crucial role in the workshop. Using AR, participants will be able to visualize and simulate flood scenarios in a realistic and immersive manner. They can explore virtual environments depicting various flood types, observe water flow patterns and understand how different factors contribute to flooding. By integrating AR technology, participants will be able to visualize complex concepts and immerse themselves in interactive learning experiences. This combination of STEAM and AR methodologies creates an engaging and comprehensive learning environment that fosters critical thinking, collaboration, and a deeper understanding of flood types and their implications.

Tools & Methods

The following tools will be utilised during this workshop:

1. Kahoot test about flood types. This is in fact a questionnaire to examine the students' knowledge on flood types, the causes of floods etc. We propose the following questions (the correct answer is shown with bold letters):
   - What is the cause of a flood? a) Prolonged rainfall b) Storm c) Earthquake **d) All of the above**.
   - What are the types of floods? a) Flash flood b) Coastal flood c) River flood **d) All of the above**.
   - What is a characteristic of a flash flood? **a) Rapid rise and fall of water** b) Standing water above the ground c) Small flood waves d) Water rise due to prolonged storm.
   - What is a characteristic of a coastal flood? a) Rapid rise and fall of water b) Standing water above the ground c) Small flood **waves d) Water rise due to cyclone or hurricane**.
   - What is a characteristic of a river flood? a) Rapid rise and fall of water **b) Standing water above the ground** c) Small flood waves d) Water rise due to moon phase and astronomical forces.

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- Which factors can influence the intensity of a flood? a) Wind b) River currents c) Atlantic currents **d) All of the above**.
- How can you protect against floods? a) Build flood barriers b) Follow flood warnings and evacuation orders c) Improve city drainage systems **d) All of the above**.

2. Group work with AR. Students will be able to use the AR application developed in the framework of the PROFF project. This AR application is available for free here and can be used in any mobile device (e.g. smart phone or i-phone).

Activities

Two activities will be performed during this workshop concerning the flood types:

1. **Kahoot test about flood types**. This can be in form of a printed or online questionnaire. Students will have some time to fill in the questions. When finished, they will discuss with their teacher about the correct answers (provided).
2. **Group work with AR**. Students will be split into groups and each group will use the ARE application to simulate a flood case in their classroom. They can change three parameters, namely amount of rainfall per area, amount of rainfall per time and rock infiltration capacity of rocks, and see how each of these parameters affects the available time to evacuate the classroom in case of a flood.

How is STEAM approached in this workshop?

In the workshop on flood types, the STEAM methodology will be incorporated by the use of Augmented Reality (AR) technology to enhance the workshop's effectiveness and engagement. More specifically:

- **Science:** The science component of the workshop will focus on understanding the scientific principles behind different types of floods, such as flash floods, river floods, or urban floods. Participants will learn about the causes, effects, and characteristics of each type through interactive discussions, case studies and data analysis.
- **Technology:** AR technology will play a crucial role in the workshop. Using AR, participants will be able to visualize and simulate flood scenarios in a realistic and immersive manner. They can explore virtual environments depicting various flood types, observe water flow patterns, and understand how different factors contribute to flooding.

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3.8. Why flash floods?

Introduction

Flash floods are phenomena that are created by intense rainfall, but they are affected by various parameters. These can be categorised into these groups: meteorological factors, geological factors, morphological factors, climatic factors and land cover. We propose an unplugged STEAM tool to simulate all these five types of factors. Students can understand the scientific part of flash floods (e.g. causes and factors affecting them), and also the effects of human activities (e.g. settlements) and their vulnerability to floods.

Tools & Methods

During this workshop, a stream table will be used (Figure 3.8.1). For more information and details on how to prepare a stream table, please see section 3.6. The necessary material can be found in section 2.

