acaSTEMy
TEACHER ACADEMY

Work Package 3

D3.2 E-manual “Digital Skills for STEM Teachers”

http://stem-digimanual.eu/

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Contents

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Introduction

This deliverable reports the development and implementation of the e-manual for "Digital Skills for STEM teachers". Overall deliverable 3.2 aligns within the purpose of work package 3, which is to help foster and develop STEM teachers' digital skills, knowledge and attitudes, and to build up their capacity to use digital tools in pedagogically meaningful ways by providing sound knowledgebase for teachers to explore.

E-manual description and link

The acaSTEmy e-manual http://stem-digimanual.eu/ is an interactive tool for educators to explore pedagogical methods and digital tools to use in their teaching-learning sequences. It is intended to serve as an incrementally improving and expanding content bank that enables the users to suggest improvements and provide their own ideas for the greater educational community to benefit from. The e-manual user interface is presented in Figure 1.

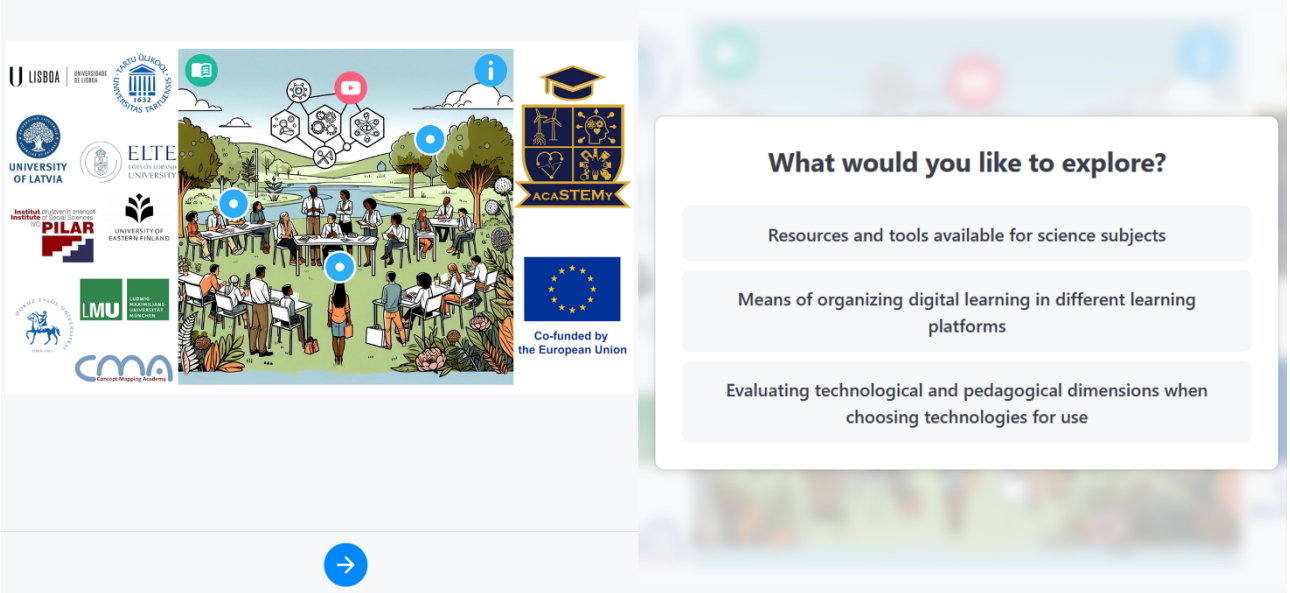

Figure 1. acaSTEMy e-manual overall user interface and navigation.

Each round object is a clickable element that can include text, pictures and/or videos as well as clickable buttons to other websites. Users can navigate forward from the blue arrow in the bottom and back from a grey arrow in the bottom (not displayed on the first page) they choose so or navigate through the manual and be prompted at the end of each path to return to beginning and explore other topics. The overall content map is presented in the Figure 2.

