OUR DIGITAL VILLAGE Co-designed digital education in rural areas

TRAINING OUTLINE

Erasmus + KA2: Partnership for innovation - Forward-looking Projects
Project Number: 101087107
D3.2 - Training Outline

Co-funded by the European Union

Document information		
Leader	FabLab / KMOP	
Contribution and Revision	All partners	
Call	ERASMUS-EDU-2022-PI-FORWARD-LOT1	
Project Number	101087107	

Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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Introduction

The Our Digital Village Project

Rapid digital transformation has influenced education, work and life and the Covid-19 pandemic has only highlighted more the divergences linked to digitisation in some territories, especially between urban and rural areas, and the need for innovation in education to respond to these challenges.

For this reason, Our Digital Village aims to intervene in rural areas by promoting the acquisition of digital and transversal skills, preparing people to face the challenges of the future. It will do so by co-creating high-quality educational content that responds to the needs of the local context, while simultaneously ensuring the long-term transformation towards digitalisation through active awareness raising on all levels of society.

Through self-analysis workshops, the intrinsic motivation to change will be explored, and the needs of each local context will be identified. These will be taken in mind while co-designing the educational materials, followed by a training for teachers and trainers to ensure their capacity to implement the co-designed activities with their learners.

The Training Outline

Description

Our Digital Village aims to create educational materials, which are adaptable to different educational and geographical contexts aiming to strengthen the digital and transversal skills of teachers, trainers, and learners. The present "Training Outline" provides a proposed training structure and materials for a 30-hour course. Its main objective is to equip teachers and trainers with the necessary skills and knowledge to implement the Our Digital Village Activity Kit, fostering the development of transversal and digital skills in both formal and non-formal educational settings. Please note that this Training Outline is not intended to be viewed as a curriculum dedicated to the educational ICT topics (Robotics, Coding, Microcontrollers, 3D modelling and printing, and web-development).

The Outline complements the Our Digital Village "Activity Kit" that includes practical ICT activities in the form of ICT challenges and pedagogical guidelines for the implementation of those activities in class. The Training Outline is composed

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of modules according to the topics covered by the Our Digital Village "Activity Kit". It covers:

- The importance of transversal and digital skills;
- Guidance on pedagogical methods that can be used with learners;
- Acquaintance with and detailed overview of the most attractive educational ICT topics, namely Robotics, Coding, Microcontrollers, 3D modelling and printing, and web-development;
- Guidance on the development of practical tasks with the use of the Outline and the Activity Kit;
- Assessment methods;
- Integration of Extra Resources.

Target Groups:

The Training Outline is primarily designed for educators, including teachers and trainers, who are looking to integrate digital education into their curricula. These educators are the direct target group of this training outline. The aim is to equip them with the necessary skills and knowledge to implement digital education sessions effectively within their schools/classes with young and adult learners. The training aims to enhance educators' ability to incorporate digital technologies into teaching, making learning more engaging and effective for students, by leveraging the Our Digital Village "Activity Kit." The educators will gain a deep understanding of digital education tools and strategies, enabling them to design and deliver lessons that not only impart digital literacy but also foster critical thinking, creativity, and problem-solving skills among learners.

Young (12+) and Adult Learners in formal and non-formal educational settings will also benefit significantly by the application of the Training Outline and the improved educational ICT practices. Learners will experience more innovative and effective teaching methods, making them better prepared for the demands of the digital age. By engaging with educators trained in the latest digital education techniques, learners will acquire essential skills that are crucial for academic success and future employment opportunities.

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This dual focus ensures that the Training Outline has a broad impact, directly enhancing the skill set of educators while indirectly benefiting learners by providing them with a more enriching and relevant educational experience.

Estimated Duration: 30 hours

Training Outline Learning Objectives

By the end of this training, participants will be able to:

- Evaluate the significance of transversal and digital skills in education.
- Apply pedagogical strategies to integrate digital and transversal skills into teaching practices.
- Effectively implement the Our Digital Village Activity Kit in both formal and non-formal educational settings.
- Develop practical tasks aligned with the acquired skills for classroom application.

Syllabus Overview

Module 1: Transversal and Digital Skills

- **Duration:** 1.5 hours
- **Learning Objectives:**
  - Define and differentiate between transversal and digital skills thus ensuring understanding of participants.
  - Analyse the significance of transversal and digital skills in education.
  - Evaluate the Our Digital Village Activity Kit as a resource for skill development at an evaluation level.

Module 2: Pedagogical Application

- **Duration**: 2.5 hours
- **Learning Objectives:**
  - Incorporate learning objectives into training sessions.
  - Familiarise with teaching methods and apply methodological approaches for digital education training.
  - Approach topics based on the learning needs of learners.

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- Structure training and develop a lesson plan for effective implementation.

Module 3: Exploring Attractive Technologies

- **Duration:** 20 hours
- **Learning Objectives:**
  - Build STEM Proficiency, promoting teamwork and creativity
  - Identify the basic principles of robotics.
  - Apply beginner, intermediate, and advanced robotics concepts through hands-on activities.
  - Understand fundamental coding concepts.
  - Demonstrate coding proficiency through practical exercises.
  - Understanding the functionality of microcontrollers.
  - The use of microcontrollers in practical educational activities.
  - Outline the basics of 3D modelling and printing.
  - Create 3D models using various proficiency levels.
  - Define the basics of web development.
  - Develop web-based projects at beginner, intermediate, and advanced levels.

Module 4: Practical Task Development

- **Duration:** 1.5 hours
- **Learning Objectives:**
  - Design practical tasks aligned with skills covered.
  - Use the Activity Kit ICT Challenges.
  - Adapt activities to education contexts.

Module 5: Assessment Strategies

- **Duration:** 2 hours
- **Learning Objectives:**
  - Identify and differentiate Assessment Types: Clearly understand the roles of diagnostic, formative, and summative assessments in digital learning.

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- Implement Assessment Strategies: Apply practical tools and techniques for effective assessment, including real-time feedback and personalised instruction.
- Create Personalised Learning Paths: Use diagnostic data to adapt learning experiences to individual student needs.
- Boost Engagement and Achievement: Employ strategies that enhance engagement and monitor progress to improve learning outcomes.

Module 6: Extra Resources Integration

- **Duration:** 1.5 hours
- **Learning Objectives:**
    - Identify and explore additional resources for self-study.
    - Evaluate the relevance of books, articles, apps, e-courses, videos, and podcasts.
    - Clarify questions and concerns regarding extra resources.

Lessons Learnt

- **Duration:** 1 hour
- **Learning Objectives:**
    - Summarise key concepts and skills covered.
    - Encourage participants to implement the Our Digital Village Activity Kit.
    - Provide information on ongoing support, community forums, and follow-up sessions.

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Trainer Profile (Guide for the selection of trainers)

The following table was created as **a guide to assist** in the selection of trainers.

For each topic, the table describes competencies across **three different levels**.

	Level of skills:		
Topics:	**Essential skills**	**Recommended skills**	**Preferred skills**
3D printing	Basic computer literacy (e.g., navigating file systems, downloading, and installing software). Understanding of geometric concepts (e.g., dimensions, measurements)	Basic knowledge of a 2D or 3D modelling software. Basic Knowledge of 3D printing technologies.	Familiarity with 3D CAD software. Experience with 3D scanning technologies and software. Understanding of engineering principles and materials science.
Coding	Basic computer literacy (e.g., navigating file systems, downloading, and installing software). Understanding of algorithms	Understanding of fundamental programming concepts (e.g., variables, loops, conditionals) and ability to write and execute simple programs Experience with visual programming environment	Familiarity with one or more programming languages. Ability to create and modify complex programs using one or more programming languages

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Robotics	Basic computer literacy (e.g., navigating file systems, downloading, and installing software). Basic understanding of robotics kits and components	Experience with robotics programming software (e.g., Scratch for Robotics). Ability to build and program robots from educational robotics kits.	Ability to design and build custom robots using robotics kits and components
Microcontrollers	Basic computer literacy (e.g., navigating file systems, downloading, and installing software). Knowledge of basic electronics concepts (e.g., circuits, voltage, current)	Understanding of basic programming concepts (e.g., variables, loops, conditional statements). Ability to design and build simple circuits using breadboards and basic components (e.g., resistors, capacitors, LEDs).	Ability to troubleshoot and debug simple hardware and software problems. Familiarity with more advanced electronics concepts (e.g., sensors, actuators, transistors).
Web Development	Basic computer literacy (e.g., navigating file systems, downloading, and installing software).	Understanding of fundamental programming concepts (e.g., variables, loops, conditionals) and ability to write and execute simple programs	Understanding the difference between front-end and back-end. Knowing how to create a complete web application using a framework.

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	Understanding of basic web development languages (HTML, CSS)	Experience with visual programming environment. Experience with JavaScript	Experience with at least SQL and database creation and PHP.

How to implement this Training Outline

The Training Outline serves as a framework designed to prepare educators for delivering digital education sessions to their students. To use the Outline effectively, trainers/educators should:

- Familiarise with the Content: Understand each module's learning objectives, activities, and resources.
- Prepare the Environment: Ensure all technological and educational materials are in place for the training sessions.
- Adapt to Learning Contexts: Customise the activities and examples to align with the specific needs of their student demographics and educational settings.
- Reflect and Feedback: Use the 'Lessons Learnt' module as a reflective practice tool, encouraging educators to share their experiences and takeaways.

Flexibility in Delivery

The training outline is designed with a degree of flexibility to adapt to the needs and interests of the participants. While the total duration is estimated at 30 hours, trainers/educators can adjust the length of individual sessions to ensure that participants achieve the learning objectives while also accommodating their schedules. The following principles should guide adjustments:

- Adjustable and Participant-Centred: Allow the time dedicated to each module or technology to be adjusted based on participants' needs and interests.
- Blended Learning: Incorporate a mix of online theoretical components and in-person practical sessions to optimise learning experiences.

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- Content Coverage: Ensure all critical aspects of the modules are covered, even if this means extending certain sessions.
- Feedback-Informed: Modify session lengths based on feedback received in the 'Lessons Learnt' module.
- Activity Flexibility: Be open to modifying the activities within the modules to better suit the needs of the trainees.

Workload

The training is structured to be completed within 30 hours. This includes:

- No Additional Work: Ensure that the outlined hours include all necessary work and that there are no expectations of significant extra work outside of these hours.
- Equitable Distribution: Distribute the workload respectively across the modules, with a balance between theoretical and practical components.
- Workload Management: Be mindful of the workload, ensuring that it is manageable and does not overburden participants.