Activities

This workshop consists of five experiments with the stream table, which will simulate different flood cases. Its arrangement is as follows:

1. Preparation of the experiments' workspace.
   - 1.1. Teachers, along with their students, will create a drainage basin, using the sediments (e.g. sand). They will create a river and give their basin the morphology they desire. Optionally, they can give it the morphology of the catchment in which their own classroom is located.
   - 1.2. Teachers and students should discuss on the physiography of catchments, hydrological cycle and the natural causes flash floods.
   - 1.3. It is important for the teacher to pre-define the following parameters:
     - 1.3.1. The sediments. **Cobbles** are highly porous, which means that the flowing water will infiltrate them more easily and thus, less water will eventually become surface runoff; the amount of the flooding water is thus reduced; **sand** has intermediate porosity and **clay** (soil) has even less. The flooding water will hence be more. If you use two types of materials **mixed**, e.g. cobbles and clay, the clay particles will cover the pores between the cobbles, preventing water infiltration.

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(a)

(b)

Figure 3.8.1. Example of a stream table: (a) when it is prepared (Source: https://www.youtube.com/watch?v=plhPOyvjU5I); (b) after the conduction of the experiment (Source: https://www.youtube.com/watch?v=a02vrgpeOxw).

1.3.2. The water discharge. If the discharge is small, it simulates low-intensity rainfall. If it is large, it will simulate a storm. You may also change the intensity constantly, stepwise or gradually. Also, you can move the source of water from the estuaries to the mountainous part or vice versa, to simulate a different direction of the storm relatively to the catchment (which would cause different types of floods).

2. First experiment on flash floods, where:
   2.1. Discharge (i.e. rainfall) will be low.
   2.2. No human interventions will be present.

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3. Second experiment on flash floods, where:
   3.1. Discharge (i.e. rainfall) will be higher.
   3.2. Human interventions will again be absent.
4. Third experiment on flash floods, where:
   4.1. There will be a wide floodplain near the basins mouth.
   4.2. Human interventions will again be absent.
5. Fourth experiment on flash floods, where:
   5.1. The relief will be relatively steep.
   5.2. There will be a settlement (e.g. houses, bridges, parks etc.).
6. Fourth experiment on flash floods, where:
   6.1. There will be a wide floodplain near the basins mouth.
   6.2. There will be a settlement (e.g. houses, bridges, parks etc.).
7. Discussion on the results of the experiments. After each experiment, teachers and students should discuss about the following:
   7.1. How does the rainfall affect runoff and thus the flood risk?
   7.2. How does the relief (steep or flat) affect the flood vulnerability?
   7.3. In which types of relief are human settlements more vulnerable to floods and why?
   7.4. In which reaches of a basin are human settlements more vulnerable to floods and why?

How is STEAM approached in this workshop?

The workshop "Why Flash Floods?" is an interactive laboratory. The active participation of the students is essential for its implementation. STEAM is approached in the following ways:

- **Science:** Students will participate in the creation of the experiments' workspace; by discussing with the tutor(s), they will create the relief of the simulated drainage basin for each experiment. Moreover, they will determine, again by discussing with the tutor(s), the characteristics of the rainfall, as well as the types and locations of potential human activities. After each experiment, students will discuss with their tutor(s) about what they observed, for example what factors affected the flood's properties and how its impacts are related (affect and/or are affected by) the human interventions. In this way, students will comprehend the physiography of flash floods, their causes, as well as what types of human interventions affect them.

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- **Engineering:** Students will be free to create their own settlement and related infrastructure (e.g. bridges etc.). At the same time, however, they will be discussing with their tutor so that they place their houses, bridges, parks etc. in the "correct" place as it would be in a real case.
- **Arts:** students will create their own relief, along with their tutor, forming basins different morphological characteristics, different drainage development and different settlements. They will participate actively in all experiments.

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3.9. Flood risk assessment: from damages to losses

Introduction

In this workshop, participants will explore the scientific principles underlying flood risk assessment and understand the factors contributing to damages and losses. The workshop will equip participants with the knowledge, skills and practical tools necessary to assess and evaluate the impacts of floods on different elements. By understanding the complexities of flood risk and the associated damages and losses, participants will be better prepared to contribute to effective flood risk management strategies, enhance community resilience and minimize the negative impacts of future flood events.

Tools & Methods

The following tools will be utilised during this workshop:

1. Pre-Workshop Survey (test). This will be used to assess the participants' knowledge and familiarity with flood risk assessment, damages and losses. It can include multiple-choice questions, true/false statements or short-answer questions to gauge their understanding of fundamental concepts.
2. Presentation. This will give the students the necessary theoretical background before the implementation of the workshop. Teachers can use the presentation(s) that have been developed through the project.
3. Case study analyses. Students will find information about actual flood phenomena and their impacts (e.g. damages, fatalities etc.), so that they become familiar with flood risk assessment.
4. AR application. The application will be used in the same way as described in section 3.7.