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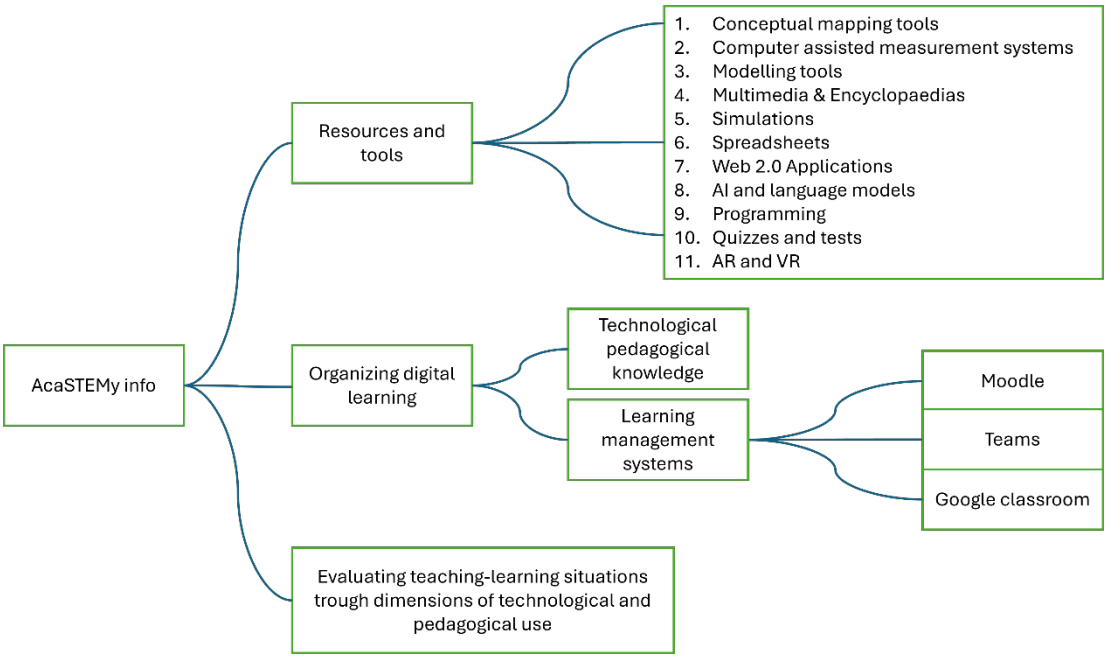

Figure 2. Contents and paths of the e-manual on main heading levels.

Target audience

The target audience for the e-manual is primarily STEM teachers. However, the e-manual is suitable for teacher education staff and researchers also. The e-manual is developed keeping in mind that teachers with any level of background in using digital technologies can find suitable entry-level technologies and approaches to be used in their teaching.

Languages and accessibility

With ThingLink automatic translation, and partner local language checks, we can, in addition to English, cover all the project partner languages, that are Estonian, Finnish, Portuguese, Turkish, Latvian, Croatian, Hungarian and German.

ThingLing as platform offers accessibility performance through their viewing mode, which makes it available to the end viewer meeting WCAG 2.2 standards at AA level (see ThingLink Accessibility Conformance Report https://support.thinglink.com/hc/en-us/article_attachments/18915648394903).

E-manual development

The e-manual development was started by UEF from an expanded Unified Theory of Acceptance and Use of Technology (UTAUT2) framework as outlined by Venkatesh et al. (2012), which is one of the many available frameworks intending to explain the use and acceptance of technologies. Following up on the researched relationships of the UTAUT2 framework, the e-manual is intended to improve the use behaviour of technologies by affecting it through three main components. First, providing research knowledge about the improved learning outcomes facilitated by the educational technologies and thus affecting the performance expectancy the teachers place upon the technology. Second, providing use-cases and information about the possibilities of technologies' use in educational settings, we intended on affect the effort expectancy as experienced by the educators on integrating technologies to their teaching-learning situations. Finally, improving the knowledge of technologies and available resources to educators we aimed at affecting the

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facilitating conditions as seen by the teachers using the manual, because according to Venkatesh et al. (2012) especially older women view the availability of resources, knowledge and support as essential to acceptance of new technology.