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Module 1: Transversal and Digital Skills (1.5 hours)

Learning Objectives

- Define and differentiate between transversal and digital skills thus ensuring understanding of participants.
- Analyse the significance of transversal and digital skills in education.
- Evaluate the Our Digital Village Activity Kit as a resource for skill development at an evaluation level.

Overview of the importance of transversal and digital skills in modern education

Transversal and digital skills are increasingly recognised as essential components of modern education due to their relevance in preparing individuals for success in the 21st century.

These skills are essential for young and adult learners to thrive in an increasingly digital and interconnected world.

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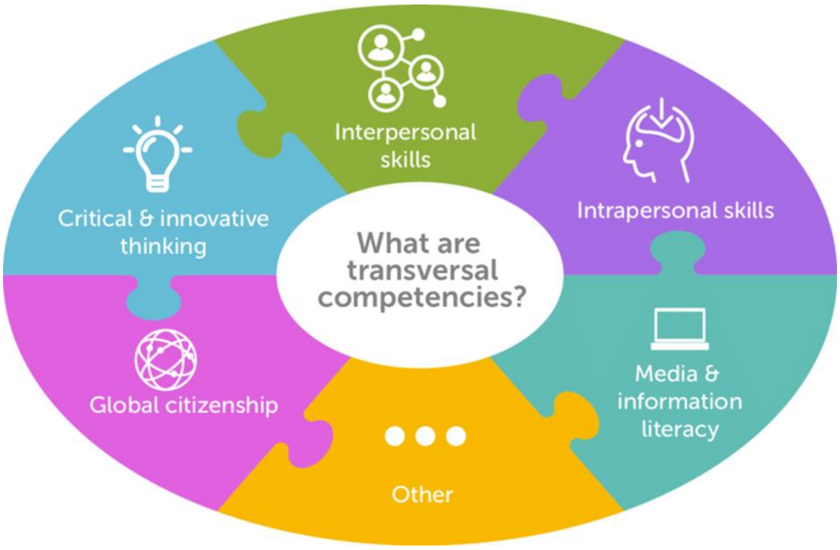
1. Transversal Skills (Soft Skills or Life Skills):



Source: UNESCO, Assessment of Transversal Competencies: Policy and Practice in the Asia-Pacific Region, 2016

Definition: Transversal skills, also known as soft skills or life skills, are a set of personal qualities and attributes that enable individuals to interact effectively with others, adapt to different situations, and navigate various life challenges. (*Source: UNESCO 2016, School and teaching practices for twenty-first century challenges)*

Examples: Communication, critical thinking, problem-solving, creativity, adaptability, teamwork, emotional intelligence, time management, and leadership.

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2. Digital Skills:

Source: Essential digital skills for a new generation: the importance of starting early, by Kiera Sowery, April 2023

Definition: Digital skills are defined as a range of abilities to use digital devices, communication applications, and networks to access and manage information. They enable people to create and share digital content, communicate, and collaborate, and solve problems for effective and creative self-fulfilment in life, learning, work, and social activities at large. (Source: UNESCO, Digital skills critical for jobs and social inclusion, updated April 2023)

Examples: Proficiency in using software programs (e.g., Microsoft Office, Adobe Photoshop), coding and programming skills, data analysis, digital literacy, internet research, cybersecurity awareness, and social media management.

3. Transversal and Digital Skills Differences

Nature:

- Transversal skills are personal and interpersonal qualities that relate to how individuals interact with themselves and others in various life situations.
- Digital skills are technical abilities that pertain to the use and manipulation of digital technologies and tools.

Applicability:

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- Transversal skills are applicable in both digital and non-digital contexts. They are essential for success in personal, academic, and professional aspects of life.
- Digital skills are primarily used in digital environments and are focused on tasks that involve technology and digital tools.

Examples:

- Transversal skills include communication and teamwork, which are valuable in face-to-face interactions, as well as in online collaboration.
- Digital skills encompass activities like coding, data analysis, and using specific software applications, which are specific to digital technology.

Universality:

- Transversal skills are universal and timeless, as they are valuable across different cultures and time periods.
- Digital skills may vary in relevance and specificity depending on the technology trends and tools of a particular era.

In summary, transversal skills are personal qualities that help individuals succeed in various aspects of life, while digital skills are technical competencies related to working with digital technologies. Both types of skills are important nowadays, as they complement each other and contribute to an individual's overall ability to thrive in today's digital and interpersonal environments.

Here it is an overview of transversal and digital skills importance (Source: Education Science, 2018):

- ➢ **Adaptation to Technological Advancements:** Digital skills are vital in today's technology-driven society. They empower individuals to adapt to rapidly evolving technologies, software, and digital tools. Learners who possess these skills are better equipped to embrace and excel in the digital age.
- ➢ **Employability and Career Opportunities:** Transversal and digital skills are highly sought after by employers across various industries. Proficiency in digital tools, data analysis, coding, and other tech-related skills enhances learners' employability and opens a broader range of career opportunities.
- ➢ **Enhanced Learning and Information Access:** Digital skills enable learners to access a vast amount of information and educational resources online. They can engage in self-directed learning, research, and collaboration, which expands their knowledge and learning experiences beyond the classroom.

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- **Critical Thinking and Problem-Solving:** Transversal skills like critical thinking, creativity, and problem-solving are essential in today's complex world. Digital tools can be used to facilitate these skills through interactive learning experiences, simulations, and real-world problem-solving scenarios.
- **Emotional intelligence** is a transversal skill, which is essential for fostering healthy relationships, effective communication, conflict resolution, leadership, stress management, and overall personal and professional success. It is a valuable skill that can be developed and nurtured to improve various aspects of one's life.
- **Communication and Collaboration:** Digital skills include effective communication in various digital mediums, which is essential for collaboration in both academic and professional settings. learners can work on group projects, share ideas, and collaborate with peers globally, preparing them for the interconnected nature of modern workplaces.
- **Digital Citizenship:** Teaching digital skills also includes fostering responsible digital citizenship. learners learn about online ethics, privacy, security, and digital etiquette, which are vital for their safety and responsible use of digital technologies.
- **Access to Educational Resources:** Digital skills are crucial for accessing and benefiting from online educational resources and platforms. They enable learners to engage with Massive Open Online Courses (MOOCs), educational apps, and e-books, democratising access to quality education.
- **Global Competence:** Transversal skills such as cultural awareness, empathy, and adaptability are essential for global competence. In a connected world, learners need to understand and respect diverse perspectives and cultures, which can be fostered through digital collaboration with peers from around the world.
- **Future-Proofing:** As the job market continues to evolve, the skills required for success may change. Transversal and digital skills provide a foundation that allows learners to adapt to new challenges and opportunities, helping them remain competitive in an ever-changing job landscape.

In summary, transversal, and digital skills are vital components of modern education. They empower learners to adapt to technological advancements, enhance employability, access a wealth of information, develop critical thinking and problem-solving abilities, communicate effectively, become responsible digital citizens, and prepare for global challenges. These skills not only benefit learners academically but also prepare them for success in the digital age and beyond.

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Methodological insights for effective attainment of transversal and digital skills in formal and non-formal education contexts

Attaining transversal (soft) and digital skills in both formal and non-formal education contexts require careful planning and implementation. Here are some methodological insights to effectively develop these skills (Source: Viana, J., Peralta, H., & Costa, F. (2017). Digital Non-formal Education as an Opportunity to Transform School. Better e-learning for innovation in education)

For Transversal Skills:

- ➢ **Integration into Curriculum:** Embed transversal skills like critical thinking, communication, teamwork, and problem-solving into the formal curriculum. Create lesson plans and activities that explicitly target the development of these skills.
- ➢ **Relevance and Contextualization**: Ensure that transversal skills instruction is relevant, meaningful, and applicable to students and adult learners' everyday lives, work environments, and personal goals. Use real-life examples, case studies, and practical exercises that resonate with students and adult learners' experiences and interests.
- ➢ **Experiential Learning:** Encourage hands-on, experiential learning experiences. Practical exercises, projects, and simulations provide opportunities for all learners to apply and enhance their transversal skills in real-world scenarios.
- ➢ **Promote Active Learning**: Emphasise hands-on, experiential learning approaches that engage students in problem-solving, decision-making, and reflection. Encourage inquiry-based learning, project-based learning, and cooperative learning strategies that foster active participation and deeper understanding of concepts.
- ➢ **Flexible Learning Pathways**: Offer flexible learning pathways and formats that accommodate students and adult learners' diverse schedules, preferences, and learning styles. Provide options for self-paced study, evening classes, weekend workshops, online courses, and blended learning models to accommodate learners' busy lifestyles and commitments.
- ➢ **Personalised Instruction**: Tailor instruction and support to meet the individual needs, preferences, and learning styles of students or adult learners. Provide personalised feedback, coaching, and mentoring to help learners identify their strengths, areas for growth, and strategies for improvement.
- ➢ **Interdisciplinary Approach:** Promote an interdisciplinary approach to education, where learners can see the connections between different subjects and how transversal skills are applicable across various domains.

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- **Peer Learning and Networking**: Facilitate peer learning, collaboration, and networking opportunities among students and adult learners to promote social interaction, knowledge sharing, and community building. Create forums, discussion groups, and study circles where learners can exchange ideas, support each other, and learn from diverse perspectives.
- **Recognition of Prior Learning:** Recognise and value students and adult learners' prior experiences, skills, and knowledge acquired through formal and informal learning contexts. Offer opportunities for learners to earn credits, credentials, or certifications based on their demonstrated competencies and achievements.
- **Assessment:** Develop assessment methods that evaluate not only subject knowledge but also transversal skills. Use rubrics and peer or self-assessment to measure learners' progress in these areas.
- **Collaboration:** Encourage collaboration among learners through group projects and activities. Teamwork and communication skills can be honed through working with peers.
- **Continuous Assessment and Feedback**: Implement ongoing assessment and feedback mechanisms to monitor learners' progress, assess skill development, and provide timely support and guidance. Use formative assessment methods, self-assessment tools, and performance-based evaluations to track learning outcomes and adjust instruction as needed.

By incorporating these methodological insights into formal and non-formal education contexts for students, adult learners, educators, and program providers can create effective learning environments that empower learners to develop and apply transversal skills for personal growth, career advancement, and active participation in society.