Activities

Three distinct activities will be performed during this workshop:

1. Pre-Workshop Survey (test), as described above.
2. Presentation of the theoretical background (by the teacher), as described above.
3. Case study analyses. In groups, students will search information about actual flood cases, trying to identify the damages and impacts caused by them. They should identify the key elements at risk, assess the impacts, and propose appropriate risk mitigation strategies. We propose the following cases:
   3.1. Houston, Texas Flooding (Hurricane Harvey, 2017)
   3.2. Mumbai, India Flooding (Monsoon Season)

   3.3. Mississippi River Flood (1993)
   3.4. Boscastle, United Kingdom Flash Flood (2004)
4. Discussion. Consequently, they will discuss with each other and the teacher about the impacts of floods on the society and the main aspects of flood risk assessment.
5. AR application. The AR application developed in the framework of PROFF will be used. For more details, please see section 3.7.

How is STEAM approached in this workshop?

In the workshop on Flood Risk Assessment (Damages - Losses), the STEAM methodology (Science, Technology, Engineering, Arts, and Mathematics) and the use of Augmented Reality (AR) can be effectively applied to enhance the learning experience and engagement of participants. This is how these elements can be incorporated:

- **Science:** Participants will explore the scientific principles underlying flood risk assessment and understand the factors contributing to damages and losses.
- **Technology:** AR technology can be utilized to provide an interactive and immersive learning experience. Participants can use AR applications or tools to visualise and simulate flood scenarios, assess damages in real-time, and explore the potential consequences of different flood events on the built environment and natural systems.
- **Arts**: The arts component can be incorporated to encourage creativity and foster innovative thinking. Participants can engage in artistic activities, such as creating visual representations or sketches depicting the impacts of floods on communities and the environment. They can also use art to communicate their findings and recommendations to a wider audience.

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3.10. STEAMing Floods: Predict, Model, Map

Introduction

Floods are one of the most catastrophic natural disasters, having a devastating impact on society, the economy, and the environment. Flood prediction, modelling, measurement and mapping are critical methods for assessing and controlling flood hazards. This workshop will introduce to the teachers the essential ideas and methods used in flood forecasting, modelling, measurement and mapping. Through this workshop, students will be able to estimate the flood vulnerability of several areas, including their residence.

Tools & Methods

The following tools will be utilised during this workshop:

1. Presentation. A brief introduction on the main factors affecting the characteristics of a flood is necessary for the completion of this workshop.
2. Drawing and calculation. This workshop will utilise simple materials, namely sheets of paper and colours, in order for students to practice on drainage basin mapping and flood hazard assessment in the simplest way possible. Students will draw a drainage basin and make the necessary (simple) calculations to identify the flood risk.

Activities

This workshop consists of a single activity, which will be developed in several stages as follows:

1. First, the teacher will present the main factors causing floods. They can use the presentation(s) developed in the framework of the PROFF project.
2. Subsequently, the teacher will draw an imaginary drainage basin, which they will split into a few smaller segments (e.g. 3, 4 or 5 segments) (Figure 3.10.1).
3. The students will split into groups. Each group will re-draw the drainage basin with the segments three times. The teacher has the following options:
    3.1. They can draw it in the board and students will try to imitate what they see.
    3.2. For the workshop to be more effective, the teacher can draw the basin in a white A4 sheet of paper and distribute to each student group. The students will then use rice papers to make three exact copies of the basin and the segments.

