Supporting the continuation of teaching STEM subjects during the COVID-19 Pandemic through project-based online practices

BeReady Conference

Designing engaging online experiences in STEM: From the BeReady handbook to the creation of a "Virtual Gallery"

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Erasmus+

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BeReady Erasmus+ project

Covid19 → new reality for educators

Get acquainted with new tools and methods

+

find ways to maintain the teaching and learning qualities of a live classroom (interactivity, collaboration etc.)

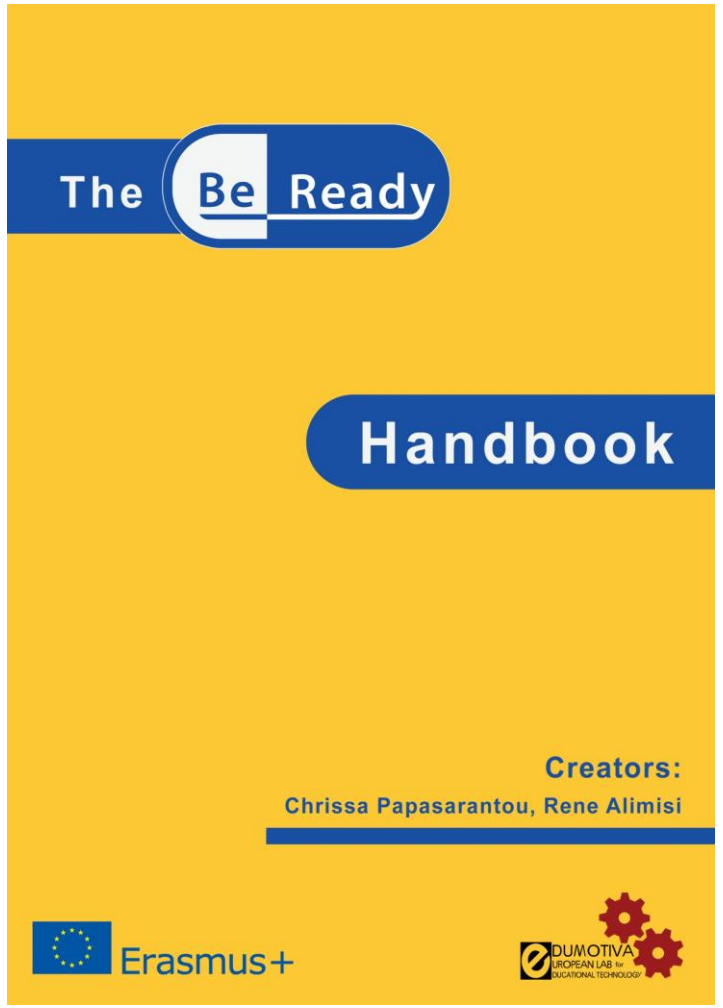
How teachers can be supported on delivering STEM projects online?

Towards creating the BeReady handbook

Creation of the **BeReady** educational **handbook**

Highlighting methods and practices that can support teachers towards designing and realizing a STEM project online

→ focus on how key stages inherent in project-based learning, (brainstorming, planning, collaboration, creation and sharing) can be supported and boosted



The content of the BeReady handbook (pp. 5-8)

Introduction

COVID-19 has proven to be a disruptive force massively affecting numerous aspects of daily life. For public health-care reasons, certain activities normally taking place in physical space were restricted or prohibited, forcing many organizations and professions to seek hybrid or exclusively digital solutions. Schools and educational organizations were among those. Educators and teachers were forced to abruptly adapt in this new virtual era. They had (and still have) to quickly get acquainted with new methods and tools and find ways to confront all the emerging difficulties, while maintaining the teaching and learning qualities of a live classroom. In short, they are called for turning their teaching – a heavily interaction-based practice – into a distant and isolating but still live and collaborative experience.

In this context, the present handbook aims at supporting STEM (Science, Technology, Engineering and Maths) educators overcoming the aforementioned struggles and finding ways to fit their teaching into this new reality. Towards this direction, and through the lens of project-based learning methodology, the handbook presents several available digital platforms and tools as well as a number of exemplary and inspiring stories and scenarios exhibiting solutions emerged from similar challenging situations. Therefore, the aim is not only to present platforms and media that facilitate remote communication, but also tools that can meaningfully support and sustain (synchronous or asynchronous) distant learning methods, and especially the stages of ideation, communication, planning, creation and sharing inherent in STEM project realization. Moreover, a number of good practices coming from real-life paradigms as well as indicative scenarios containing ideas for the potential use and deployment of the proposed tools, are presented to encourage and inspire the teachers and educators.

The handbook does not provide ready-made solutions but aims at showing teachers and educators that different tools can be combined to facilitate student online learning and engagement in STEM projects.

About this handbook / How was this handbook written

While going through this handbook, one might wonder how this collection of tools was shaped. One may also realise that there are additional tools which although suitable for facilitating the online realization of STEM projects and distance learning are not listed here. The BEREADY handbook does not aim to cover all the available tools; this would be impossible. It aims at providing a sufficient list of tools which can transform online learning experiences into more engaging, meaningful for the students, real and relevant ones. Our methodology for gathering input focuses on extended review over the internet as well as on feedback retrieved from the consortium of the BEREADY project through an online form. The online form (see appendix, page 85) aims to gather input for 7 different categories, namely:

- existing digital platforms for online education,
- tools that can support online collaboration,
- online tools that can support ideation/brainstorming,
- online tools that can be used by students for doing the necessary planning,
- digital tools that can support the stage of creation,
- online tools and/or services that can support the stage of sharing, as well as
- good practice examples, strategies and/or inspiring stories concerning the enhancement of learning experience through and with the help of digital online technology.

Presenting the pedagogical methodology

Project-based learning (PBL) is a dynamic methodology that organizes learning around projects. PBL can transform the way STEM subjects are taught. Recent studies show that PBL supports learners to explore in a more authentic way scientific ideas and practices, make decisions, solve problems and reflect upon the way they learn better.

What is a project?

"Projects are intensive experiences that engage students in activities that are interesting to them and important to the course(s) of study. They can involve community members and settings, and they often result in an exhibition or product for a real-world purpose or audience" [39].

The duration of a project varies. Usually a project is not concluded within a few hours. Typically a project can last for two weeks to a whole semester. An innovative aspect of Project-based learning (PBL) is that it pushes against teacher-centred lessons and helps make learning meaningful and useful to students by establishing connections to life outside the classroom, addressing real world problems, and developing real world skills. A project encourages collaboration with experts/mentors/professionals or representatives of specific communities and accommodates different learning styles.

The project is the central teaching strategy through which the students are introduced and engaged with the central concepts of a subject [40].

> *"I can see how PBL is the vehicle by which I can teach both the Common Core Standards and the 21st century competencies [...] I am also very excited that I don't have to throw out all the great units I have taught in the past, but instead can view them through a PBL lens".*
>
> *Teacher's reflection on PBL, retrieved online from https://www.edutopia.org/discussion/example-pbl-early-elementary-how-i-started*

PBL supports learners to develop a variety of skills including the ability to work well with others, make thoughtful decisions, take initiative, solve problems, develop self-directed learning skills and motivation for learning [41]. Thus, established principles of learning, such as motivation, relevance, practice, active learning, and contextual learning operate significantly in a PBL environment, and to a much lesser extent in conventional curricula.

> *"One of the major advantages of project work is that it makes school more like real-life. It's an in-depth investigation of a real-world topic worthy of children's attention and effort"*
> (Sylvia Chard, Associate Professor of Education, University of Alberta, Alberta, Canada)

Practicing project-based learning online

When practicing project-based learning online or in a distance context, the social aspects inherent in this methodology can be further enhanced leading to significant educational outcomes. The challenges imposed by the distance between the participants can potentially enhance the critical reflections upon planning and the sharing procedures.

As George and Leroux [41] point out, the projects by nature require interaction and good collaboration among the learners but also among learners, teachers, mentors and other participants. In the distance context this need is real and from the very beginning mechanisms

The content of the BeReady handbook (pp. 9-15)

Reviewing supporting tools for online STEM education

Digital platforms for online education

As digital platform is defined a digital service that facilitates interactions between two or more distinct but interdependent sets of users who interact through the service, and via the internet. When this platform is implemented for educational purposes, it can be described as a digital space to share information and educational content, which is intended to be accessed and used both from teachers and students [1][2]. This type of platforms can also be identified as computerized learning systems, electronic educational technologies or/and e-learning platforms.