For Digital Skills:

- **Assessment of Digital Literacy Levels:** Begin by assessing the digital literacy levels of students and/or adult learners to identify their existing knowledge, skills, and competencies related to technology use. Use surveys, diagnostic tests, or interviews to assess learners' proficiency with basic digital tools, software applications, internet navigation, and online communication.
- **Targeted Curriculum Design:** Develop a curriculum that is specifically designed to address the digital skills needs of students or adult learners. Focus on practical, relevant, and job-related digital competencies that are aligned with learners' educational goals, career aspirations, and everyday life activities.

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- **Flexible Delivery Modes:** Offer flexible delivery modes and learning formats that accommodate adult learners' diverse needs, preferences, and schedules. Provide options for face-to-face instruction, online courses, blended learning models, self-paced study, and evening or weekend classes to accommodate learners' work, family, and other commitments.
- **Personalised Support:** Provide personalised support and guidance to help students/adult learners overcome digital literacy barriers and challenges. Offer one-on-one tutoring, coaching, or mentorship to address individual learning gaps, provide technical assistance, and build learners' confidence in using digital tools effectively.
- **Contextualized Learning Contexts**: Embed digital skills instruction within relevant and meaningful contexts that resonate with students/adult learners' interests, goals, and real-world experiences. Integrate technology-enhanced activities into vocational training, workforce development programs, adult literacy classes, and community-based initiatives to make learning more engaging and applicable.
- **Collaborative Learning Opportunities:** Foster collaborative learning environments where adult learners can collaborate, share ideas, and learn from each other's experiences. Encourage peer-to-peer support, group projects, and collaborative problem-solving activities that leverage the collective knowledge and expertise of the learner community.
- **Continuous Feedback and Assessment**: Provide regular feedback and assessment opportunities to monitor learners' progress, identify areas for improvement, and celebrate achievements. Use formative assessments, quizzes, performance tasks, and self-assessment tools to track learners' digital skills development and adjust instruction as needed.
- **Digital Literacy Programs:** Implement structured digital literacy programs in both formal and non-formal settings to ensure that learners are familiar with basic digital tools, online safety, and responsible internet use.
- **Technology Integration:** Incorporate technology into the learning process. This can include using educational software, online resources, and digital tools to enhance engagement and learning.
- **Hands-On Practice:** Provide ample opportunities for hands-on practice with digital tools and platforms. Learners should be encouraged to create digital content, solve problems using technology, and experiment with various digital resources.
- **Cybersecurity and Digital Ethics:** Include modules on cybersecurity and digital ethics to ensure that learners understand the importance of responsible digital behaviour and are aware of potential risks.

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- **Adaptability and Continuous Learning:** Emphasise the importance of adaptability and continuous learning in the digital age. Encourage learners to stay updated with emerging technologies and tools.
- **Integration of Lifelong Learning Principles:** Promote a culture of lifelong learning and ongoing skill development among adult learners by emphasising the importance of continuous learning and adaptation in a rapidly evolving digital landscape. Encourage learners to explore new technologies, stay informed about digital trends, and seek out professional development opportunities to remain competitive in the digital age.

By implementing these methodological insights in formal and non-formal education contexts for students and adult learners, educators and program providers can effectively support the acquisition and application of digital skills, empowering adults to thrive in an increasingly digital world.

General Insights:

- **Personalised Learning**: Recognise that different learners may have varying levels of proficiency and comfort with transversal and digital skills. Tailor instruction to meet individual needs.
- **Inclusivity**: Ensure that all learners, regardless of their background or abilities, have access to opportunities for skill development. Consider support for diverse groups (minorities, migrants, other vulnerable groups).
- **Teacher Training:** Invest in professional development for educators to equip them with the knowledge and skills required to effectively teach transversal and digital skills.
- **Real-world Context:** Connect the development of these skills to real-world applications and scenarios. Show learners how these skills are relevant in their daily lives and future careers.
- **Assessment and Feedback:** Provide regular feedback to learners on their progress in developing these skills. Encourage self-reflection and self-assessment.
- **Continuous Improvement:** Continuously evaluate and refine the methods and resources used to teach transversal and digital skills based on feedback and evolving educational technology.

By integrating these methodological insights, formal and non-formal education contexts can effectively foster the development of transversal and digital skills, equipping learners with the abilities they need for success in the 21st century.

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Module 2: Pedagogical Application (2.5 hours)

Learning Objectives

- Incorporate learning objectives into training sessions.
- Familiarise with teaching methods and apply methodological approaches for digital education training.
- Approach topics based on the learning needs of learners.
- Structure training and develop a lesson plan for effective implementation.

In Module 2, our focus is on the effective integration of learning objectives into training sessions, the nuanced approach to topics based on the diverse learning needs of learners, and the synthesis and structuring of training sessions, including the development of a comprehensive lesson plan for optimal implementation.

Integrating Learning Objectives into Training Sessions

At the core of successful digital education lies the alignment of learning objectives with training sessions. This involves a thoughtful consideration of what participants need to achieve and how each session contributes to those overarching goals. To ensure coherence, instructors must clearly communicate these objectives at the outset of each session, providing a roadmap for participants to understand the purpose and expected outcomes.

1. Clarifying Learning Objectives:

- Clearly define the learning objectives for each session, specifying the skills and knowledge participants should acquire.
- Communicate these objectives explicitly at the beginning of each session to set clear expectations.

2. Aligning with Overall Goals:

- Ensure that learning objectives align with the broader goals of the comprehensive training program.
- Demonstrate how each session contributes to the overarching goal, creating a cohesive learning journey.

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3. Assessing Understanding:

- Implement periodic checks to gauge participants' understanding of the learning objectives.
- Be prepared to adjust the session pace or content delivery based on the feedback received during these checks.

4. Practical Application:

- Relate learning objectives to real-world scenarios, emphasising the practical application of acquired skills.

This practice not only fosters engagement but also sets the stage for an effective transfer of knowledge.

Teaching methods and approaches for digital education training

In the ever-evolving landscape of digital education, mastering diverse and innovative teaching methodologies is paramount for fostering a holistic learning experience. The ICT Challenges as well as the proposed teaching methodologies presented in the Activity Kit serve as a conduit for integrating various approaches that not only enhance technical proficiency but also instil critical thinking, collaboration, and problem-solving skills essential for the digital era. In the Activity Kit, the following teaching methodologies are proposed:

- **Project-Based Learning (PBL)** immerses learners in hands-on, real-world projects mirroring challenges encountered in personal or professional settings. Whether constructing a robot, crafting a coding application, or designing a 3D-printed model, each ICT challenge unfolds as a comprehensive project. PBL encourages experiential learning, allowing learners to delve into complex problems, collaborate with peers, and apply their digital skills practically, fostering a deeper understanding. The educational goal is to cultivate learners' creative capacity, navigating ill-structured problems within small teams. PBL thrives on creativity and collaboration, offering valuable opportunities for learners to make connections across content and practice.
- **Problem-Based Learning** is a complementing approach to PBL, framing ICT challenges as authentic problems awaiting innovative solutions. This pedagogical approach fosters active learning by immersing learners in meaningful problem-solving experiences. The methodology prompts learners to analyse, research, and devise

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practical solutions to real-life scenarios, cultivating critical thinking and decision-making abilities. The iterative PBL process involves problem analysis, self-directed learning, and reporting, with a tutor guiding and facilitating learners' inquiry paths. Problem-Based Learning within the Activity Kit transforms the learning process into a dynamic exploration of real-world challenges.

- **Collaborative learning** stands as a pillar of effective digital education. Within the ICT Challenges, group work is integrated to encourage learners to share insights, pool strengths, and collaboratively address challenges. Collaborative learning involves two or more learners working together to jointly solve a group task, relying on knowledge sharing to build common ground and collective understanding. It goes beyond mere cooperation, involving joint knowledge construction, enhancing not only technical skills but also effective communication and teamwork.
- **Inquiry-Based Learning (IBL)** is encouraging learners to ask questions, explore possibilities, and conduct independent research fosters curiosity and self-directed learning. IBL empowers learners to take initiative in their education, promoting a deeper understanding of digital concepts and instilling a lifelong passion for learning and discovery. The IBL process involves learners posing questions, investigating topics, and seeking answers through hands-on experiences, promoting a deeper understanding of subjects.

Further, teaching digital technologies effectively requires a combination of technical knowledge and non-technical skills. Beyond technical proficiency, non-technical skills, often referred to as soft skills, play a crucial role in digital education. These skills encompass behavioural and personal skills, cross-sectional and basic work skills, and soft and method skills. These non-technical skills are essential for creating a positive learning environment, fostering learners' engagement, and supporting the development of essential skills beyond technical expertise.

For effective teaching in the digital realm, educators must embody and impart these non-technical skills to learners:

- **Active Listening:**

Active listening involves giving full attention to a speaker, processing the information received, and responding with pertinent comments and appropriate

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questions. Active listening is essential for the development of facilitative and collaborative teams. It contributes to the effectiveness of group communication and is crucial for group functioning.

- **Communication Skills:**

General communication skills are fundamental non-technical skills that IT professionals must possess. This includes both traditional communication skills and the ability to communicate via new technologies.

- **Understanding and Using Communication Technologies:**

Essential for the long-term achievement in IT projects. Given the global scope of IT initiatives, innovative use of technology-based communications has become imperative. Knowledge sharing through communication technologies creates shared understanding, context for organisational knowledge, and facilitates collaboration.

- **Creative Thinking and Ideation:**

Creative thinking involves the generation of new and innovative ideas. Ideation is the process of developing and communicating a new idea. Creative and innovative uses of IT are essential for creating a competitive advantage and inspiring new ideas.

- **Critical Thinking Skills:**

Critical thinking is reflective and reasonable thinking focused on what to believe or do. It includes the ability to test assumptions, make critical evaluations, and critically review systems approaches. Essential for the implementation of thorough and effective IT systems. Critical thinkers can contribute to the development of a learning organisation, fostering double-loop learning and knowledge creation.

- **Understanding Diversity:**

Diversity can impact project team perceptions and end-user perceptions. Gender and cultural differences have major impacts on communication and group

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processes. It is necessary to have the ability to identify opportunities arising from diverse individuals' involvement in IT planning and execution.

- **Interpersonal Skills**

Relationship quality, including interpersonal communications, trust, and overall satisfaction, is vital for an IT professional's success.

- **Problem-Solving Skills:**

Important for developing and implementing complex IT projects. It involves integrating information from various sources to improve organisational performance.