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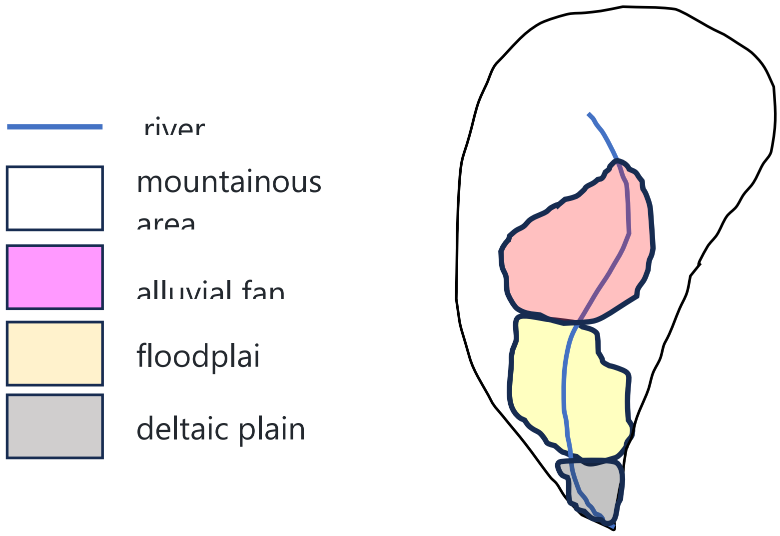

Figure 3.10.1. An imaginary basin, separated into four segments.

4. The teacher will select at least three parameters affecting the flood hazard. The number of parameters will be the same as the number of student groups. Each group will be assigned with one parameter.
5. For each parameter, the teacher will give all segments a simplified characterization. For example, for the parameter "geology", some segments will be "permeable", some will be "impermeable" and some will be intermediate. Teachers can choose parameters and characterizations from Table 3.10.1.
6. From the given table, each student group will give each segment of the basin a value for their corresponding parameter (1: low, 2: medium, 3: high).
7. They will colour the segments in a "reasonable" colour palette (1: green, 2: yellow, 3: red).
8. When all students have finished, they will share their numbers, so that all students have all the segments categorised.
9. Students will calculate the flood vulnerability for each segment, as an average of all parameters.
10. In their second copy of the basin, they will draw the segments according to their flood score (0-1: green; 1-2: yellow; 2-3: red).
11. Students and teacher will discuss on their results (which areas are more prone to flooding and why).
12. Students will calculate again the flood score for the segments, but this time the teacher will give the parameters a weight (for example, 1, 2, 3 etc.). They can use the order of appearance in Table 3.10.1 (from higher to lower), or they can use a different order.

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Table 3.10.1. Parameters (in bold) and characterisations (in regular), categorised per flood vulnerability (low, medium, high).

Low	Medium	High
Geomorphology		
Mountains	Floodplains Deltaic plains	Alluvial fans
Geology		
Permeable	Partly permeable	Impermeable
Land use		
Forests	Cultivations	Barren areas
Slope		
high	medium	low
Proximity to river		
river is away	intermediate	river is near
Historic floods		
a few	intermediate	many
Constructions		
flood-proofing	none	constructions close to rivers

1. To calculate the final flood score, students will find the product of flood value (1-3) and weight of each parameters and they will sum them. They will divide the result to the sum of all weights to find the final score.
2. Teacher and students will discuss on the differences between the two methodologies.

How is STEAM approached in this workshop?

The workshop will use a variety of teaching approaches to offer participants a thorough learning experience. A large part of the program will be the STEAM approach. The aspects of STEAM will be ensured as follows:

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- **Science:** The whole activity is based on the science of floods. Students will become familiar with the primary parts of a drainage basin, the primary factors affecting the flood hazard, as well as how these two interact with each other.
- **Technology:** For simplification reasons, digital technologies will not be used during this workshop. However, the way students will estimate the flood hazard shares the same philosophy as a researcher would do, by utilising a Geographic Information System (GIS) (except in a very simpler way). Therefore, students will be able to perform the same work in a GIS environment once they learn how to use it.
- **Arts:** During some phases of the workshop, students will have to draw their basin and divide into parts, while in other phases they will fill them with colours. In this way, they can have an artistic expression of themselves, as well as make their results more appealing.
- **Mathematics:** Students will make different calculations to assess the flood vulnerability of their study area. In this way, their final results will not be quantitative (i.e. “low” or “high” vulnerability), but instead quantitative (e.g., one segment may have a flood vulnerability score of 2.2 out of 3).

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3.11. Flood risk management

Introduction

This workshop focusses of flood risk management and provides knowledge for flood protection measures and flood risk assessment. It discusses the planning, organisation and management of flood protection and activities before, during and after floods.