One of the reasons that an educator may use a digital learning platform is for turning the entire educational process into a more interesting, engaging and interactive experience and probably/possibly to a personalized one. Another reason – which was highly dictated during the pandemic – is the need of finding alternatives in cases that the access to physical class is difficult or restricted. On top of that, and from a financial point of view, digital learning platforms can offer a rather cheap solution for engaging a wider audience to the educational process. This is also facilitated by the wide spread of technology (i.e., smartphones, tablets etc.), and the vast number of applications that can offer access to more or less serious online educational platforms and tools.

Most of the platforms designed for educational purposes integrate the so-called Learning Management Systems (LMSs) or/and Virtual Learning Environments (VLEs) applications, enabling teachers to perform educational coursework online, thus permitting "a more connected and accessible educational experience for students" [3]. They are also enhanced with education software, such as Student Information Systems (SIS), that allow students' data management (i.e., storing and tracking student information, grades, attendance record etc.) [5].

The tools included in each platform aim at different needs regarding the learning process and the educational objectives, offering synchronous (i.e., methods that reflect and simulate the dynamic of a live classroom where "students learn simultaneously and collectively" [15]) and asynchronous (i.e., students learn on their own pace) eLearning services. It is highlighted that those systems and/or environments facilitate the creation of multiform educational content such as syllabi, lectures, multimedia files and readings [3] [4]. They also support the evaluation of students through quizzes and tests, while facilitating the distribution of assignments and the corresponding feedback on an individual or on a class level. Moreover, they provide channels for communication not only with students, but also with parents, through personal messages, mobile notifications and forums.

Some rather well-known international examples of digital platforms for online education that were recorded are Microsoft Teams, Moodle, Webex, Google Classroom and Edmodo. Other paradigms coming from national level (e.g., eClass offered by Greek Academic Network GUnet) may equally offer convenient solutions regarding synchronous or asynchronous eLearning services. The majority of those platforms offer tools for online synchronous or asynchronous teaching, assessment and feedback, collaboration and communication as well as video conferencing. In particular:

-Microsoft Teams

Microsoft Teams is a communication platform developed by Microsoft, as part of the Microsoft 365 family of products (*Figure 1*). It offers a variety of features and tools for communication and collaboration (like public and private chat workspace, ability for videoconferencing etc.), as well as a shared storage space for uploading multitype of files (such as word, excel, video, documents etc). Teams is considered as an appropriate platform for both educational and

Note: In order to meet the needs of present days (e.g., lack of physical courses due to pandemic), some of the existing asynchronous eLearning platforms tend to host services that allow live interaction. Edmodo for example is hosting Zoom video conferencing tools, enabling live teaching activities as well as communication and collaboration between teachers and students, eClass is hosting teleconference tools that combine real-time on-line conversations and message exchange, while Blackboard Unite is hosting a secure online virtual classroom where teachers and students can connect, share content, meet and work in groups.

The following table gathers all the aforementioned digital platforms and a number of features and services that are considered crucial being included in tools aiming to facilitate online teaching. Through this table, educators can have a quick overview of the existing environments for supporting eLearning processes, compare the offered services and features, and decide which one fits better to their needs.

	MsTeams	Google Classroom	Moodle	Webex	Edmodo	eClass	Blackboard	Khan Academy
Synchronous	√	√		√				
Asynchronous	√	√	√	√	√	√	√	√
Video Call/ Conferencing	√	√		√				
Uploading/Sharing Files	√	√	√	√	√	√	√	√
Chat room/ Messenger	√	√	√	√	√	√	√	√
Tracking progress and grades	√	√	√	√	√		√	√
Monitoring activity	√	√	√	√	√		√	
Free License	√	√	√	√	√	√	√	√
Application for smartphone	√	√	√	√	√		√	√

The content of the BeReady handbook (pp. 16-19)

Tools for online collaboration/communication

Most of the digital platforms, mentioned in the previous section, host tools that can facilitate the collaboration and communication not only among teachers and students, but also between teachers and parents.

Collaboration – and communication in terms of collaborative activities – are both very important parts of the learning process. According to the National Education Association guide [6], the creation of collaborative learning experience in the classroom leads to better understanding of the learning process and therefore – in comparison with individual efforts – to gain more knowledge. Students are able to build upon the experiences and results of others and others can learn from their own experiences and outcomes. In this sense, communication can be crucial for developing social skills, as well as for enhancing students' self-esteem.

Therefore, supporting collaboration and communication in an online learning environment is considered as a crucial factor for sustaining the qualities of the learning process, met in a physical class. The face-to-face interaction cannot be substituted but a careful selection of tools can enhance the online learning experiences.

Some of the gathered paradigms referred to tools that are embedded in digital platforms for online education (i.e., Google Classroom, Webex, MS Teams etc., the majority of which has already been mentioned and presented in the previous section of the present document), while others referred to individual tools such as Zoom, Skype and ClassDojo. The tools presented bellow encourage the exchange of ideas, feedback, while allow the communication of students' future plans and ways of dealing with emerging problems.

In detail:

-Tools embedded/hosted in digital platforms for online education

The majority of the digital platforms for online education host – among others – tools and/or services for facilitating collaboration and communication between participants. Synchronous digital platforms (i.e., MsTeams, Google Classroom, Webex, Moodle) provide services for video meetings, organization of video conferences, live broadcasting, break out rooms for smaller groups or interpersonal communication, as well as tools for commenting and instant messaging; while asynchronous digital platforms (i.e., Edmodo, Blackboard, eClass) host services and tools for enabling a more mediate communication and collaboration (e.g., hosting Zoom tools for video and/or audio calls, or teleconference tools that combine real-time on-line conversations and message exchange etc.).

-Zoom

Zoom (*Figure 9*) is a partially free web service providing an easy and efficient cloud platform that facilitates online audio and video communication, by hosting tools for organizing and accommodating meetings, webinars, and break-out rooms [7]. Concerning education, zoom can support remote and hybrid learning environments, suitable for every educational grade. It also supports a wireless content sharing through screen sharing and recorded video stream, which both are considered as very beneficial features for teachers and students [7]. Zoom proved as one of the favorite tools for teachers and students during the COVID 19 pandemic. However, issues related to streaming bandwidth (i.e., need of fast internet speed) and security are some of the major disadvantages that might lead users seeking for alternative solutions.

Figure 9: graphical representation of Zoom's environment – image retrieved from: https://www.zdnet.com/article/new-zoom-feature-can-alert-room-owners-of-possible-zoombombing-disruptions/

- Skype

Skype is a proprietary application providing online video chat and voice calls between computers, tablets, mobile devices, and wearables (i.e., smartwatches), as well as instant messaging services. Users may transmit text, video, audio and images, as well as make online presentations by using sharing screen feature (*Figure 10*). Video conference calls are also allowed.

Figure 10: Preview of Skype's environment during a video call – image retrieved from: https://www.plainconcepts.com/alternative-skype-business/

The content of the BeReady handbook (pp. 20-24)

Online tools for supporting ideation/brainstorming

Ideation (or brainstorming) is considered as a method of implementing cognitive processes towards the generation and development of ideas in order to solve a problem [9] [10]. It is a collaborative process, and therefore it is normally performed as a group activity. In this process all the members of a group/team suggest and discuss their ideas revolve around approaching a given problem. In design thinking – towards the creation of projects linked to interaction design – the ideation stage includes a number of sessions such us sketching, prototyping, brainstorming and brainwriting [12]. Therefore, it is considered as a crucial part of the process since it puts the design process into an anthropocentric perspective. Through ideation, designers are able to gain "*a deeper understanding of design principles, of human psychology, technology and society*", thus designing more meaningful projects [12]. Many ideas can be formed during ideation stage, generated from previous knowledge, personal experiences, analogies to the existing problem, as well as from abstract words and hypotheses [13].