This universal framework on the acceptance and use of technology can be further viewed from the pedagogical use point of the Technological, Pedagogical and Content Knowledge (TPACK) framework as outlined by Mishra and Koehler (2006), as technology use has become increasingly big part of students' lives in the schools and outside of it. To facilitate the use of technologies in the classroom the teachers must possess sufficient knowledge about the adoption of technologies to school practice. Moving specially to science education context, the TPACK framework has been improved upon by Jimoyiannis (2010) and shaped to help facilitate science teachers' professional development. It is through this framework that the e-manual was conceptualized to account for more than simply informing the teachers about the available technologies for use in both the scientific and classroom settings and indeed provide the teachers with tools to identify the teaching-learning situations where they might gain some added value by evaluating the possibilities of integrating specific technologies. This is further taken into account by designing the e-manual to be incorporated in WP4 activities as it has been reported by König et al. (2024), multiple intervention studies found out that the pre- and in-service teachers are more likely to design ICT integration into their lesson plans when they have had learning opportunities about technologies in their initial teacher education or in teacher professional development.

The e-manual development was put on hold in the first stages of the acaSTEMy project as it was discussed that mapping the STEM teachers' competences as per T2.1 survey should be conducted first and information about the self-reported technological and pedagogical knowledge of the respondents in each partner country could be evaluated through the multiple choice and open-ended questions. As the survey timeline prolonged from the initial projections to fall 2024, the international data was not available to support the development of the e-manual before the consortium meeting in Split, Croatia.

During the consortium meeting in Split, Croatia (October, 2024), the overall idea of e-manual and the ThingLink scenario tool (Figure 3) as the technological solution was introduced to the consortium. ThingLink scenario tool was chosen because it provides immersive, multimedia, interactive and updatable solutions. Solutions that are not typical for "manuals", but relevant and highly demanded for modern guiding materials. In Split, the UEF team organized focus group discussions among the consortium partners. Although the focus group was more about the overall Roadmap of digital competences over the project aims, the focus groups were also aimed to refine the theoretical foundation (Jimoyiannis, 2010; König et al., 2024; Venkatesh et al., 2012) and expertise overlook of the e-manual content and themes needed by the STEM teacher educators and teachers on different levels of interactions on student learning. According to the partners and the survey data, there is a particular need for AI-related knowledge, digital learning environments supporting active learning sequences and self-regulated learning processes, as well as knowledge of available simulations, modeling tools and interactive materials towards core STEM concepts.