Tools & Methods

This workshop will have the form of a fruitful discussion between the teacher and the students, which is why students need to have a background on floods (e.g. by completing some of the previous workshops on floods).

Besides this, students will use several sources of information, mainly the internet, to find information about the topics addressed (see Activities section).

Activities

This workshop will be implemented in the following stages:

1. Presentation of the flood risk management. The teacher will present briefly the theoretical background, by using the presentation(s) developed through he PROFF project.
2. The teacher will discuss with students about activities that can be taken before, during and after a severe flood event, with emphasis on security and rescue works.
3. In groups, students will search, find and propose a list of flood protection measures and they will discuss with each other on their characteristics (efficiency, cost, environmental impacts etc.).
4. The teacher and students will summarise the obtained knowledge and experiences and make the concluding remarks.
5. Students will make suggestions of measures that can be applied to their own area of residence.

How is STEAM approached in this workshop?

The STEAM methodology will be applied in this workshop through various ways. In particular:

- **Science:** Participants in this workshop will learn how different measures can be applied before, during and after flood. They will discuss the possible activities

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mainly of security and rescue works. This will help participants in understanding and analysis of flood management.

- **Technology:** Students will be familiarised with data acquisition, thus developing a critical thinking regarding which data sources are reliable and which information drawn from the internet should be used.
- **Engineering:** Students will be able to select the proper activity for flood protection before – structural / nonstructural measures, during security and rescue works and after flood renovation of the environment and evaluation of flood.

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3.12. Flood protection measures

Introduction

Participants in the Flood protection measures (structural, nonstructural) Workshop will be expected to actively engage with the material and participate in all aspects of the workshop. During the workshop, participants will work in small groups to apply their knowledge and skills. Participants should be prepared to collaborate, share ideas, learn from each other and to participate in the discussion.

Tools & Methods

This is a rather simple workshop with no particular requirements in terms of equipment or materials. It will be based on discussions between the teacher and the students, and will be accompanied by the following:

1. Presentation. The teacher will make a brief introduction to the subject, by using the presentation(s) created through the PROFF project.
2. AR application. The application will be used in the same way as described in section 3.7.

Activities

1. This workshop will have the form of a fruitful discussion between the teacher and the students. Individual stages of the workshop include:
2. Introduction to the theoretical background. The teacher will present the primary flood protection measures that are frequently used by several states.
3. Augmented Reality (AR). Students will be split into groups and each group will work with the AR application created by the project's partners. For more information about the AR application, please see section 3.7.
4. Discussion. Students will discuss with their teacher about their observations.

How is STEAM approached in this workshop?

In the workshop on flood types the STEAM methodology will be incorporated in the following ways:

- **Science:** The science component of the workshop will focus on understanding the scientific principles behind different types of floods protection measures (structural and nonstructural). Participants will learn about the mitigation measures through interactive discussions, hydrological and data analysis.
- **Technology:** The technological aspect will be covered by the AR application, which requires the usage of a mobile phone.

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- **Engineering:** Students will be familiar with protective measures and how they work, where and in which cases they can be applied, when and why should they be avoided etc. In this way, they will also gain engineering skills and knowledge, combined with the purely scientific part.

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4. Suggested literature for further reading

Atmojo, I. R. W., Ardiansyah, R., Saputri, D. Y., & Adi, F. P. (2021). The effectiveness of STEAM-based augmented reality media in improving the Quality of natural science learning in elementary school. *Al-Ishlah: Jurnal Pendidikan*, *13*(2), 821–828. https://doi.org/10.35445/alishlah.v13i2.643

Balgopal, M. M. (2020). STEM teacher agency: A case study of initiating and implementing curricular reform. *Science Education*, *104*(4), 762–785. https://doi.org/10.1002/sce.21578

Barth, N. C., Stock, G. M., & Atit, K. (2022). From a virtual field trip to geologically reasoned decisions in Yosemite Valley. *Geoscience Communication*, *5*(1), 17–28. https://doi.org/10.5194/gc-5-17-2022

Boice, K. L., Jackson, J. R., Alemdar, M., Rao, A. E., Grossman, S., & Usselman, M. (2021). Supporting teachers on their STEAM journey: A collaborative STEAM teacher training program. *Education Sciences*, *11*(3), 105. https://doi.org/10.3390/educsci11030105