- **Ethics:**

A comprehensive understanding of ethics, including the ethical implications of IT, is crucial for developing ethical IT professionals and leaders.

Approaching Topics Based on the Learning Needs of Learners

Understanding the diverse learning needs of participants is paramount. By incorporating elements of design thinking and emphasising non-technical skills or soft skills, trainers can create an inclusive learning environment. This adaptability ensures that the content resonates with the audience, making the educational experience more meaningful and relevant to their individual contexts. Trainers should consider the following elements:

1. Recognizing Diverse Learning Styles:

- Recognise and acknowledge diverse learning styles within the group.
- Tailor content delivery methods to appeal to visual, auditory, and kinaesthetic learners.

2. Prioritising Inclusivity:

- Employ a mix of instructional methods, such as lectures, group discussions, hands-on activities, and multimedia presentations.

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- Ensure materials and activities are accessible to participants with varying levels of prior knowledge and skills.

3. Apply Participatory Teaching Methods:

- Encourage participants to engage in problem-solving activities that mirror real-world challenges.
- Integrate creative elements into the learning process, fostering an environment where innovative thinking is valued.
-

4. Soft Skills Emphasis:

- Emphasise the importance of effective communication skills, both in the context of digital education and broader professional settings.
- Promote collaborative learning experiences to enhance interpersonal skills and teamwork.

5. Continuous Feedback Mechanism:

- Establish a feedback loop to gather insights from participants on their learning preferences.
- Use this feedback to adapt teaching approaches and materials throughout the course.

Synthesising and structuring a Training session on digital education

To optimise the learning journey, trainers should proficiently synthesise information and structure sessions in a coherent and progressive fashion. A meticulously designed lesson plan serves as the cornerstone of a fruitful training session. Crafting an effective lesson plan entails dissecting content into manageable segments, integrating interactive components, and allowing room for reflection and discussion. A comprehensive lesson plan encompasses well-defined objectives, appropriate teaching methodologies, and flexible strategies tailored to meet participants' evolving needs. This systematic approach involves considerations such as allocated time, participant engagement techniques, and the integration of the Our Digital Village Activity Kit. Lesson Plan templates for all levels of learners (beginners, intermediate, advanced) are available in the Activity Kit, providing a practical tool to streamline the planning process and ensuring consistency in delivering impactful training sessions.

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Additionally, intertwining practical activities with theoretical concepts is a key strategy for creating a dynamic and captivating learning experience in digital education training. To achieve this balance in drafting your training session using the Activity Kit, consider the following elements:

1. **Identify Learning Objectives:** Clearly choose the learning goals you wish your learners to achieve through each session. Understand the key theoretical concepts that participants need to grasp.
2. **Select Appropriate Practical Activities**: Choose practical activities that directly relate to the theoretical content and the level of your learners.
3. **Seamless Integration**: Ensure that practical activities seamlessly integrate with the theoretical content. Activities should not feel like isolated exercises but rather extensions of the concepts being discussed.
4. **Link Practical Insights to Theory:** During and after each activity, explicitly connect the practical insights gained with the underlying theoretical frameworks. Help participants see the direct relevance and application of what they are learning.
5. **Encourage Reflection**: Build reflective components into the sessions. After completing a hands-on task, prompt participants to reflect on what they learnt and how it connects to the theoretical knowledge presented.
6. **Promote Active Participation and Create a Collaborative Environment:** Design sessions and apply teaching methodologies that encourage active participation. Foster collaboration among participants during practical activities so that individuals can learn from each other's perspectives and experiences.
7. **Offer Ongoing Support:** Provide support and guidance as participants engage in practical activities. Address questions, offer feedback, and create an environment where learners feel comfortable exploring and applying new concepts.
8. **Adapt to Participants' Pace:** Be flexible in adapting the pace of practical activities based on participants' understanding. Allow for additional exploration if certain concepts require more attention.
9. **Assess Understanding Through Activities**: Use the practical activities as opportunities for formative assessment. Observe how participants apply theoretical concepts in their hands-on tasks and provide constructive feedback.

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Module 3: Exploring Attractive Technologies (20 hours)

3.1 Robotics (4 hours)

Learning Objectives:

- Build STEM Proficiency, promoting teamwork and creativity
- Identify the basic principles of robotics.
- Apply beginner, intermediate, and advanced robotics concepts through hands-on activities.

Introduction to educational robotics

*"Robotics education is usually conceived as a two-fold mission: education **in** robotics and education **with** robotics. The **in** case promotes knowledge and understanding of the design, analysis, application, and operation of robots; the **with** concept is broader and entails the use of robotics as a tool for teaching and learning science, technology, engineering, arts, and math (STEAM) subjects and developing 21st-century skills: creativity, problem-solving, critical thinking and teamwork(...)"*
(Dimitris ALIMISIS - Technologies for an inclusive robotics education - 2021)

Educational robotics stands out as an important and engaging methodology for learning, embracing the dual purpose of acquainting with robots and transferring STEAM skills. Through hands-on projects, learners not only explore the mechanics of robots but also cultivate key abilities, such as programming and creative problem-solving. This practical approach fosters active learning, sparking curiosity and contributing to the formation of individuals with multifunctional skills essential for success in an increasingly complex technological landscape. Educational robotics becomes an exciting bridge between theory and practical application in the STEAM disciplines.
All this is extremely useful also for adult learners, as the growth in understanding and applying computational thinking, which permeates all digital STEM disciplines, can be an excellent tool for tackling challenges related to the world of work. Knowledge of these disciplines can be an important aspect of a resume and therefore useful for entering the job market.
Preparing teachers and trainers for the world of educational robotics involves practical steps to ensure a smooth journey. Robotics kits, think of them as toolsets, come with programmable parts and sensors, making the learning process hands-on and accessible. Starting with simple robot assembly, teachers and trainers gradually introduce coding, making it feel like learning a new language in easy steps. As activities progress, learners move into more intricate

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coding, using sensors to create interactive experiences. Teachers and trainers can find a wealth of resources online, from tutorials to lesson plans, supporting them in crafting engaging and educational experiences. These resources cover a range of activities suitable for workshops and courses, progressing from basic tasks to more complex challenges.
For instance, teachers and trainers can guide learners through fun challenges that encourage creative problem-solving, enhancing adaptability. Workshops can delve into advanced tasks like autonomous navigation, refining both coding and practical problem-solving skills. This step-by-step approach empowers educators to seamlessly integrate educational robotics into lessons, fostering a comprehensive STEAM learning experience. The hands-on approach not only demystifies technology but also cultivates an engaging environment where learners thrive in acquiring both technical and soft skills crucial for their future journeys. Overall, by providing accessible kits, online resources, and progressively challenging activities, educators can confidently navigate the exciting realm of educational robotics, creating dynamic and enriching learning experiences.

Overview of the most commonly used educational robotics kits

Educational robotics kits typically come in assembly boxes, providing a comprehensive package for learners to delve into the world of robotics. These kits are designed to facilitate hands-on learning, catering to various skill levels and age groups. In these kits, you'll find an array of components, ranging from programmable hubs to sensors, actuators, and an assortment of building blocks to construct different robot variations.

The *programmable hub* serves as the brain of the robot, allowing learners to input commands and control the robot's actions. Sensors, a vital part of the kit, enable the robot to perceive its environment. Common sensors include proximity sensors, which detect nearby objects, and light sensors that measure ambient light levels. Touch sensors respond to physical contact, while gyroscopes aid in detecting orientation and movement.

Actuators, another crucial component, bring the robot to life by converting digital commands into physical movements. Motors are commonly included, allowing learners to explore the mechanics of motion. *Wheels and gears* offer possibilities for designing mobile robots, fostering an understanding of engineering principles. The kit often includes an assortment of building pieces, allowing learners to physically construct their robots. This hands-on approach enhances spatial awareness and fine motor skills, contributing to a holistic learning experience.
Instructions, usually provided in both printed and online formats, guide learners through the assembly process. Clear, step-by-step guidance simplifies the construction, ensuring that learners can focus on understanding the mechanics rather than getting bogged down by complexity. Online resources, frequently

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offered in the form of tutorials and interactive platforms, play a crucial role in supporting both teachers and learners.

Lesson plans are often structured based on difficulty levels, accommodating various learning stages. Educators can tailor the lessons to their learners' proficiency, moving from basic assembly to more advanced programming. The curriculum typically incorporates both physical construction and programming components, creating a well-rounded educational experience.
Programming in educational robotics is often facilitated through *block-based languages,* specifically designed to be user-friendly, even for beginners. These visual programming languages employ drag-and-drop blocks, each representing a specific command or function. This approach simplifies the coding process, making it accessible and engaging for learners without the need for prior coding experience.

			
Programmable HUB	Sensors	Actuators (motors)	Block-based language

User guide for hands-on coding activities for varying skill levels

There are various brands and models of educational robotics kits, many of which include assembly boxes, while some come with pre-built robots ready for programming. Since the principles of use, logic, and the type of activities are similar, in this chapter, we will refer to a specific robotics kit without mentioning commercial names. However, it should be understood that all the concepts outlined below can be applied to the majority of kits available on the market.

Preliminary Operations and Basic-Level Activities

The initial steps for using a robotics kit typically involve **preliminary operations**, such as reorganising the components in the assembly box and accessing resources like the programming app, assembly instructions, and a potential repository of suggested activities with step-by-step instructions.
Begin by organising the kit's components, becoming familiar with each part, port, cable, sensor, and actuator. This preliminary operation lays the foundation for a hassle-free assembly process.

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Guidance is key, and resources for instructions are readily available, either online or through other accessible means. **Teachers, trainers, and learners should locate instructional materials** to assist in assembling the kit, understanding activities, and navigating the basics of programming.

Just hub and motor, first experience

Initiate your journey by **making the first connections and creating basic programs to test individual components**. This hands-on approach allows you to witness how sensors respond to environmental cues, how actuators follow commands, and how different parts collaborate. It's a foundational step that sets the stage for more complex operations.

An **initial exercise** could then typically involve **connecting the programmable hub to a single motor** and constructing a simple code to make it move. Repeating this operation helps understand the functioning and programming blocks involved in using various sensors and actuators included in the kit.