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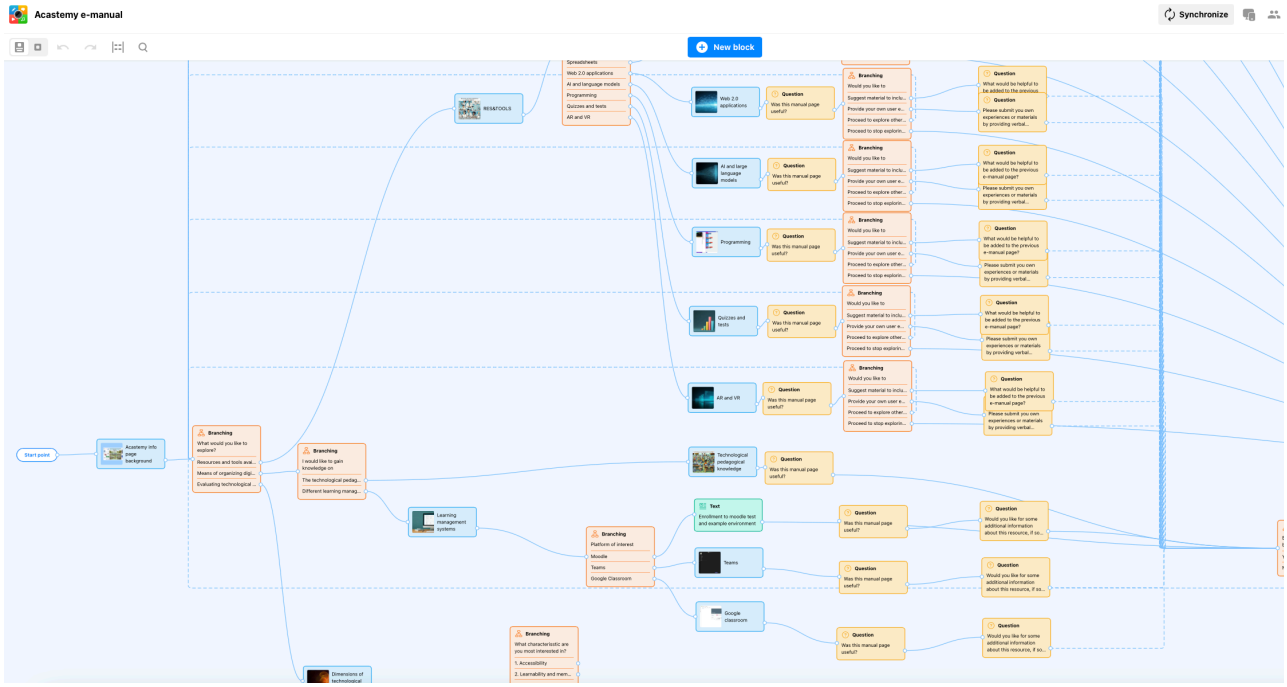

Figure 3. ThingLink's scenario tool as the technological solution for the e-manual.

In the first acaSTEMy Train the Trainers workshop, the draft of e-manual was presented by Justus Kinnunen. The overall feedback was good and only some questions and comments were expressed, most of them being about the content, structure and practical tools. Therefore, between the acaSTEMy Train the Trainers workshops the partners were given a task to discuss the e-manual content and structure. The partners provided suggestions to the e-manual through acaSTEMy TTT test environment Moodle (Figure 4). Most of the 32 suggested tools (Annex 1) have been included in the e-manual tool. Some of the total 24 suggested pedagogical approaches (Annex 2) were too broad to be included but will be considered over project time and to be included if WP4 modules and learning unit development, implementation and feedback suggests so. All the 23 overall structure suggestions (Annex 3) have been considered while finalizing the e-manual. However, unfortunately some of the ideas could not be implemented with the decided ThingLink scenario tool.