Likewise, and in the context of education, ideation/brainstorming is considered as a strategy, implemented by teachers to actively engage students on focusing on a problem and generating ideas towards its solution [11]. Expressing ideas and listening to others, are both critical parts of the ideation process. All students should have the opportunity to express their ideas as well as being encouraged to express anything that comes to their mind, without fear of receiving negative feedback. Thinking outside the box should be more than welcomed. Recording ideas, by writing them down on papers, on a white/blackboard or even on sticky-notes that would be placed on the wall, can ignite more ideas, and turn the entire process to a fruitful and lively discussion.

Through this process – and by respecting others' opinions/ideas – students are able to understand the problem, see it from different perspectives, and adjust their previous knowledge by accommodating new information [11]. As a result, students are able to become more aware of the different aspects of a problem that needs to be solved.

Therefore, ideation/brainstorming is perceived as a critical part of the learning process, especially for STEAM oriented activities that promote the DIY culture.

With this as a solid base – and in the context of the present project – a number of online tools that can support ideation/brainstorming stage were recorded. Some of the gathered paradigms are digital workspaces for visual collaboration and online collaborative whiteboards (e.g., Miro, Mural), Mind Mapping Tools, and tools generating World Clouds. The suggested tools encourage the online recording of ideas, while facilitating the entire process through visualizing the incoming data (i.e., generating word clouds, producing diagrams etc.).

In particular:

-Online digital workspaces/ online collaborative whiteboard platforms

Online digital workspaces such as Miro (*Figure 13*) and Mural (*Figure 14*), are online visual collaboration platforms for teamwork, empowering ideation/ brainstorming. They are equipped with an infinite digital whiteboard in which users can write down their ideas and thoughts by using a set of widgets, such as sticky notes, freeform pen, shapes, and arrows, as well as prebuilt templates that facilitate the organization of inserted information. This kind of platforms facilitate collaboration and sharing with other members of a team through features such as mouseover (i.e., indicating the location of other users' cursor), screen sharing as well as video, chat and commenting.

Figure 13: Screenshot of Miro's environment – Image retrieved from: https://miro.com/

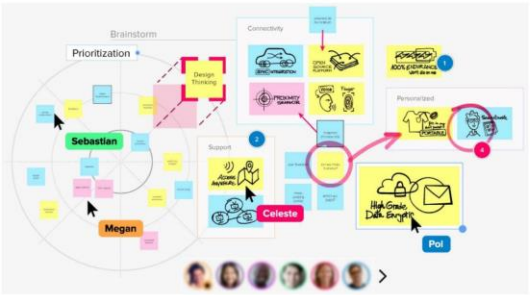


Figure 14: Screenshot of Mural's environment – Image retrieved from: https://www.innovationtraining.org/what-is-mural-and-how-to-use-mural-for-design-thinking/

-Mind Mapping Tools

Mind Mapping tools (such as Mindmaps and MindMup) are mind mapping maker design tools that facilitate the organization of ideas and thoughts by turning users' notes into tree-like diagrams (*Figure 15*). The maps can be stored in the cloud and shared to and with other users, assisting ideation stage and consequently collaboration, planning and teamwork, while Mindmaps application can be also operated in an offline mode.

The content of the BeReady handbook (pp. 25-28)

Online tools for supporting planning

Planning is defined as the process of thinking about the activities (i.e., identifying key steps, setting deadlines, listing of materials needed and more) required to achieve a desired goal. In the context of BeReady project, the goal is performing an online educational activity.

> *"when students independently or in teams interact with the materials to answer a question or solve a problem, they are developing higher order thinking skills that are so foundational to a STEM education." [14]*

The stage of planning is usually inherent in project-based learning practices. By using notebooks, agendas or even sticky notes on boards, students can organize a roadmap of their work, thus understanding the key steps that need to be performed towards the realization of a learning activity. In this process, a variety of approaches are revealed, which can lead to a profound and more lasting learning experience [14]. Moreover, and regarding teamwork, planning can lead to a (better) role allocation.

In order to recreate this experience in a digital environment, online tools that can facilitate the aforementioned activities are explored and recorded. Some representative examples are Trello, Asana and OneNote.

-Trello

Trello is an application functioning as a collaboration tool that helps users to organize their to-dos, projects, and other lists onto "cards" and "boards" (*Figure 19*). Users can add new tasks or comment on existing one. Moreover, users can change the position of a card over the board, in case they want to inform others for the progress of a work/task, helping the team to keep track of what projects are in progress, who is working on what, and how far along a task is. Cards can also function as repository space for ideas and thoughts on the project.

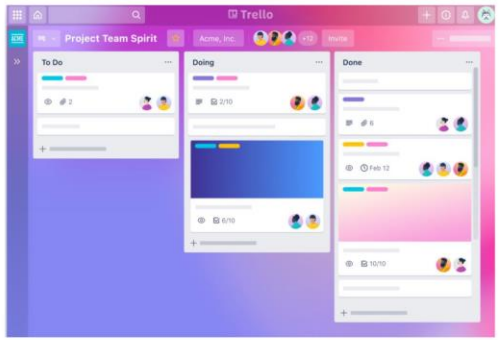


Figure 19: Graphical representation of Trello environment – Image retrieved from: https://trello.com/

-Asana

Asana is a web and mobile application for workflow management and team collaboration. Through the Board menu Asana permits users to plan the tasks of an existing project by organizing them in sub-categories (*Figure 20*). These sub-categories appear in columns, providing a rather clear view of all the needed steps towards the realization of a project. Also, through Calendar, Asana permits users to keep track of tasks over-time and therefore meet deadlines, if any.

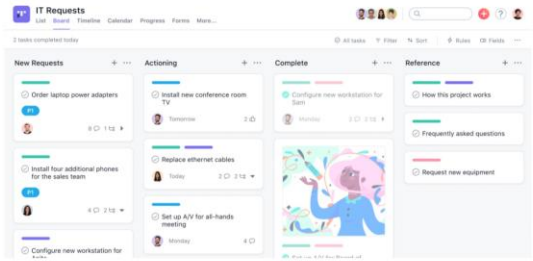


Figure 20: Preview of Asana's environment – Image retrieved from: https://asana.com/

-OneNote

OneNote is available as part of the Microsoft Office suite, as well as a free, standalone application via the official website. It is a digital notebook that allows free-form information gathering (*Figure 21*). It can host multitype of inserted information such as notes, drawings, screen clippings, and audio commentaries. The content can be shared with other users (i.e., members of the team, teachers, family etc.) offering a multi-user collaboration digital environment.

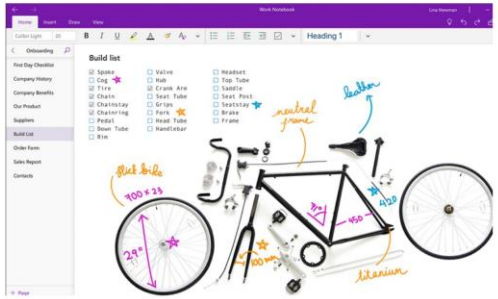


Figure 21: Preview of Microsoft's OneNote background – Image retrieved from: https://www.microsoft.com/en-us/microsoft-365/onenote/digital-note-taking-app

The content of the BeReady handbook (pp. 29-57)

Digital tools for supporting the stage of creation

Depending on the learning activity and the relevant tasks, the stage of creation can be supported through a variety of tools. There are a number of criteria for choosing the more suitable tools, which vary based on the user (teacher or/and student) and the project to be developed. Another criterion can be the field of implementation and if the tool will be used for general scope or should be related to a specific area. Moreover, since, the tools are intended for use by the teachers (i.e., for preparing educational content) and/or by the students (i.e., for practicing their skills towards implementing their STEM project), another criterion should be the inherent level of complexity/difficulty of each tool (i.e., for beginners, for intermediate users or for professional users).

Last, another important factor is the technical aspects of a tool (i.e., if is a web-based tool or offline installation is required, if it is compatible with all the operational systems etc.) as well as its accessibility (i.e., whether is a license free tool or not, and under which conditions).

Based on the aforementioned criteria, a number of different tools were gathered and are accumulated in the following table. The selected tools – which will be analyzed in the following pages – are categorized according to the implementation they are intended for (i.e., programming, production of 2d visualizations and graphic content, 3d modelling etc.).