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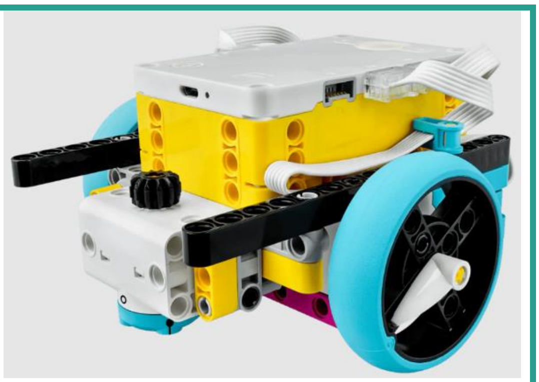
First robots

Moving forward, delve into the **assembly of simple robots**. This tactile activity not only solidifies understanding but also sparks creativity. Physically construct basic robots using the assembled components, and then embark on the programming phase. Create simple routines that prompt your robots to respond to basic commands, fostering a sense of accomplishment.



First moving robot

A typical first exercise for a basic robot may involve building a robot consisting **only of a programmable hub and two motors**, each with a wheel, plus a third support that allows the robot to rotate or traverse curves (this support could be a spherical wheel or a skate). Once the assembly is complete, proceed with programming, creating a program **that simply makes the robot move forward, backward, or navigate curves**. For these types of operations, you play with the speed differences between the two wheels: when the wheels rotate at the same speed, the robot moves straight, otherwise, it follows curves, the curvature of which increases with the greater speed difference between the wheels. As an extreme case, if the two wheels move at opposite speeds, the robot rotates in place. Programming apps often provide predefined blocks to manage the movement of robots based on this setup.

The next step, without the need to make changes in the physical construction of the robot, involves starting to **create progressively more elaborate programs** to guide the robot along a specific path. This activity can be easily modulated at various levels of difficulty: you can begin by instructing the robot to move, assigning specific starting and ending points, and **placing one or more obstacles along the path**. This can then progress to programming paths that require optimization of the code. For example, a program guiding a robot along a square path can be created using **"loop" blocks** instead of simply repeating commands.

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Fully interactive robots

Despite the use of sensors being a simple application in itself, they can be used to build and program robots capable of autonomously performing predetermined operations that adapt to the surrounding world by exploiting sensor readings. Therefore, by **adding sensors** to the previously built two-wheeled robot, progressively **more complex behaviours** can be conceived based on conditional logic, corresponding to specific programming blocks.

Stop with obstacle - ultrasonic sensor

A first example of an interactive mobile robot could involve incorporating an ultrasonic sensor, capable of detecting the presence and distance of an obstacle. This can lead to generating code that instructs the robot to perform a specific movement based on the obstacle's presence condition. Typically, the robot would start moving and only stop when the sensor detects the presence of an obstacle closer than a specified threshold.

The construction of robots and their programming can become **progressively more complex**, allowing the achievement of behaviours with conditional logic based on more than one sensor or the various levels of their readings and thresholds.

For example, one could **add a colour sensor** to the previous robot, in addition to the ultrasonic sensor. The movement of the robot could then be conditioned by both the colour perceived by the sensor (usually positioned downward to influence its behaviour by colouring the surface it moves on) and the presence of any obstacles in front of the ultrasonic sensor. An example of a

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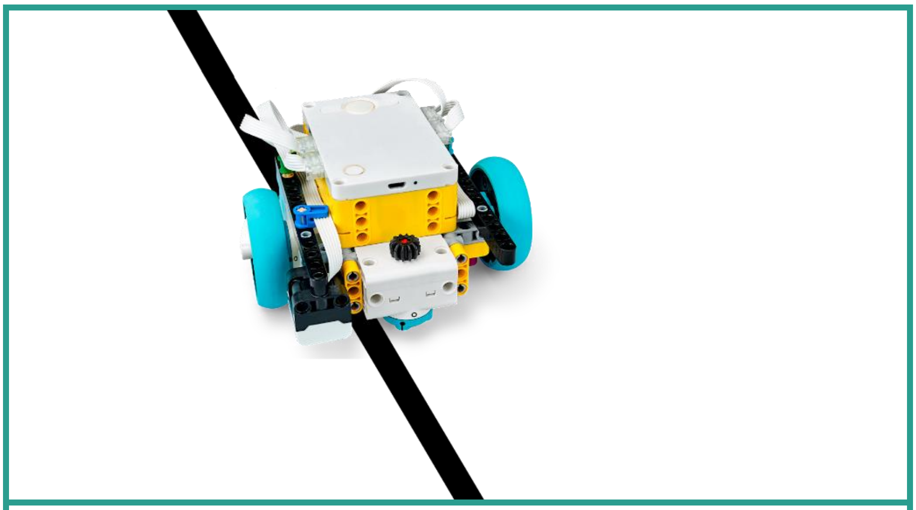
behaviour/program could be: go straight if you read the colour green, turn right if you read the colour red, and turn left if you read the colour blue, but in any case, stop if you detect an obstacle closer than 10cm.



Line following robot

Another typical example of a construction and programming exercise, often included in many educational robotics kits, involving the use of a colour sensor on a dual-motor and dual-wheel layout, is commonly referred to as **"line following."** Essentially, the goal is to build and program a robot capable of traversing a track by following a simple black line marked on the surface of the movement area (or playing field). By applying **the colour sensor pointed downward**, it can detect the presence or absence of the line. At this point, the exercise becomes a manual programming challenge: you need to program a behaviour that, by adjusting the movement of the wheels based on the line readings, enables the robot to move along the line. This typically involves alternating curved movements forward, to the right, and to the left, **much like a dog following a scent** with its nose to reach its source.

Of course, up to this point, we have seen how to tackle various levels of complexity while essentially keeping the robot's construction configuration unchanged. Considering that with an average kit, **completely different models can be built**, one can understand the vast potential for generating behaviours and challenges based on individual creativity or ideas derived from curriculum programs. As an example, it's worth noting that with the typical and widely used robotics kit featured in the images and examples on these pages, one can build and program **a robot capable of solving the Rubik's Cube**.

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Complex projects example: playing with robots and Rubik's cube

3.2 Coding (4 hours)

Learning Objectives

- Build STEM Proficiency, promoting creativity
- Understand fundamental coding concepts.
- Demonstrate coding proficiency through practical exercises.

Introduction to coding

"Programming languages are like any other language. Only in this case, kids don't learn to express themselves and communicate with other people. Instead, they get to understand how to communicate with technology. Technology that is all around us - in our smartphones, computers, vehicles, everywhere!
But understanding and communicating with computers is only a part of it. ***Coding also helps develop multi-disciplinary competencies such as computational thinking, problem-solving, creativity and teamwork - excellent skills for all walks of life.*** *The ability to solve problems, to cope with failure and try again, or to collaborate with others, are traits looked-for in many fields."*
(https://codeweek.eu/why-coding)

Educational coding is a powerful tool that has gained significant importance in recent years. It serves as a dynamic method to cultivate and enhance computational thinking skills in learners of all ages. Coding, or programming, involves instructing computers to perform specific tasks through the creation and execution of algorithms. This process is not just about acquiring technical skills

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but extends to fostering critical thinking, problem-solving abilities, and a deep understanding of technology.

One of the primary benefits of educational coding is its **ability to build and enhance computational thinking**. This refers to the development of a structured approach to problem-solving that involves breaking down complex issues into manageable steps. Through coding exercises, individuals learn to think algorithmically, design logical solutions, and execute them systematically, skills that are invaluable in various academic and professional domains.

Coding education is not limited to technical proficiency alone; it has a transformative impact on a broad range of skills. Learners engaging in coding activities develop creativity, as they are encouraged to find innovative solutions to problems. Collaboration and communication skills are also honed through group coding projects, mirroring real-world collaborative work environments.

Furthermore, coding education instils a sense of digital literacy, fostering an analytical and critical approach to technology. Learners become adept at understanding how technology functions, and they are encouraged to question and evaluate the impact of technology on society. This promotes responsible and ethical use of technology, ensuring that individuals are not just consumers but informed and conscious contributors to the digital landscape.

Overview of the main tools available for educational coding

There are various resources available to embark on a coding teaching/learning journey, considered a fundamental skill with great importance by the European Commission and the scientific and educational communities in general. Even though coding can be practised in an "unplugged" manner, meaning creating and executing algorithms without the use of computer devices, the typical approach to coding involves using a device such as a PC, tablet, or even a mobile phone, along with applications that provide the working environment for building and testing computer code.

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Several websites offer the opportunity to access these programming environments directly from the browser, eliminating the need to download or install a specific application. **Since these resources are usually free to use**, not intended for profit, and are associated with universities and research centres, we list below the main reference sites:

- **https://scratch.mit.edu/** (Suitable for both learners and adult learners)
  "Scratch is a high-level block-based visual programming language and website aimed primarily at children as an educational tool, with a target audience of ages 8 to 16(...). The service is developed by the MIT Media Lab, and has been translated into 70+ languages, and is used in most parts of the world. Scratch is taught and used in after-school centres, schools, and colleges, as well as other public knowledge institutions."
  [https://en.wikipedia.org/wiki/Scratch_(programming_language)]
  Certainly, the most reliable, recognised, and used resource, as well as one that we will use in the guide in the following pages.

- **https://code.org/** (Suitable for both learners and adult learners)
  "Code.org is a non-profit organisation and educational website founded by Hadi and Ali Partovi aimed at K-12 learners that specialises in computer science.[2] The website includes free coding lessons, sounds, and many more things used to help learners code fluently. The initiative also targets schools in an attempt to encourage them to include more computer science classes in the curriculum."
  [https://en.wikipedia.org/wiki/Code.org]
  It's a coding education platform that provides, among other things, a pathway with step-by-step activities to make learners independent in their progress from a basic level to a more comprehensive experience.

- **https://codeweek.eu/training** (Suitable for both learners and adult learners)
  A page dedicated to training from the official website of the Codeweek initiative promoted by the European Commission. Various resources and training paths can be found there.