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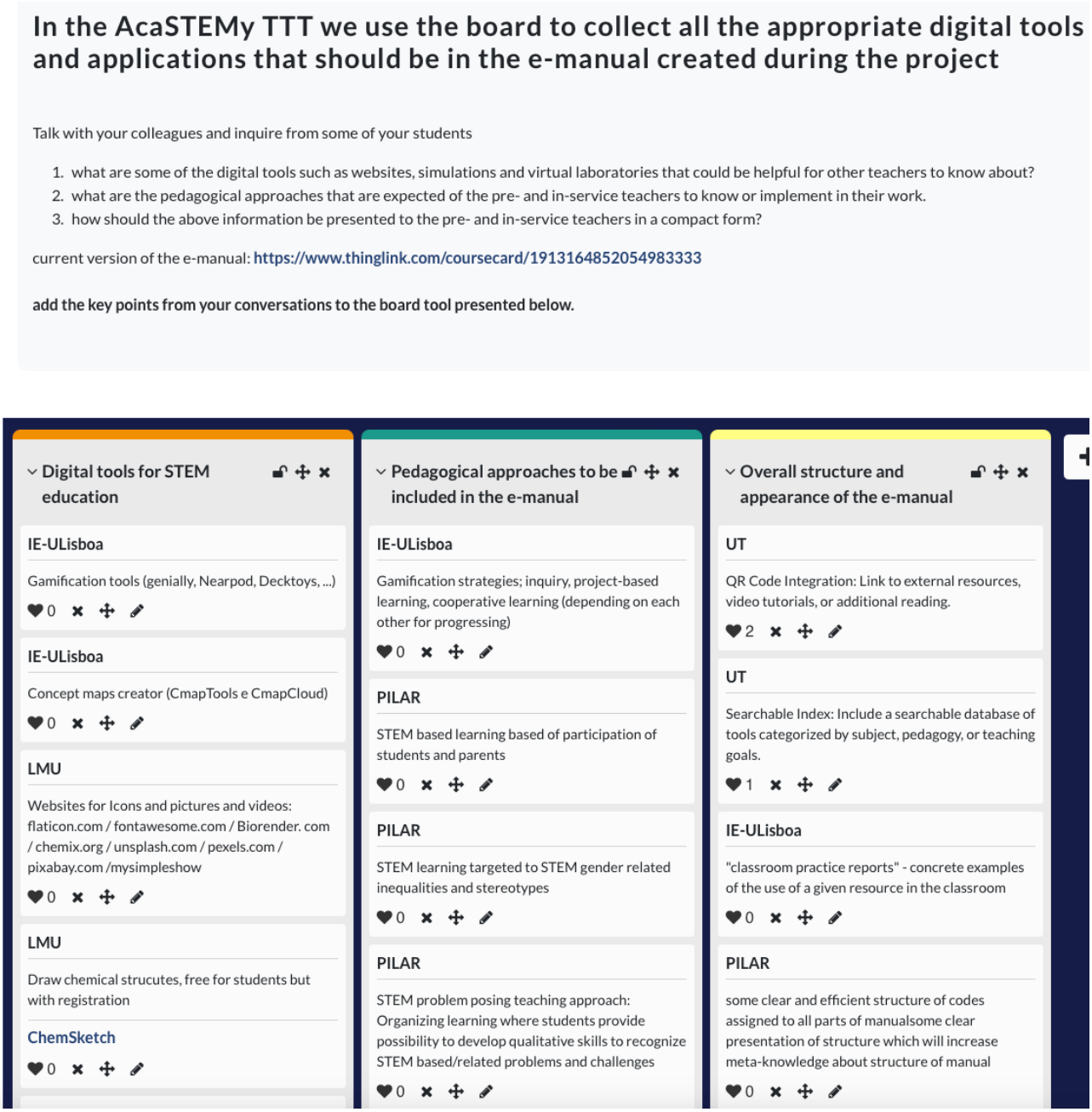

Figure 4. Suggestions from partners for e-manual, assignment between acaSTEMy Train the Trainers workshops (D3.1).

Finalizing the e-manual has been delayed because the e-manual was planned to be developed based on the materials and approaches from the Task 3.3 (Train The Trainers). As the Train The Trainers (D3.1) was agreed to also be delayed to December 2024 – January 2025, for it being the most appropriate time for the project partner staff members, it made the finalizing work of the e-manual by the UEF team to be delayed by 3 months. In addition, as the chosen e-manual technological solution now makes it possible to be revised and updated without major problems in the publication and distribution while simultaneously accessible to users, it is agreed that the e-manual will be incremental by its nature.

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Usage in WP4, WP5 and after the project

The manual will be used by the partners as a manual for digital learning introduction in WP4 and WP5. WP4 teaching-learning modules include one about digitalization (Tasks 4.1 and 4.2), where e-manual can be introduced to various STEM pre- and in-service teachers. WP4 introduces also acaSTEMy micro-credentials (Tasks 4.3 and 4.4), where two digitalization learning units are designed. E-manual will be a part of both of these learning units and proposed as learning and supportive material for the participants. In addition, the acaSTEMy micro-credentials have an output of lesson plans from the participants. With relevant consent of the participants, their lesson designs and usage of digital tools and resources could be used as an exemplary material in the e-manual to enhance the social and peer learning influence of the e-manual.