Digital tools for supporting the stage of creation

Category	Tools
Visualization and graphic content production	Canva, GIMP, Inkscape, Sketchbook
3d modelling and parametric design	TinkerCAD 3D, FreeCAD, AutoCAD, 3dsMax
Circuit making	TinkerCAD circuit, Circuito, Eagle
Block-based programming	Scratch, mBlock, Open Roberta Lab, Microsoft MakeCode
Interactive simulations/ representations in Maths and Science	Geogebra, Free Math Apps, CanFigurelt, PhET Interactive Simulations, Physics Interactives, TEAL Studio Project, Biology Simulations, Virtual Labs by MERLOT, Virtual Biology Lab, LabXchange
Utilizing the concept of gamification	Cells Alive, Socrative, Kahoot!, Quizizz
Multipurpose/Multitasking	Explain Everything, Padlet, Nearpod
Creating and editing audiovisual material	FilmForth, Adobe Spark Video, Animoto, DaVinci Resolve, Audacity, Storyboard That

- Tools for visualization and graphic content production

Teachers and students need to frequently produce visual graphic content to illustrate part of their ideas or parts of an activity (i.e., create an image for a tutorial, create a diagram to present the work flow etc.). A tool that can be rather convenient for such processes is **Canva**. Canva is a graphic design platform, used to create social media graphics, presentations, posters, documents and other visual content (*Figure 24*). It has a wide variety of editable ready-made templates, and a user-friendly toolkit, making the software a suitable option for beginners. Therefore, it can be used by both teachers and students towards the preparation and the production of educational material and content for any subject.

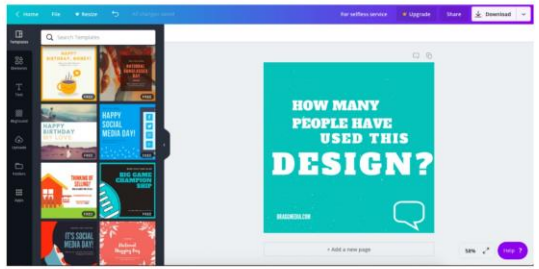


Figure 24: Screenshot of Canva's environment – Image produced by the authors

Another tool for graphic design is **GIMP**. GIMP is an open-source raster graphics editor used for image creation and image modification, as well as for free-form drawing (*Figure 25*). It is slightly advanced compared to Canva, but still is considered as an easy and user-friendly solution for beginners and intermediate users, and a convenient option for users who prefer producing their images from scratch.

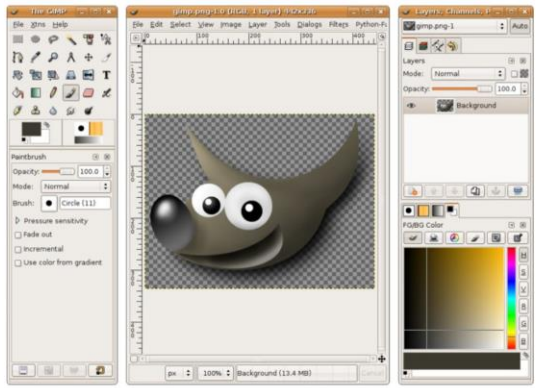


Figure 25: Screenshot of GIMP's environment – Image retrieved from: https://commons.wikimedia.org/wiki/File:Gimp_2.13_Ubuntu.png

Inkscape is another tool for graphic design which - among others - allows users to create vector images (*Figure 26*). Unlike raster graphics which are composed of pixels, vector images consist of points, and consequently lines and curves, enabling the production of images ideal for

The content of the BeReady handbook (pp. 58-65)

Online tools and/or services for supporting the stage of sharing

Sharing is considered as an equally important aspect in project-based learning, reflecting one of the fundamental dimensions of maker movement [38]. By tools and services for sharing we are referring to any online/digital means that allow students and teachers to share their projects with others, to present the current status of their work, to showcase their work in the wider public, as well as to share ideas, thoughts, solutions and consequently share experiences.

On the one hand, sharing of experience can be proved very fruitful for school community members since it provides opportunities for exchanging ideas and good practices with other schools or other educational communities, which eventually can lead to building synergies and the establishing networks of communication [16]. On the other hand, sharing of work and projects can have a great impact on students, since it can lead to enhancing their educational experience and increasing their sense of awareness concerning their future educational choices and consequently their professional orientation [16]. Also, receiving positive feedback can boost their confidence, while the entire process (i.e., presenting their own work, interacting with other people from the educational community) can enhance their social skills as well as a sense of ownership (i.e., the feeling of presenting something that was developed by them and by their own hands), progressively forming a feeling of wholeness [38]. Moreover, sharing can boost interdisciplinarity and interculturalism, leading to broadening the horizons of both teachers and students.

Through this lens – and in the context of the present project – a number of online tools and services that can support the stage of sharing are recorded. Some of the gathered paradigms are social media (e.g., Facebook, Instagram, Youtube etc.), blogs and wikis, as well as platforms offering space for sharing (e.g., Instructables, Frontier for Young Minds etc.). The suggested tools encourage the online exchanging of ideas, while facilitating communication by providing tools for commenting and chatting.

-Social media

Social media, like Facebook, Instagram, Twitter and Youtube, are platforms or/and applications offering multiple and rather easy and intuitive ways of communication and sharing information (*Figure 67*). Users can share content as individuals, or through a specific-topic-related page and/or group, targeting a particular audience. Users can upload content of different and multiple format (i.e., images, text, video), organize the content by hashtags and geographical tagging, publish stories and videos, expand their network by following and be followed by other users and/or groups, as well as communicate through public comment sectors or individual chat rooms. In this way they can reach multiple and different kinds of audience and on a global scale. However, due to the tremendous amount of content that is uploaded on a daily basis, the shared information on social media might not have the expected correspondence and impact. Also, another major drawback is the existence of fake profiles with malicious behavior or ambivalent intentions.

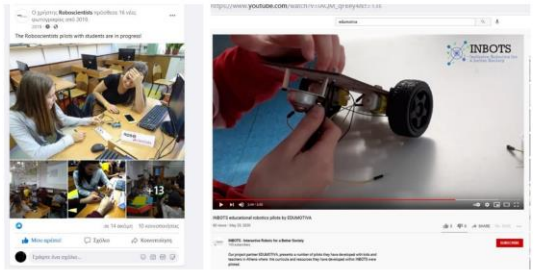


Figure 67: Example of sharing through Facebook posts (left) and Youtube channel (right) – Image produced by the authors

-Blogs and Wikis

Blogs serve as a personal space for users to upload, organize and share information. Based on users' interests, a blog can have a more or less formal content (i.e., containing elaborated information around a specific topic or personal diary-like notes). A blog can contain texts, images, videos and links, while providing space for public commentary. Therefore, a blog can be an important digital space for sharing and exchanging knowledge. In education, blogs can function as a place for sharing resources. These types of blogs are referred to as edublogs (*Figure 68*). An edublog is a blog for sharing educational related content that permits educators (teachers and students) to create their own free blog by using blogging features and tools (text editor, image and video uploader etc.) and therefore, sharing information and tips among community (i.e. blogs written as learning journal, blogs created to keep in contact with student's parents etc.). Educational blogs can also be used as an engagement and reflective assessment tool.

Figure 68: Screenshot from the edublogger site captured and produced by the authors

The content of the BeReady handbook (pp. 66-69)

Learning from others: good practices and inspiring strategies

"We teachers are standing on the shoulders of giants before us who have developed tried-and-true strategies by testing them out, reflecting on the outcomes, and honing those strategies over decades or longer. And they work; they get results." [34]

Good practice or best practice is defined as a strategy/technique or a combination of methods that has been proven to work well and produce optimal results. It is promising, and can be recommended as a model with an added-value or with "*a high level of widely-agreed effectiveness*" [33] [34].

Good practices are inspiring stories that can boost teachers' confidence regarding the implementation of a new method, tool, strategy etc. since they present successful stories based on years of experience or reliable research data. In this sense, good practices should also function as a starting and challenging point not only for employing new methods but also for evolving them through the lens of personal needs and experience as far as teaching and learning are concerned [34].

In the context of BeReady, we are seeking for examples of already existing digital communities boosting or/and practicing online education, as well as strategies and methods that have already been applied regarding online teaching and learning.