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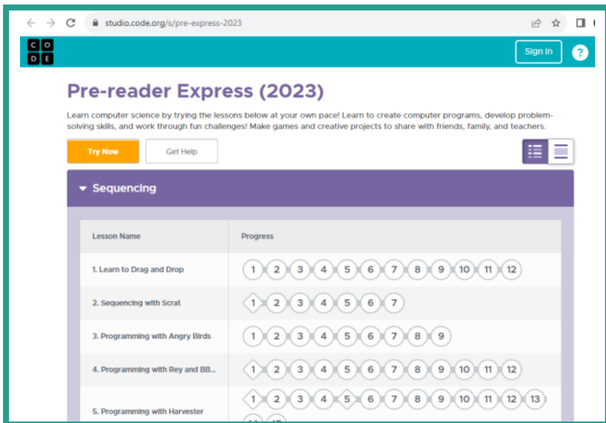
User guide for hands-on coding activities for varying skill levels

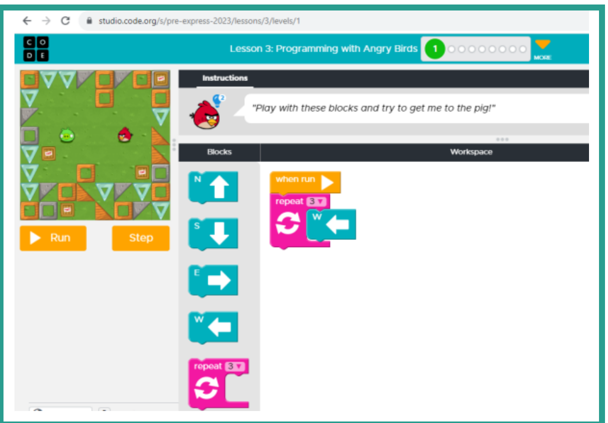
Since there are various resources for practising coding, in the following pages, we will only refer to some of them, aiming to convey general logical concepts that, in practice, are considered applicable through each of the available resources.

A learning journey starting from elementary operations

A very gradual way to approach the coding world with a step-by-step guide that takes us by the hand into the coding realm is definitely the one proposed by code.org. Within the website, it provides not only educational units with examples and exercises but also a section specifically dedicated to a gradual learning path suitable for everyone (especially recommended for beginners and when wanting to stimulate curiosity towards this discipline). At the end of the course, a customizable official certificate is also issued with the participant's name.



A page from the student section of code.org, providing access to a complete path of step-by-step exercises for ages 5-7 (pre-reader).



An example of a step-by-step exercise/guide on how to create a simple visual block code.

The infinite possibilities of the most widely used coding application: initial experiments with “Scratch”

As previously described, we can now assert that the most acclaimed application in the field of educational coding is “Scratch”, whose development by MIT has contributed to the birth and widespread adoption of the concept of educational coding as we know it today. **To the extent that the terms "coding" and "Scratch" are often used interchangeably as if they were synonymous**.

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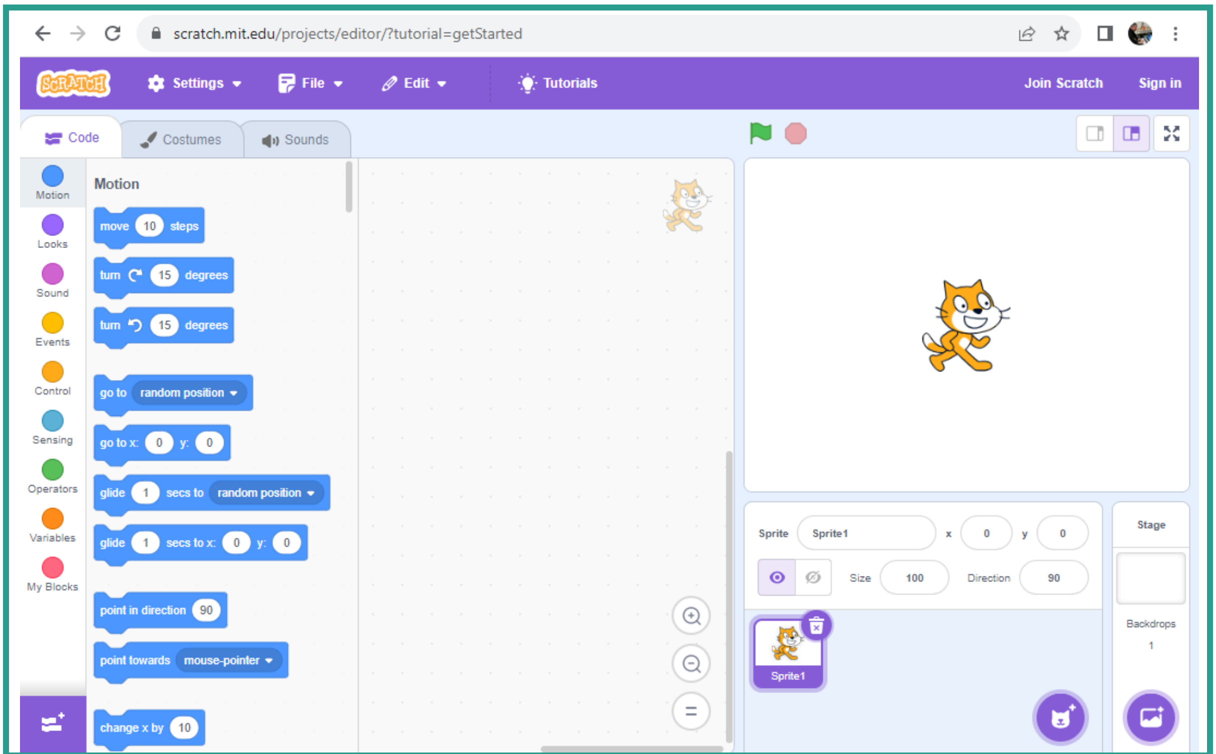
The use of Scratch is essentially tied to its official website, and, with a few exceptions, the application and all the learning/teaching paths one might want to undertake revolve around the site itself, which is **completely free and available in dozens of languages**.

The site is structured in a very user-friendly way and, from the homepage, offers the option to create an account or start creating directly without an account. Regardless of how we choose to use it, with or without an account, the page for code creation is divided into **three different areas**: the left side, where we find all the code blocks we need to build our programs, essentially an archive of instructions to pick and customise; the central area of the page, where we create our code by combining the instruction blocks to achieve the desired result; finally, there is the right side of the page, where we find the "stage" and any characters, called "sprites": in this part of the page, we see our code come to life, generating behaviours, actions, and reactions on the characters and the background of the stage itself.



The page for code creation with Scratch, divided into three areas.

The initial experiments we can undertake with this application are related to one of its most common uses: **storytelling**. This involves constructing code that enables characters (sprites) to tell a story. On the left, we can start selecting the blocks that interest us **to make the sprites move, change their appearance, or**

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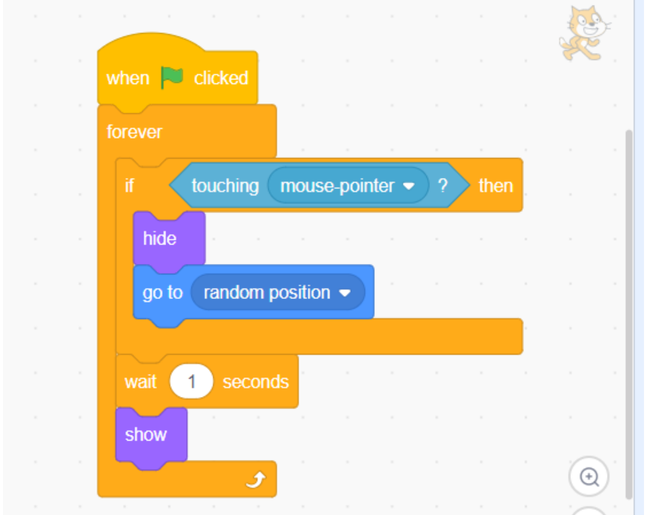
emit sounds. There are countless examples of how to do this on the website itself, along with useful step-by-step guides, such as this one: https://resources.scratch.mit.edu/www/guides/en/Getting-Started-Guide-Scratch2.pdf

Using "Events" and "Control" Blocks to Structure Code with Loops and Conditions

After experimenting with simple storytelling programs, the next step is to start using blocks found in the "Events" and "Control" sections. Here, we'll find blocks that allow us to create temporal structures with waits and repetitions, as well as those that enable us to manage conditions—meaning executing pieces of code only "if" certain conditions occur.

These blocks are crucial for creating structured code, and their functionality is fundamental for understanding and abstracting concepts related to computational thinking.

As an example, let's imagine wanting our character (sprite) to interact with us by playing hide-and-seek—when we hover the mouse pointer over it, it disappears only to reappear shortly after in a different random position. How can we impart such logic? We need to think algorithmically and abstract the basic concepts: we need to indefinitely repeat an instruction that hides the character only when the condition of being touched by the mouse pointer is met. Then, we make it move to a random position and ensure that when the previous condition is not met, it stays still and visible. Below is a block code that achieves the mentioned behaviour.



With this code, the cat keeps hiding for one second when we hover over it with the mouse and reappears at a different point on the stage.

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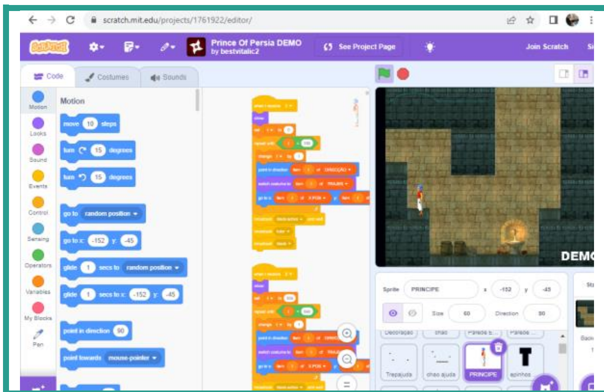
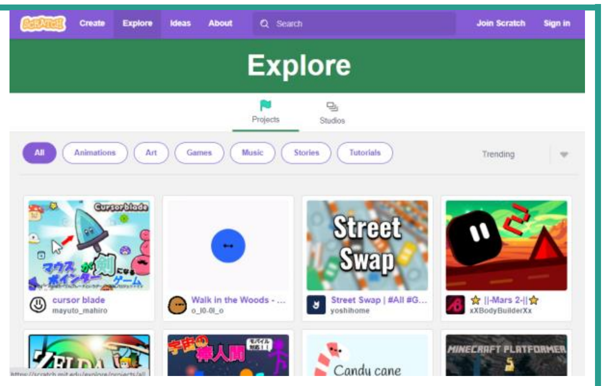
Towards increasingly complex codes, thanks also to the work of the community

Observing the usable blocks on Scratch, one easily realises the nearly infinite possibilities to increase the complexity of algorithms. In addition to the aforementioned blocks for motion, appearance, sound, and various control and event blocks, there are blocks that allow the creation of variables, blocks with numerical and string operators, blocks for creating interactions (sensing blocks), and finally, one can construct complex and lengthy codes at will and turn them into custom blocks ("My blocks").