In the e-manual the UEF team has designed it so that feedback is asked about the usefulness of the manual page after the user has explored a topic or resource. This way the manual can be further improved upon, and users can also suggest other materials and tools to be incorporated in the e-manual, as well as provide their own pedagogical use-cases. Although the UEF team possesses a comprehensive knowledge about digital technologies, this way users of the e-manual can provide more information and ideas to help improve the e-manual further, especially during the piloting phase of the learning units, as well as after the project as the MCC programme is up and running.

References

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Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly*, *36*(1), 157–178. https://doi.org/10.2307/41410412

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Annex 1. Suggested content as digital tools from the partners.

Category	Description	Link
Concept Mapping		
CmapTools e CmapCloud	Concept maps creator	https://cmap.ihmc.us
Modelling Tools		
Tinkercad	3D design tool for STEM projects	https://www.tinkercad.com/
SketchUp	3D modeling software for engineering and design	https://www.sketchup.com/en
ChemSketch	Tool for drawing chemical structures	https://www.acdlabs.com/resources/free-chemistry-software-apps/chemsketch-freeware/
Thingiverse	Repository of 3D models	https://www.thingiverse.com/
Multimedia/Encyclopedia		
Khan Academy	Online educational organization with video lessons	https://www.khanacademy.org/
MERLOT	Curated collection of free learning materials	https://merlot.org/merlot/
Websites for Icons and pictures and videos	Resources for icons, pictures, and videos	flaticon.com, fontawesome.com, Biorender.com, chemix.org, unsplash.com, pexels.com, pixabay.com, mysimpleshow
Zooniverse	Platform for citizen science projects	https://www.zooniverse.org/
Simulations		
PhET Interactive Simulations	Free science and math simulations	https://phet.colorado.edu/hu/
Labster	Virtual lab simulations for science	https://www.labster.com/
Simbucket	Interactive science simulations	https://www.simbucket.com/
Algodoo	Physics simulation tool	https://www.algodoo.com/
GeoGebra	Dynamic mathematics software	https://www.geogebra.org/
Desmos	Advanced graphing calculator	https://www.desmos.com/

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Web 2.0 Apps		
Padlet	Collect ideas and collaborate	https://padlet.com
Edpuzzle	Add questions and annotations to videos	https://edpuzzle.com/
Learning Apps.org	Create small learning apps and games	https://learningapps.org/
Book Creator	Create learning environments	https://bookcreator.com/teachers/
AI and Language Models		
Leonardo AI	Image creation tool	https://app.leonardo.ai/ai-generations
Wolfram Alpha	Computational knowledge engine	https://www.wolframalpha.com/
PhotoMath	Scan handwritten equations for calculations	https://photomath.com
Programming		
Code.org	Learn coding and computer science	https://code.org/
Blockly Games	Educational games teaching programming principles	https://blockly.games/
SoloLearn	Learn different coding languages	https://sololearn.com
Quizzes and Tests		
Kahoot!	Gamified quiz platform	https://Kahoot.it
Quizizz	Interactive quiz platform	https://quizizz.com
Quizlet	Flashcard preparation tool	https://quizlet.com/
Mentimeter	Interactive voting and data collection	https://www.mentimeter.com/
AR and VR		
Google Earth	Geography-related science topics	https://earth.google.com/web/
Mol AR App	3D views of molecular structures	-
Beaker	Turns your phone into a virtual beaker	-

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Annex 2. Pedagogical approaches relevant to the e-manual according project partners.

Inquiry-Based and Problem-Based Learning	*Description*	Collaborative and Cooperative Learning	*Description*
Inquiry-Based Learning (IBL)	*Encourages students to ask questions and explore answers through guided experimentation and research.*	Collaborative Learning	*Promotes teamwork through shared digital platforms like Google Workspace or Microsoft Teams.*
Problem-Based Learning (PBL)	*Centers around real-world problems requiring interdisciplinary solutions.*	Cooperative learning	*Learners depend on each other and learn together and from one another.*
Project-Based Learning (PjBL)	*Students complete hands-on projects that integrate digital tools with STEM content.*	Self-directed learning	*Empowers learners to lead their own learning journey, offering opportunities for differentiation.*
STEM problem posing teaching approach	*Organizing learning where students develop skills to recognize STEM-based problems and challenges.*	Cross-Disciplinary Teaching	*Integrates STEM with non-STEM subjects like art or social studies to foster broader application.*
Experiential Learning	*Learning through doing, often supported by virtual labs and interactive simulations.*	STEM based learning based on participation of students and parents	*Involves both students and parents in the learning process.*
Context-based learning	*Puts the subject content in a meaningful context.*		