Inspiring digital communities

In this section we present online communities and platforms that can enrich the learning experiences and act as sources of support, guidance and inspiration. In the traditional class, teachers and educational advisors often seek opportunities to widen the classroom's walls by offering students opportunities to interact with experts, professionals, other school community members and more. The question that is raised is the following: How can this aspect be reflected in the online classroom as well? Below we present several online solutions that aim at broadening the learning experiences and have been well received by the school community worldwide. The presented solutions are indicative; many more exist. While reviewing them, it is worth considering how these can be better integrated in the online learning experience for supporting students implementing their STEM projects, draw inspiration, receive guidance, boost their self-confidence and/or simply enhance their sense of belonging in an educational community where their work and ideas are valued and discussed.

-iCouldBe

iCouldBe (https://www.icouldbe.org/) is an online community of professional mentors that aims to inspire and empower high school students to stay in school, plot career pathways and succeed in life. In this community, the mentees (i.e., the students) who are seeking of advices are creating a profile in which they are adding information about themselves regarding their educational goals, their career interests and their milestones, as well as some self-reflective information (i.e., what they admire most to themselves, what are they proud of etc.)[3]. Based on the uploaded information, each mentee is assigned to a mentor. The mentor will initially try to inspire the mentee through sharing activities that will initiate brainstorming and a self-reflective conversation (e.g., the mentor shares a video or/and a quote presenting a real's person perspective on a topic, and then asks the mentee if and how s/he correlates to this, based on her/his background). Then, again by sharing real-life paradigms, the mentor tries to assist the

[3] Trying to create a safe and secure environment for both mentors and mentees, the iCouldBe platform does not ask participants to share any personal information that would reveal their identity (i.e., last name, address, social media accounts etc.). For this reason, the communication is strictly text-based. No video calls, or voice calls are allowed, while there are filters that monitor the conversation between mentors and mentees (or between mentees) prohibiting any action that is against the iCouldBe rules.

kids and teens in the role of the reviewer", it does not accept young children – including high school students - as co-authors.

Frontier for Young Minds initiative is considered as a good practice due to the fostered methods regarding the implementation of age-appropriate language and audiovisual material towards creating a comprehensible, engaging and wider accessible content. Educators can be inspired on how to enhance their projects and activities with age-appropriate methods or simply find resources for boosting the content of curriculum activities.

Figure 78: Screenshot from the site of Frontiers for Young Minds, captured and produced by the authors

Inspiring methods and strategies for online education

One of the trickiest and rather difficult tasks in a live class is participation and methods for encouraging students to become part of the discussion regarding assigned activities. Digital learning increases this problem since it adds new communication barriers (i.e., students don't know when is the right time to speak, cameras are turned off leading to disembodied presences deprived of facial or/and embodied expressions etc.). This problem was magnified during the pandemic. To overcome this difficulty, Edutopia site gathers and proposes eight strategies for improving participation in virtual classroom, based on real examples and experiences that were shared by over 20 educators (https://www.edutopia.org/article/8-strategies-improve-participation-your-virtual-classroom).

-Adopting think-pair-strateegy via Zoom and Google docs

One of them – that can be applicable to secondary education – is the adoption of the think-pair-share strategy (TPS). TPS is a learning strategy promoting the collaboration among students towards solving a problem or answering a question regarding an allocated activity [35]. TPS is based on two fundamental steps, namely a. thinking individually the allocated activity and the ways that can be solved or answered and b. sharing the outcomes of this individual process with classmates. This second step leads to the development of discussions around the assignment and eventually to increased participation as well as engagement and deeper understanding of the topic.

One of the teachers, adapted this strategy through the implementation of Zoom. After allocated an activity, students were split in groups and placed into breakout rooms. Each group was asked to discuss the topic and record their answers on a shared Google doc. In this way students were able to reflect their ideas both verbally and written. After that, all teams were gathered back to the class and a representative from each team shared their answers with the

The content of the BeReady handbook (pp. 70-82)

A closer look into implementation through learning scenarios

Scenario 1: Creating a virtual gallery

Who	George (ICT teacher)
Students	15 students/ 13 years old
The topic	Project in programming with references to Arts
The tools	Zoom and breakout rooms, Google docs, Scratch, GIMP, Blog, online community
Pedagogical considerations and good practices	Interdisciplinary learning, encouraging brainstorming & planning, teamwork, opening up the classroom walls to experts/**professionals**. scaffolding, sharing

The full scenario:

George is an ICT teacher in a secondary school in Greece. This year he works with 13 years old students. Covid-19 situation forced him into online teaching and challenged the realization of STEM projects. He is currently considering how to contextually introduce students into programming tasks. He imagines a virtual gallery created in Scratch. His idea is while the user is navigating in the virtual gallery to get information about the artworks included therein. He communicates with his students through Zoom. His idea is to group them into teams of three.

In the first session he presents the project idea to the students. He has invited the Art director/Curator of a local gallery who presents some artworks from different art movements, providing key information about the depicted content and the artists. The invited speaker also releases information on how an exhibition in a gallery is organized, emphasizing on the fact that an exhibition is normally oriented towards the work of a specific artist or a specific art movement. Then George calls them to think aloud in Zoom around the project and the possible challenges trying to answer their queries and provide clarifications. George has created one Google Doc for each team.

Scenario 3: The Egg Drop Challenge

Who	
The topic	Project based learning in general The Egg Drop Challenge
Students	
The tools	MS Teams, YouTube, Canva, Tracker
Pedagogical considerations and good educational practices	design/prototyping/testing/refinements, gamification

The full scenario:

Julia is a physics teacher in primary school. Usually, physics is introduced in Poland in 7th and 8th grade but she convinced her school administration that it would be helpful to start lessons in 6th grade - spending additional time not constrained with mandatory topics on having a "fun" out of physics. Without stress of marks and exams students should be able to be more open, creative and collaborative, which will be beneficial during "regular" learning.

One of her favorite school projects was always "The Egg Drop Challenge". The task is to throw a raw egg out of a window - and ensure its safe landing. To introduce topic to her students in the introductory lesson she played a video from YouTube channel "Minute Physics" with cartoon-style animation that stresses how hard it it to land spacecrafts on Mars and describes different ideas about landing techniques

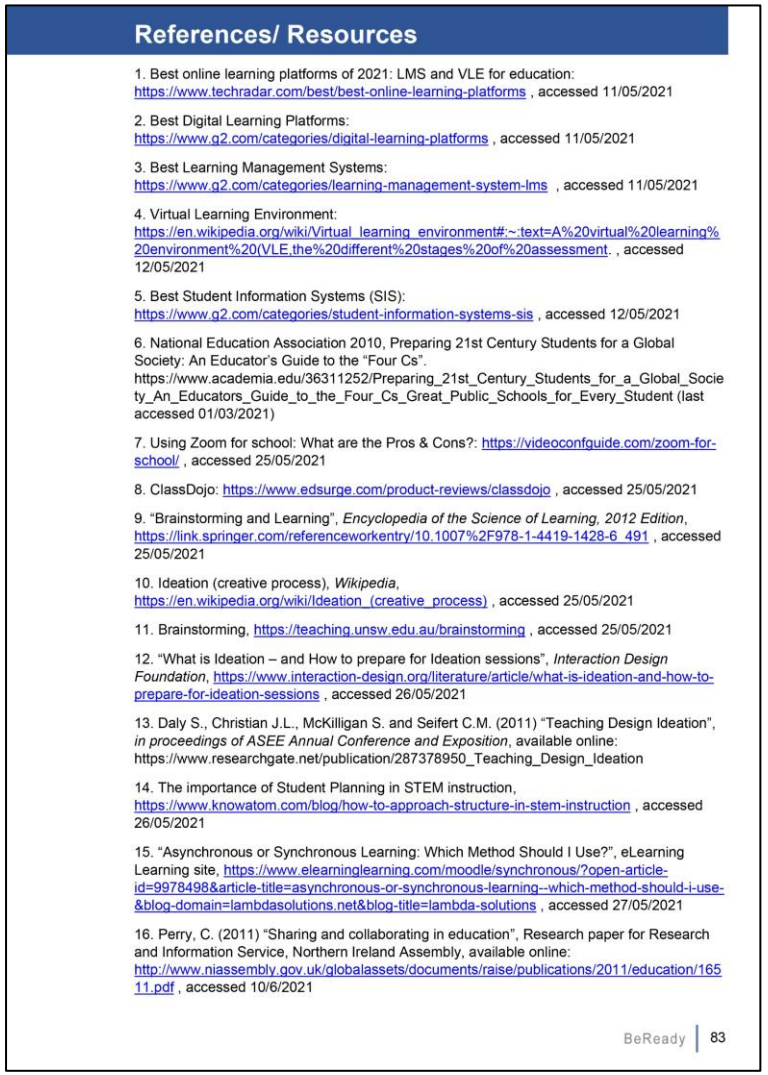
(https://www.youtube.com/watch?v=h2nggKL2JQU).