Boon Ng, S. (2019). *Exploring STEM competences for the 21st century*. UNESCO, Oficina Internacional de Educación. https://hdl.handle.net/20.500.12799/6641

Bryan, L., & Guzey, S. S. (2020). K-12 STEM Education: An Overview of Perspectives and Considerations. *Hellenic Journal of STEM Education*, *1*(1), 5–15. https://doi.org/10.51724/hjstemed.v1i1.5

Çalişkan, O. (2011). Virtual field trips in education of earth and environmental sciences. *Procedia - Social and Behavioral Sciences*, *15*, 3239–3243. https://doi.org/10.1016/j.sbspro.2011.04.278

Carignan, A., & Hussain, M. (2016). Designing an Earthquake-Proof Art Museum: An Arts-and Engineering Integrated Science Lesson. *Journal of STEM Arts, Crafts, and Constructions*, *1*(1), 2. http://scholarworks.uni.edu/journal-stem-arts/vol1/iss1/2

Chaturvedi, P., Arora, A., & Dutt, V. (2018). Learning in an interactive simulation tool against landslide risks: The role of strength and availability of experiential feedback. *Natural Hazards and Earth System Sciences*, *18*, 1599–1616. https://doi.org/10.5194/nhess-18-1599-2018

Cliffe, A. D. (2017). A review of the benefits and drawbacks to virtual field guides in today's Geoscience higher education environment. *International Journal of Educational Technology in Higher Education*, *14*, 28. https://doi.org/10.1186/s41239-017-0066-x

Dailey, D., Bunn, G., & Cotabish, A. (2015). Answering the Call to Improve STEM

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Education: A STEM Teacher Preparation Program. *Journal of the National Association for Alternative Certification*, *10*(2), 3–16. https://eric.ed.gov/?id=EJ1083948

Davies, R., & Trowsdale, J. (2017). The value of instability: lessons from reviewing how and why creativity and the arts might interact with STEM education. *European Journal of Curriculum Studies*, *4*(1), 584–600.

de Mendonca, M. B., & Valois, A. S. (2017). Disaster education for landslide risk reduction: an experience in a public school in Rio de Janeiro State, Brazil. *Natural Hazards*, *89*, 351–365. https://doi.org/10.1007/s11069-017-2968-2

DeJarnette, N. K. (2018). Early childhood STEAM: Reflections from a year of STEAM initiatives implemented in a high-needs primary school. *Education*, *139*(2), 96–112.

Evelpidou, N., Karkani, A., Komi, A., Giannikopoulou, A., Tzouxanioti, M., Saitis, G., Spyrou, E., & Gatou, M. A. (2022). GIS-Based Virtual Field Trip as a Tool for Remote Education. *Geosciences*, *12*, 327. https://doi.org/10.3390/geosciences12090327

Evelpidou, N., Karkani, A., Saitis, G., & Spyrou, E. (2021). Virtual field trips as a tool for indirect geomorphological experience: A case study from the southeastern part of the Gulf of Corinth, Greece. *Geoscience Communication*, *4*, 351–360. https://doi.org/10.5194/GC-4-351-2021

Evelpidou, N., Spyrou, E., Psycharis, S., & Iatrou, P. (2021). Experimenting with the shape of the Earth's relief through surface runoff tables: A P2P STEM didactic scenario approach for Makerspaces. *Proceedings of the Panhellenic and International Conference "STE(A)M Educators & Education", Regional Center for Educational Planning of Western Greece (PE.K.ES. D.E.), 07-09 May 2021*.