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Differentiated and Adaptive Learning	*Description*	Gamification and Design Thinking	*Description*
Differentiated Instruction	*Adapts content and methods to suit diverse learning needs, including digital tools for personalization.*	Gamification	*Incorporates game elements to boost motivation and engagement.*
Adaptive Learning	*Uses AI-driven tools like Smart Sparrow or Knewton to tailor content to individual student needs.*	Gamification strategies	*Uses game-based strategies to enhance learning.*
Scaffolded Instruction	*Gradually introduces complexity in STEM tools and methods, providing support as students develop proficiency.*	Flipped Classroom	*Teachers assign digital content for pre-class preparation and focus on hands-on activities or discussions in class.*
Differentiated learning	*Organizing learning units for groups of students at various STEM proficiency and literacy.*	Design Thinking	*Encourages students to use creative problem-solving skills through iterative prototyping, often supported by 3D design tools.*
STEM learning targeted to STEM gender-related inequalities and stereotypes	*Focuses on addressing gender-related issues in STEM education.*	STEM Integration	*Emphasizes cross-curricular connections between science, technology, engineering, and mathematics.*
		Engineering and Technology situational learning	*Organizes learning with a focus on applicability solutions in solving real problems.*

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Annex 3. Proposed overall structure ideas from the partners.

Practical Applications and Examples	*Description*	User Feedback and Customization	*Description*
Case Studies and Examples	*Include real-life examples of how tools and methods were successfully applied in lessons.*	Teacher Testimonials	*Include brief quotes or feedback from teachers who have successfully used the tools or methods.*
Downloadable Lesson Plans	*Offer sample lesson plans demonstrating tool integration.*	First page/slide	*Better put logos to the bottom like a legal notice; have a short 'welcome' video that explains a little what is going on in the e-manual.*
Short Video Tutorials	*Provide quick overviews of digital tools and their application in classroom settings.*	When hoovering over the first three buttons	*Provide a short summary/introducing sentence for each button.*
Classroom practice reports	*Concrete examples of the use of a given resource in the classroom.*	Right now, there is a 'congratulations' at the end	*Consider a loop so users can inform themselves about other things directly.*
		When clicking on the buttons	*Ensure users are directed to a new slide with different options.*
		Automatic translation	*Ensure the e-manual can be translated automatically.*
		Website tree	*Provide a website tree for navigation within the e-manual.*
		Clear overall visualization	*Build clear overall visualization of the structure of the manual.*
		Efficient structure of codes	*Assign clear and efficient codes to all parts of the manual.*

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Interactive and Visual Elements	*Description*	Content Organization and Accessibility	*Description*
Interactive Resource Map	*Use a visual map or table of contents linking to categories like simulations, virtual labs, and teaching tools.*	Quick Reference Tables	*Highlight key features, age groups, and curriculum relevance for each tool or method.*
Interactive Infographics	*Summarize key information visually, with clickable elements to access further details.*	Searchable Index	*Include a searchable database of tools categorized by subject, pedagogy, or teaching goals.*
QR Code Integration	*Link to external resources, video tutorials, or additional reading.*	Decision Trees	*Help teachers select tools or approaches based on their specific classroom needs.*
Interactive E-Manual App	*Develop an app version of the e-manual for mobile access with interactive elements like quizzes or activity recommendations.*	Checklists	*Create checklists for teachers to evaluate which tools align with their teaching objectives.*

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