Afterwards she conducted group discussion to sum up new knowledge from

, mainly falling into two categories:

- decreasing speed (though reducing kinetic energy of impact), like parachutes or propellers with drag opposite to velocity, balloons with helium or hot air, use of wings, drones...
- Damping impact (absorbing or dissipating kinetic energy of impact), like strings, bubble foils, cotton, soft/spring/elastic materials as a padding...

The content of the BeReady handbook (pp. 83-97)



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Link for downloading the handbook:

https://www.beready.pw.edu.pl/files/Be_Ready_Handbook_Final.pdf

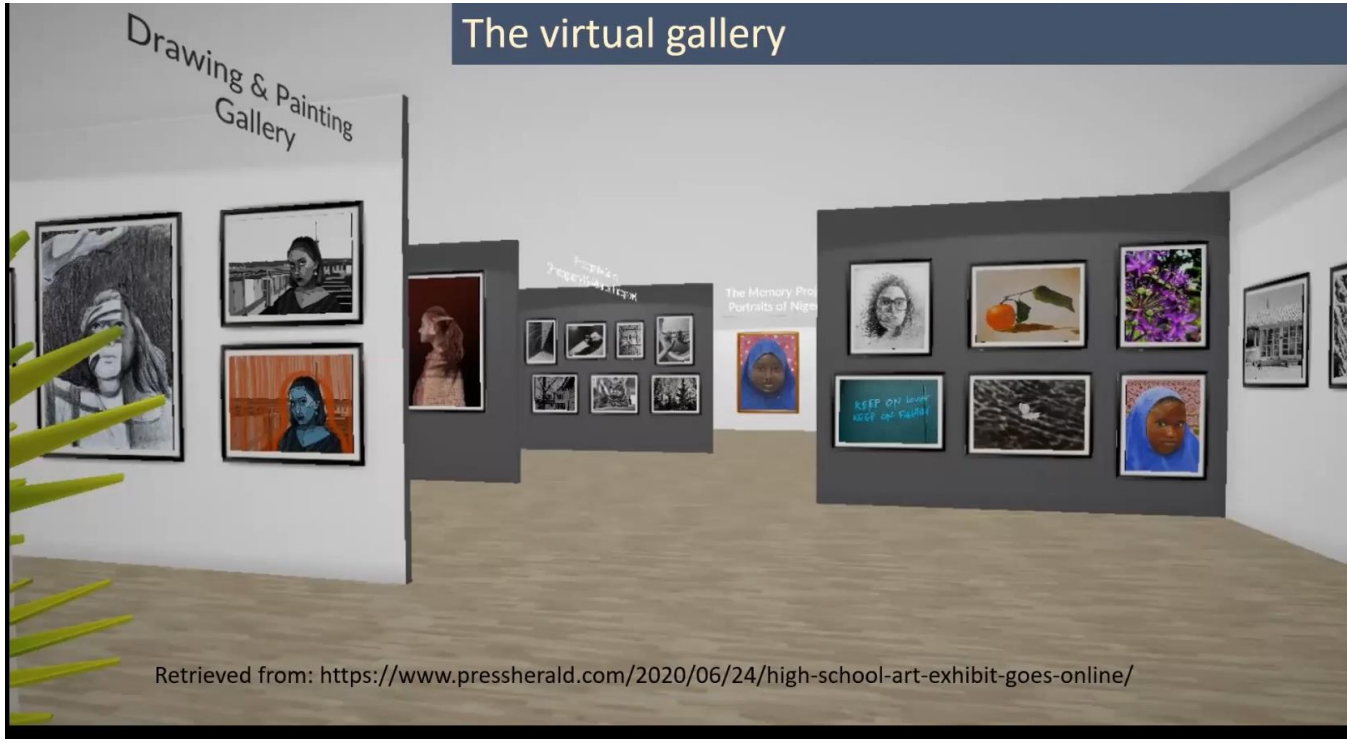
The learning scenario of Virtual Gallery

Creation of a virtual gallery from scratch, around a thematic area by going through the stages of brainstorming, planning, creation, and sharing

- how an online course can be designed
- Working in teams towards creating a virtual gallery for organizing and presented STEM related content
- explore programming concepts through tools appropriate for school education

4 live webinars:

- scaffolding the learning experience

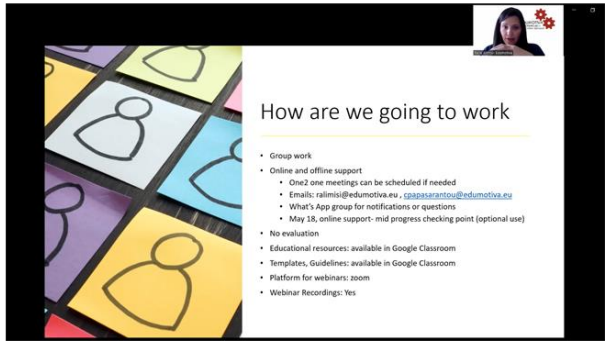


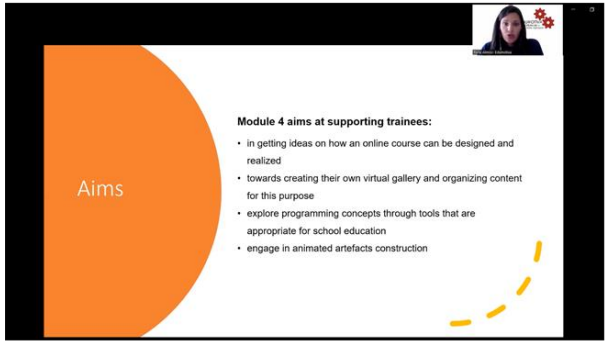
1st Webinar (28/4/2022)

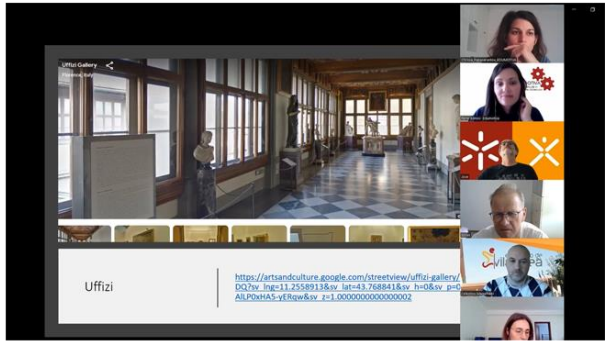
Introductory webinar to the main topic:

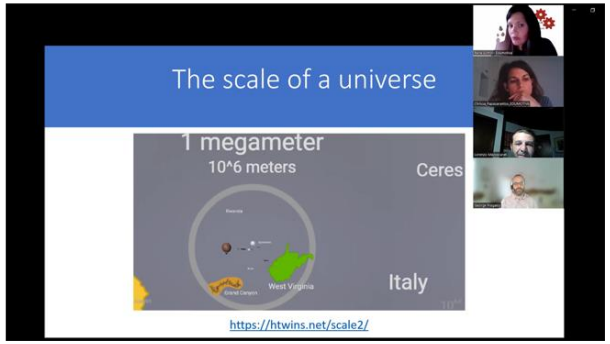
"Creation of a virtual gallery"

- Setting the framework and the main goals
- Engaging and familiarizing participants to "virtual gallery" concept through presenting interactive examples
- Discussions in Break-out rooms (zoom) and in the plenary
- Assigning the first activity (create teams and declare the topic of the V.G.)