Fedesco, H. N., Cavin, D., & Henares, R. (2020). Field-based Learning in Higher Education. *Journal of the Scholarship of Teaching and Learning*, *20*(1), 65–84. https://doi.org/10.14434/josotl.v20i1.24877

Feig, A. D., Stokes, A., & Gilley, B. (2019). Achieving Inclusive Field-based Education: Results and Recommendations from an Accessible Geoscience Field Trip. *Journal of the Scholarship of Teaching and Learning*, *19*(2), 66–87. https://doi.org/10.14434/josotl.v19i1.23455

Gates, A. E. (2017). Benefits of a STEAM collaboration in Newark, New Jersey: Volcano simulation through a glass-making experience. *Journal of Geoscience Education*, *65*(1), 4–11. https://doi.org/10.5408/16-188.1

Grier, J. M., & Johnston, C. C. (2009). An inquiry into the development of teacher identities in STEM career changers. *Journal of Science Teacher Education*, *20*(1), 57–75. https://doi.org/10.1007/s10972-008-9119-2

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Harknett, J., Whitworth, M., Rust, D., Krokos, M., Kearl, M., Tibaldi, A., Bonali, F. L., Van Wyk de Vries, B., Antoniou, V., Nomikou, P., Reitano, D., Falsaperla, S., Vitello, F., & Becciani, U. (2022). The use of immersive virtual reality for teaching fieldwork skills in complex structural terrains. *Journal of Structural Geology*, *163*, 104681. https://doi.org/10.1016/j.jsg.2022.104681

Herro, D., & Quigley, C. (2016). STEAM enacted: A case study of a middle school teacher implementing STEAM instructional practices. *Journal of Computers in Mathematics and Science Teaching*, *35*(4), 319–342. https://www.learntechlib.org/primary/p/174340/

Jesionkowska, J., Wild, F., & Deval, Y. (2020). Active learning augmented reality for STEAM education—A case study. *Education Sciences*, *10*(8), 198. https://doi.org/10.3390/educsci10080198

Jitmahantakul, S., & Chenrai, P. (2019). Applying virtual reality technology to geoscience classrooms. *Review of International Geographical Education Online*, *9*(3), 577–590. https://doi.org/10.33403/rigeo.592771

Jones, G., Dana, T., LaFramenta, J., Adams, T. L., & Arnold, J. D. (2016). STEM TIPS: Supporting the beginning secondary STEM teacher. *TechTrends*, *60*, 272–288. https://doi.org/10.1007/s11528-016-0052-5

Juškevičienė, A. (2020). STEAM teacher for a day: a case study of teachers' perspectives on computational thinking. *Informatics in Education-An International Journal*, *19*(1), 33–50.

Kang, N. H. (2019). A review of the effect of integrated STEM or STEAM (science, technology, engineering, arts, and mathematics) education in South Korea. *Asia-Pacific Science Education*, *5*(1), 1–22. https://doi.org/10.1186/s41029-019-0034-y

Keebler, J. R., Wiltshire, T. J., Smith, D. C., & Fiore, S. M. (2013). Picking up STEAM: educational implications for teaching with an augmented reality guitar learning system. *Virtual, Augmented and Mixed Reality. Systems and Applications: 5th International Conference, VAMR 2013, Held as Part of HCI International 2013, 21-26 July 2013*, 170–178. https://doi.org/10.1007/978-3-642-39420-1_19

Kim, M. S., & Keyhani, N. (2019). Understanding STEM teacher learning in an informal setting: a case study of a novice STEM teacher. *Research and Practice in Technology Enhanced Learning*, *14*, 1–16. https://doi.org/10.1186/s41039-019-0103-6

Klippel, A., Zhao, J., Jackson, K. Lou, La Femina, P., Stubbs, C., Wetzel, R., Blair, J., Wallgrün, J. O., & Oprean, D. (2019). Transforming Earth Science Education Through Immersive Experiences: Delivering on a Long Held Promise. *Journal of Educational Computing Research*, *57*(7), 1745–1771. https://doi.org/10.1177/0735633119854025

Kundu, S. N., Muhammad, N., & Sattar, F. (2017). Using the augmented reality sandbox for advanced learning in geoscience education. *Proceedings of 2017 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE), 12-14 December 2017*, 13–17. https://doi.org/10.1109/TALE.2017.8252296

Lee, H., Bae, T., & Lee, H. (2016). Development and Application of the Scientific Inquiry-based STEAM Education Program about Earthquakes. *Journal of the Korean Earth Science Society*, *37*(6), 476–488. https://doi.org/10.5467/jkess.2016.37.7.476

Lillquist, K. D., & Kinner, P. W. (2002). Stream tables and watershed geomorphology education. *Journal of Geoscience Education*, *50*(5), 583–593. https://doi.org/10.5408/1089-9995-50.5.583