All of this, combined with the ability to modify or create new sprites and backgrounds and add, for example, recorded sounds, allows the creation of codes capable of performing highly articulated interactive operations, such as perfectly functioning video games. As in all disciplines, to make great strides in a learning path, it is crucial to learn from the experiences of others. In this regard, exploring the projects provided by the Scratch user community is very useful. These projects can be both viewed by users and examined from the inside to understand their logic and discover how the code was structured.



A remake of a portion of a famous video game, redone using Scratch



Explore the work of the community to learn from others

3.3 Microcontrollers (4 hours)

Learning Objectives

- Build STEM Proficiency, promoting teamwork and creativity
- Understanding the functionality of microcontrollers.
- The use of microcontrollers in practical educational activities.

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Understanding microcontrollers and their applications

Within STEM education, the integration of microcontrollers stands as a pivotal advancement, opening a multitude of opportunities for practical learning and innovation.

At its essence, **a microcontroller is a compact, programmable device housing integrated circuits that serve as the core of various electronic applications**. From robotics to coding, these devices empower learners to seamlessly merge theoretical knowledge with hands-on applications, bridging the gap between classroom concepts and real-world applications.
The versatility of microcontrollers is a key advantage, seamlessly fitting into a spectrum of educational activities suitable for learners of all ages and proficiency levels. Whether designing circuits, developing interactive projects, or programming algorithms, **microcontrollers provide a hands-on platform for exploration, experimentation, and innovation**.

Beyond their versatility, microcontrollers contribute to a holistic understanding of STEM disciplines. By engaging in interdisciplinary projects, learners gain insights into science, technology, engineering, and mathematics, refining critical thinking, problem-solving, and teamwork skills. Navigating the complexities of programming and circuitry, learners absorb theoretical knowledge while refining practical skills crucial in today's technology-driven landscape.
An additional benefit lies in the accessibility and affordability of microcontrollers, breaking down barriers to entry and democratising STEM education. With numerous open-source platforms and a vibrant community of educators, microcontrollers offer a cost-effective way for schools and individuals to embrace STEM concepts.

Moreover, microcontrollers facilitate captivating STEM projects, such as building a weather station with sensors for data collection, creating a smart garden irrigation system with automated watering based on soil moisture levels, or developing a robotic car programmed to navigate through a predefined path. These examples underscore the limitless potential of microcontrollers to fuel creativity, experimentation, and real-world problem-solving within STEM education.

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Overview of the most common educational microcontroller boards

When talking about microcontrollers for STEM education applications, we generally refer to **electronic boards** that house the actual microcontroller, a programmable microchip. These boards also feature a series of components allowing the connection of the microcontroller to a PC or a similar device for programming. Additionally, there are other connections enabling the management of input and output electrical signals to handle **sensors and actuators that interact with the environment**. Furthermore, the board might already include a set of built-in actuators and sensors.

Several companies manufacture and sell microcontrollers for STEM education, typically offering **kits** that include the main board, various sensors and actuators for different applications, cables for making connections, and a breadboard or a similar **tool for prototyping electrical circuits**.

Example of an “Arduino” KIT

Example of a “Microbit” KIT

In general, sensors and actuators belong to the category of electrical transducers, meaning devices capable of converting electrical energy into a different type of energy. For example, a motor or a servo motor (actuators) transforms electrical energy into mechanical energy, a LED (actuator) converts electrical energy into light radiation, a microphone (sensor) changes the energy of sound waves into electrical energy, and so on.

Typically, in a STEM education kit with microcontrollers, you might find sensors, which are transducers that read a property in the world and transform it into an electrical signal. These can include sensors for temperature, light, humidity, microphones, ultrasonic sensors, potentiometers, and more.

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Regarding actuators, which are transducers that convert electrical energy into another form of energy, kits usually include items such as electric motors, servo motors, LED lights, or other types of displays.
Microcontrollers are generally accompanied by software environments that allow the creation of programs, either through block-based programming or text-based coding, which can then be uploaded to the board.

User guide for hands-on coding activities for varying skill levels

Since there are various microcontrollers boards, in the following pages, we will only refer to some of them, aiming to convey general logical concepts that, in practice, are considered applicable through each of the available resources.

A board with integrated sensors and actuators, programmable using blocks

Among the various boards available on the market, there are some particularly suitable for taking the first steps into the world of microcontrollers. They are **designed to be used without necessarily having to build an electronic circuit with cables**, connectors, and a breadboard. These boards already contain some integrated sensors and actuators and often come with a block-based programming environment with online resources for step-by-step lessons.
This makes initial approaches very straightforward, although it may be insufficient if you want to create more complex projects using generic sensors and actuators that are not immediately compatible. An example of such a board for starting from a basic level is the "Micro:bit" board from the BBC (https://microbit.org/new-microbit/). It comes integrated with an LED matrix, a microphone, touch sensors, buttons, a light sensor, accelerometer, and compass, along with various possible connections, including a USB port for providing electrical power and programming it via a computer.

Additionally, alongside all of this, a website rich in educational resources has been created. It easily allows the use of ready-made lessons with video tutorials and provides several apps for programming the board.

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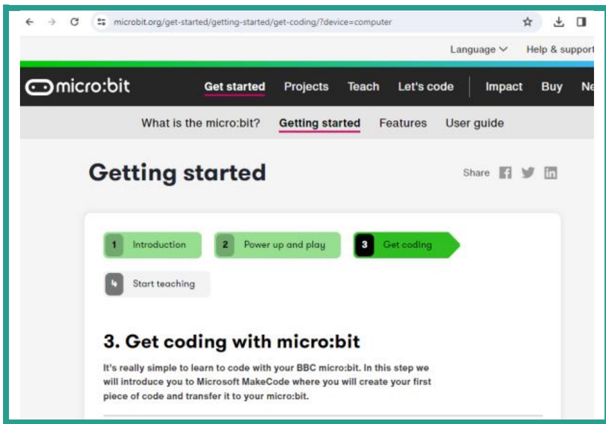
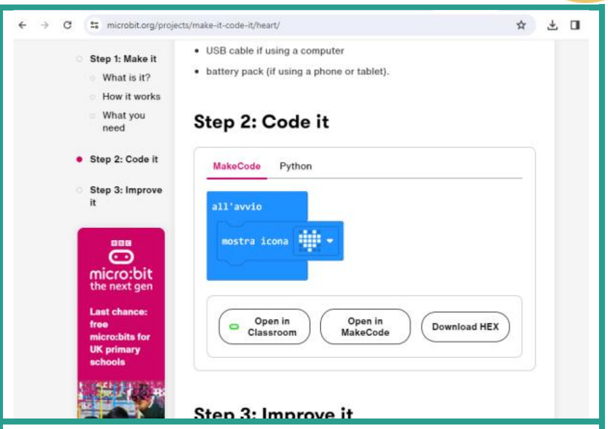


One of the "get started" pages on the micro:bit website

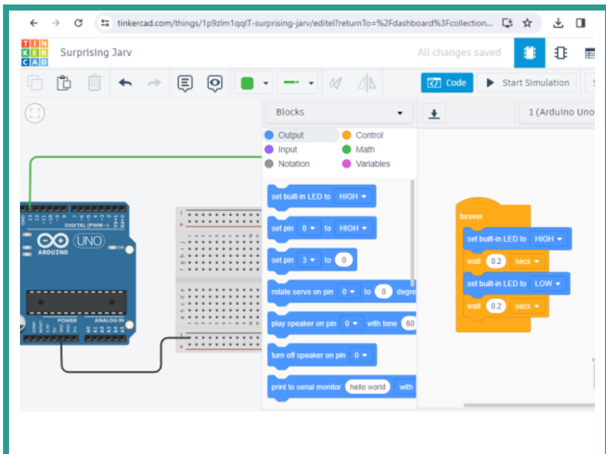


One of the many step-by-step guides: the beating heart

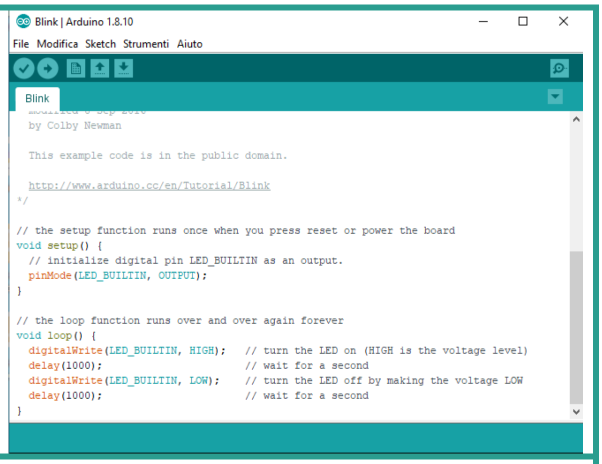
From blinking lights to robotic and home automations: the world of Arduino, ESP, and their clones

If we have a KIT like those offered by "Arduino," with a board, a breadboard, connectors, and various sensors and actuators, **the possibilities for creating content are truly endless**. Adding more sensors or actuators will easily increase the complexity of our projects.

The **skills** required to tackle a project can range **from electronics, programming, physics, etc**. Fortunately, we can start with basic projects here as well. Often, these KITS come with a PDF or printed guide containing many projects at **various difficulty levels**, starting from the classic "LED blinking". However, there are also very useful resources, such as the "Circuits" section on the Autodesk Tinkercad website.



Tinkercad Circuits



Arduino IDE

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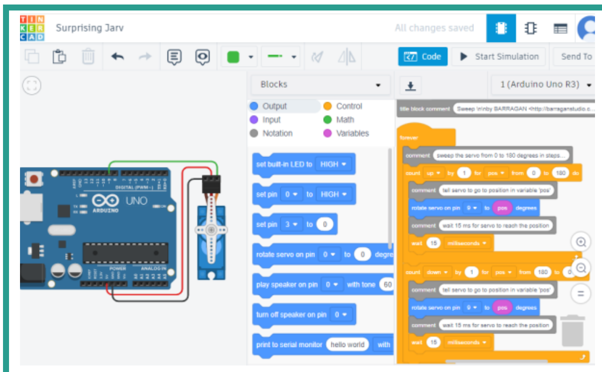
Despite the approach to microcontrollers involving learning a textual language like C++, this transition, which can be an initial barrier for some, can be made very smooth by using resources that allow programming our circuit with a block-based language similar to those used for coding and robotics. In some cases, such as Tinkercad Circuits (https://www.tinkercad.com/circuits), **it is even possible to build a digital twin of the circuit and simulate its operation after programming it with blocks**.