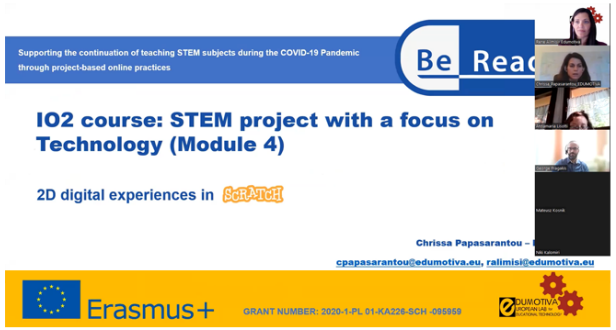
2nd Webinar (4/5/2022) / 3rd Webinar (6/5/2022)

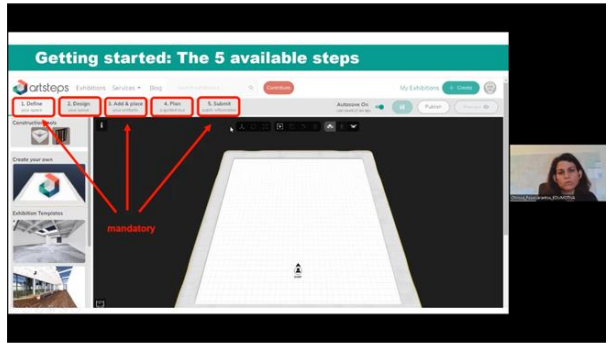
2D digital experiences in Scratch /

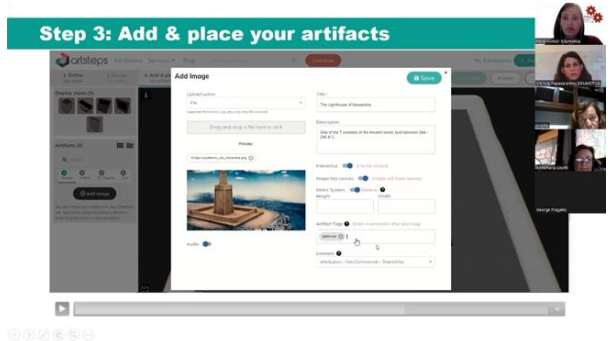
3D digital experiences in Artsteps:

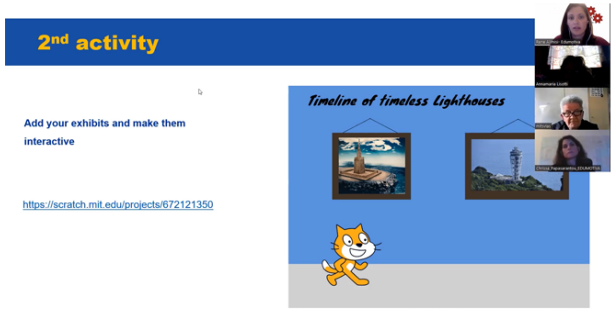
- Short intro to Scratch and Artsteps tools
- Activities for familiarizing participants with the environments/features
- Discussion for questions and clarifications

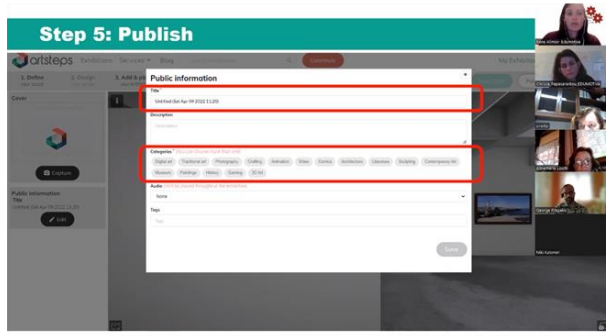
* After the end of the 3rd Webinar, the participants had approx. 2 weeks to create their virtual gallery.









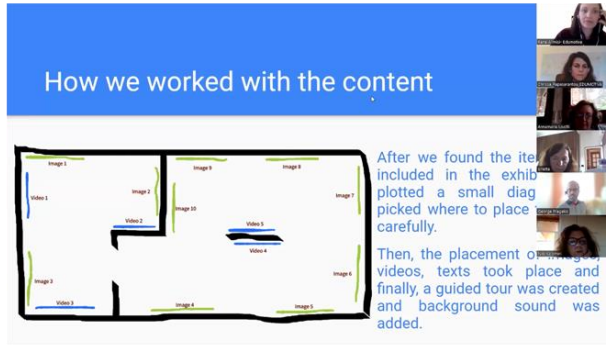


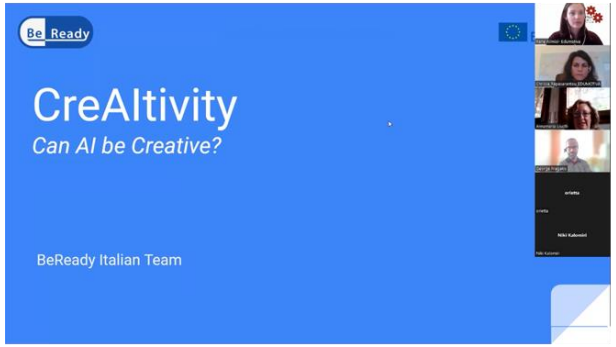
4th Webinar (23/5/2022)

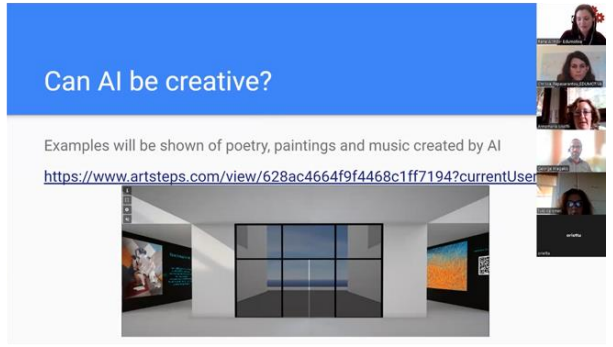
Grand opening and backstage:

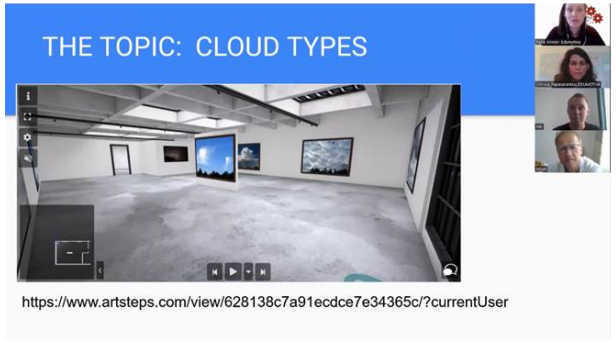
- Each team presented the gallery that they created in Artsteps and gave feedback regarding their experience

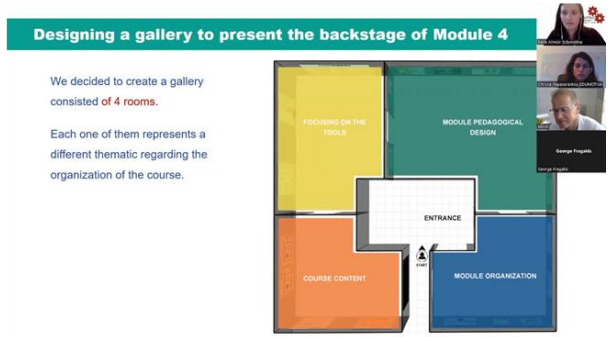
- The trainers presented how the module was designed and key considerations that were taken (be in participants shoes by creating the “Backstages” virtual gallery)











The learning scenario of Virtual Gallery : the tools

Announcements/sharing material:

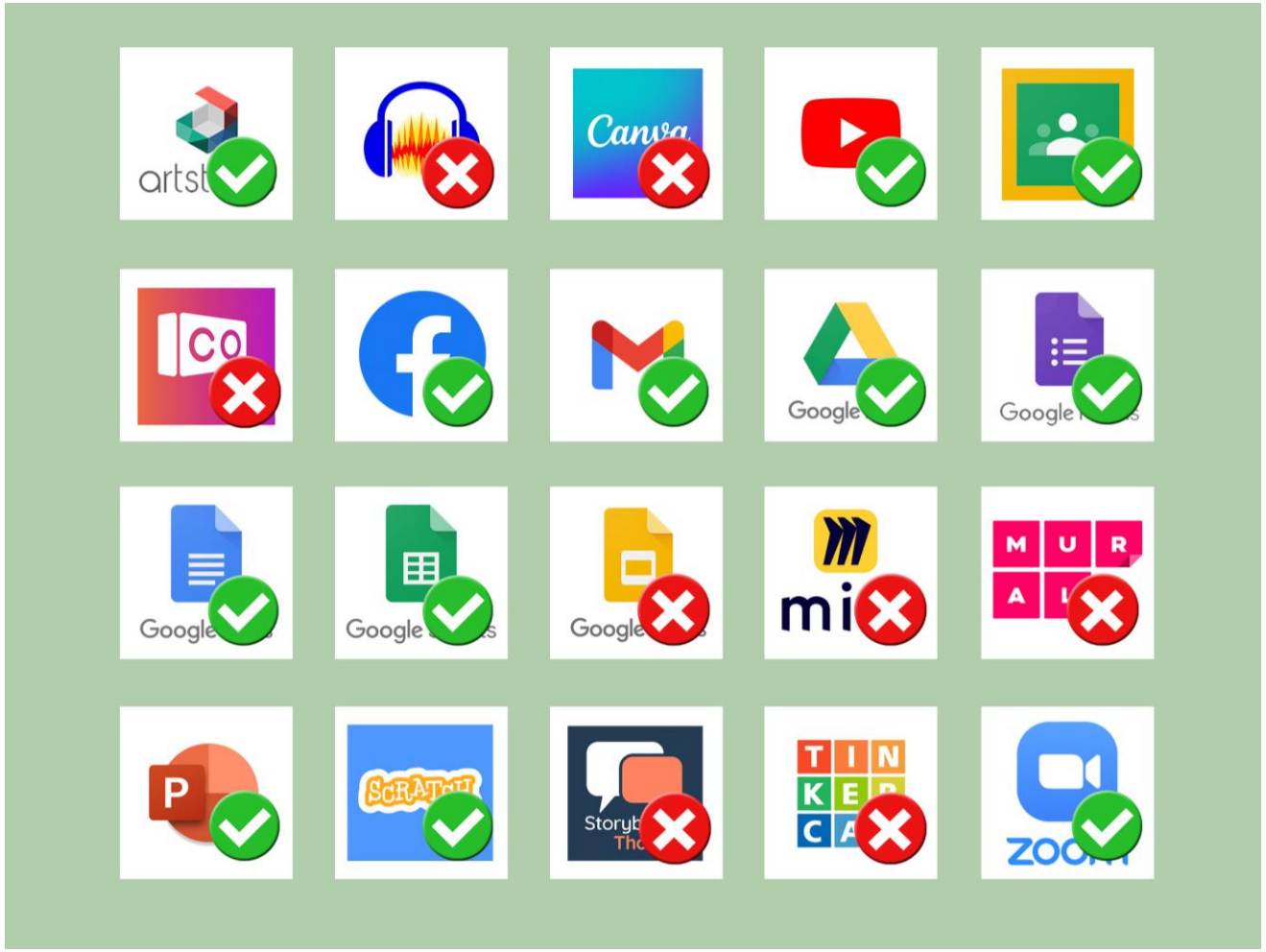
Google classroom

Facebook

Google docs

Webinars repository space:

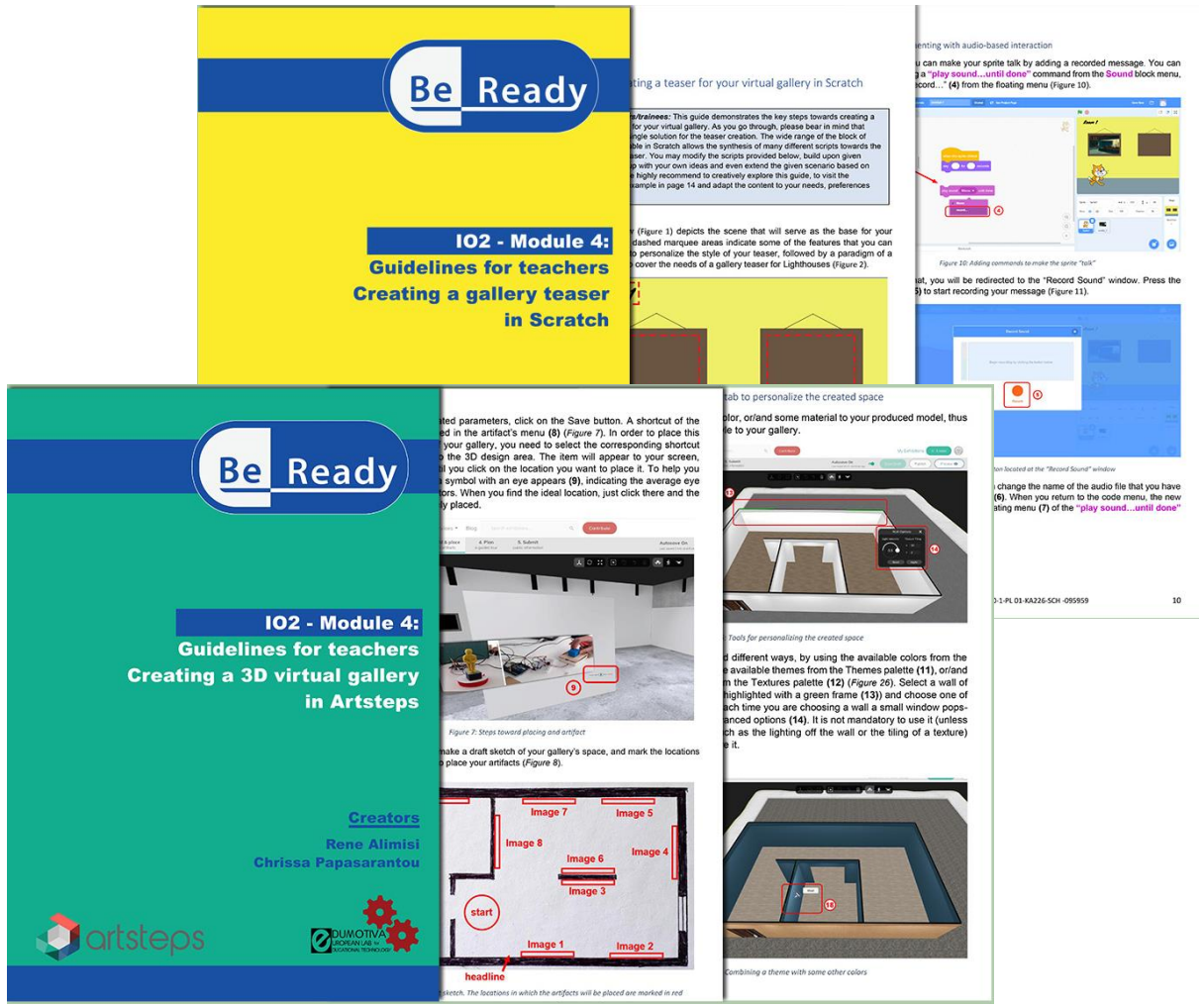
YouTube



OERs

Provide multimodal OERs (documents, videos, half-baked solutions) in order to:

- Support online teaching
- Facilitate different learning styles
- Give ideas for further extending the scenarios



Evaluation

Positive feedback was received:

- The module was a good example of how a STEM project can be released online
- The goal was clear
- There was a good balance between theory and practice
- The pace, the workload and the requirements were appropriate
- Organized in an engaging way, suitable for adult learners
- Weak point → not enough (personal) time for practicing deeper the proposed tools

Conclusion

- The strategies and tools contained in the handbook **can** support teachers on designing and releasing STEM projects online
- Learning scenarios included in the handbook **can** assist on delivering STEM projects online, in a meaningful way
- Learning scenarios such as the virtual gallery, permit the creation of interdisciplinary projects, while allowing participants to infuse their personal interests in the making process

BeReady Conference

Thank you for your attention!

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Erasmus+

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The BeReady partnership

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