Mamo, M., Kettler, T., & Husmann, D. (2005). Learning Style Responses to an Online Soil Erosion Lesson. *Journal of Natural Resources and Life Sciences Education*, *34*, 44–48. https://doi.org/10.2134/jnrlse.2005.0044

Mereli, A., Evelpidou, N., Psycharis, S., Drinia, H., Antonarakou, A., Mereli, M., & Maria, T. (2023). Education of students from Greek schools regarding natural disasters through STEAM. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(8), em2314. https://doi.org/10.29333/ejmste/13437

Mogk, D. W., & Goodwin, C. (2012). Learning in the field: Synthesis of research on thinking and learning in the geosciences. *Special Paper of the Geological Society of America*, *486*, 131–163. https://doi.org/10.1130/2012.2486(24)

Nersesian, E., Spryszynski, A., & Lee, M. J. (2019). Integration of virtual reality in secondary STEM education. *2019 IEEE Integrated STEM Education Conference (ISEC)*, 83–90. https://doi.org/10.1109/ISECon.2019.8882070

Pellas, N., Dengel, A., & Christopoulos, A. (2020). A scoping review of immersive virtual reality in STEM education. *IEEE Transactions on Learning Technologies*, *13*(4), 748–761. https://doi.org/10.1109/TLT.2020.3019405

Psycharis, S. (2018). STEAM in education: A literature review on the role of computational thinking, engineering epistemology and computational science. computational steam pedagogy (CSP). *Scientific Culture*, *4*(2), 51–72. https://core.ac.uk/download/pdf/211836954.pdf

Quigley, C. F., & Herro, D. (2019). *An educator's guide to steam: Engaging students using real-world problems*. Teachers College Press.

Quigley, C. F., Herro, D., & Jamil, F. M. (2017). Developing a conceptual model of STEAM teaching practices. *School Science and Mathematics*, *117*(1–2), 1–12. https://doi.org/10.1111/ssm.12201

Reed, S. E., Kreylos, O., Hsi, S., Kellogg, L. H., Schladow, G., Yikilmaz, M. B., Segale, H.,

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Silverman, J., Yalowitz, S., & Sato, E. (2014). Shaping Watersheds Exhibit: An Interactive, Augmented Reality Sandbox for Advancing Earth Science Education. *AGU Fall Meeting Abstracts*, ED34A-01. https://ui.adsabs.harvard.edu/abs/2014AGUFMED34A..01R%2F/abstract

Riggs, E. M. (2005). Field-based education and indigenous knowledge: Essential components of geoscience education for Native American communities. *Science Education*, *89*, 296–313. https://doi.org/10.1002/sce.20032

Silva-Hormazábal, M., & Alsina, Á. (2023). Exploring the Impact of Integrated STEAM Education in Early Childhood and Primary Education Teachers. *Education Sciences*, *13*(8), 842. https://doi.org/10.3390/educsci13080842

Spyropoulou, N., & Kameas, A. (2023). Augmenting the Impact of STEAM Education by Developing a Competence Framework for STEAM Educators for Effective Teaching and Learning. *Education Sciences*, *14*(1), 25. https://doi.org/10.3390/educsci14010025

Stainfield, J., Fisher, P., Ford, B., & Solem, M. (2000). International Virtual Field Trips: A new direction? *Journal of Geography in Higher Education*, *24*(2), 255–262. https://doi.org/10.1080/713677387

Vaughan, K. L., Vaughan, R. E., & Seeley, J. M. (2017). Experiential Learning in Soil Science: Use of an Augmented Reality Sandbox. *Natural Sciences Education*, *46*, 160031. https://doi.org/10.4195/nse2016.11.0031

Woods, T. L., Reed, S., Hsi, S., Woods, J. A., & Woods, M. R. (2016). Pilot study using the augmented reality sandbox to teach topographic maps and surficial processes in introductory geology labs. *Journal of Geoscience Education*, *64*(3), 199–214. https://doi.org/10.5408/15-135.1

Zhbanova, K. S. (2017). How the arts standards support STEM concepts: A journey from STEM to STEAM. *Journal of STEM Arts, Crafts, and Constructions*, *2*(2), 1.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

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