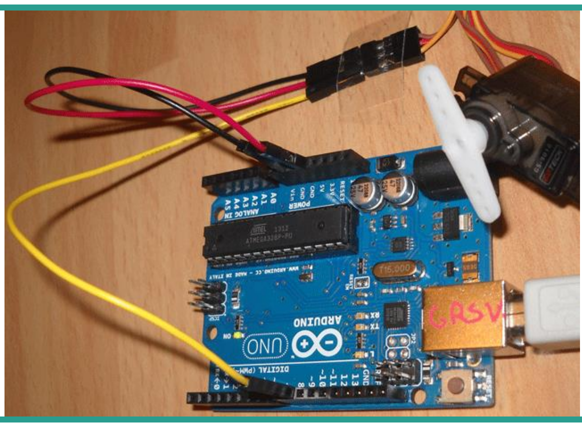
However, there is also the option to download the C++ version of the programs to load it into a dedicated programming environment like "Arduino IDE" and upload the code to the board to make the circuit work in the real world.

The process of creating a device to perform a specific task using a KIT could be as follows: **choose the component(s)** we find useful based on their functionality, **connect them** to the microcontroller board following the component specifications (type of connection, possible presence of other accessory components like resistors or capacitors), **and finally create the program** that executes the instructions to achieve the expected behaviour. All of this can be done using a digital simulator and a block programming app or by directly building the circuit and programming it with a language like C++.

For example, if we want to create **a device that opens and closes a box**, we could **use Arduino and a servo motor**. The servo motor will be connected to the board (if done through a breadboard, we'll have the option to easily add other components to our prototype), and the entire setup will require a program that instructs the microcontroller (Arduino) to move the servo motor based on a timing sequence or certain conditions.



Arduino and servo motor digital prototype



Arduino and servo motor real prototype

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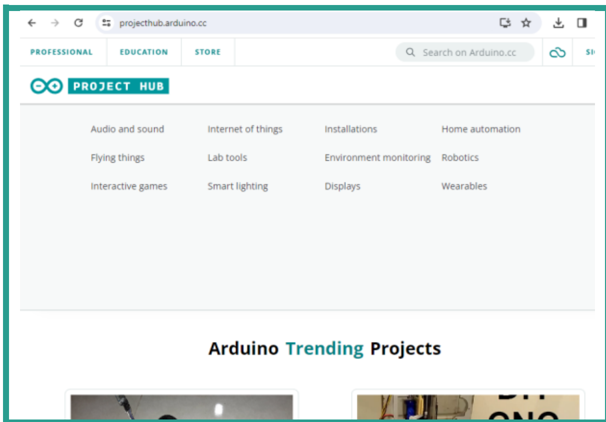
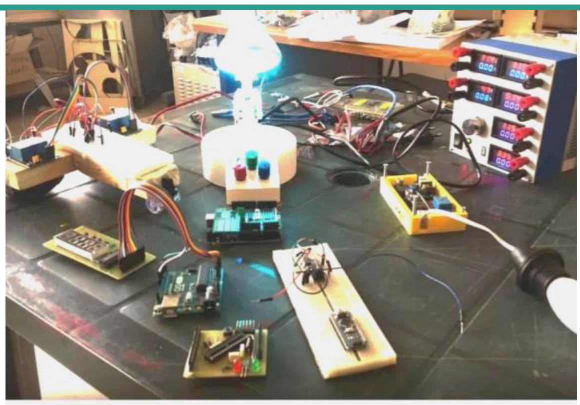
Embarking on a journey to learn how to create increasingly complex projects inevitably involves **seeking inspiration and guidance from the vast community of makers** who consistently contribute with new ideas and projects, often detailed with step-by-step tutorials. In this regard, we mention an important online resource, namely the "project hub" of the Arduino community.



Arduino Project HUB



More complex projects with microcontrollers

3.4 3D Modelling and Printing (4 hours)

Learning Objectives

- Build STEM Proficiency, promoting creativity
- Outline the basics of 3D modelling and printing.
- Create 3D models using various proficiency levels.

Understanding 3D modelling and printing

3D modelling is a computer graphics procedure in which specialised software is used to generate a mathematical representation of a three-dimensional object or shape.

A 3D model is the digital representation of a physical object, and it is used across numerous industries. Applications and software for 3D modelling are employed in numerous fields, including architecture, construction, product development, science, medicine, film, television, and video games, in order to stimulate, render, and visualise graphic designs.

The fundamentals of 3D modelling work are associated with specialised terminology.

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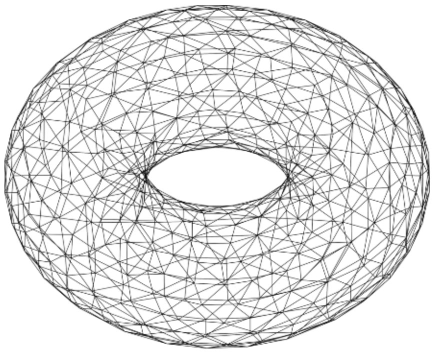
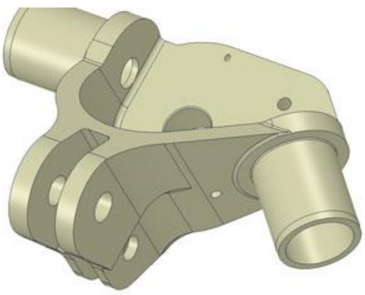
- **A polygon** is a collection of fundamental geometric entities, each of which is composed of vertices and straight edges.
- **A vertex** is the tiniest component of a polygon.
- **An edge** is the intersection of two polygonal facets on the surface of the polygon.
- **A mesh** is a three-dimensional model composed of vertices, edges, and faces that define the form.
- A face is an area that has three or more edges enclosing it.

Wireframe, surface, solid, and 3D sculpting modelling are the four fundamental forms of 3D development. Wireframe modelling utilises edges and vertices to depict solely the fundamental structure of an object or character. In contrast, surface modelling displays the surface texture, shading, and colour of a 3D model through a polygonal mesh. Solid modelling represents the interior and exterior of the 3D-modelled object, surpassing mere surface representation. Ultimately, 3D sculpting, also known as polygonal modelling, adds intricate textures and details to the polygonal geometry of the 3D model.

	
Wireframe modelling	Solid modelling

The elemental 3D modelling workflow consists of the following stages: conceptualising, modelling, texturing, shading, rigging and animation, and effects. The stage of **conceptualising** involves thinking through the object that is to be created, following the logical sequence of a storyline. At this point, making a storyboard is essential. This is a sequential arrangement of the photographs that, in accordance with the script, will eventually be turned into 3D models in one of the subsequent phases.

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Following this, the actual 3D modelling procedure begins. The artists utilise specialised software to create three-dimensional drawings of the objects, intending to animate them in a subsequent phase.

Texturing involves the incorporation of a two-dimensional image into either the model's background or the model itself, which was generated in a preceding phase.

Afterwards, light and shadow must be balanced to create objects that are as realistic as possible. This stage is called **shading**.

Animation and rigging involve providing the intended motion of the model and adjusting if needed. The process of adding a moveable skeleton to a model is known as rigging, as an animated model cannot exist without one.

The final step in the 3D modelling process is the incorporation of music and after-effects to produce an even more vibrant animation.

3D printing is a method by which a three-dimensional, solid, tangible model is created from a digital file, typically by depositing numerous thin, consecutive layers of material. This rapid rise in popularity is because it enables manufacturing to be accessible to a large number of individuals. This is related to the printers' small size and relatively small price.

Early manufacturing techniques are frequently denoted as "traditional manufacturing" because additive manufacturing was not brought into existence until the 1980s. In order to understand the fundamental distinctions between additive and traditional manufacturing, it is necessary to classify all techniques into three categories: subtractive, formative, and additive manufacturing.

3D objects are constructed using **additive manufacturing**, which involves the deposition and fusion of 2D layers of material. This technique requires almost no initial investment or time, which makes it ideal for prototyping. Rapid production and disposal of used components are possible. An additional asset of 3D printing is the capacity to produce components with virtually any geometry.

Objects are produced by **subtractive manufacturing** processes, such as turning and milling, which involve the removal of material from a solid block, commonly known as "blank." Its applicability is nearly universal, as virtually any material may be machined. Exceptionally precise and highly repeatable components can be manufactured using this technique due to the extensive control over each process step. It is the most cost-effective method of production for the vast majority of designs, despite the fact that it increases preparation time and expenses due to the need for Computer Aided Manufacturing (CAM) to plan customised tool trajectories and efficient material removal.

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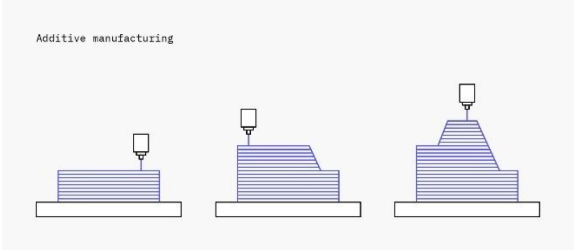
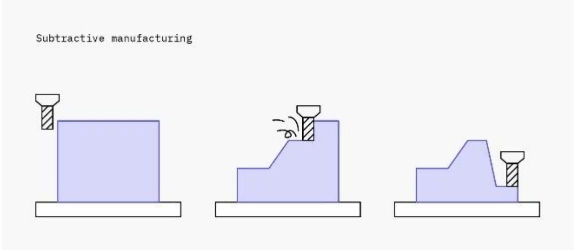


Additive manufacturing



Subtractive manufacturing

By forming or moulding materials into the desired shape with heat and/or pressure, **formative manufacturing** processes such as injection moulding and stamping produce objects. The purpose of formative techniques is to reduce the marginal cost of producing individual parts; however, establishment costs are exorbitant due to the need to create custom moulds or machinery for the manufacturing process. With near-perfect repeatability and the ability to manufacture components from a wide variety of materials (including metals and plastics), these processes are nearly always the most cost-effective for mass production.

In general, at the initial stage of the 3D printing process, a virtual model of the potential object is created. This design will function as a guide for the 3D printer to reproduce. Using computer-aided design (CAD) software, which can generate precise drawings and technical illustrations, the virtual design is developed. A 3D scanner, which basically takes photographs of an extant object from various angles to copy it, may also be used to generate a virtual design. Once the virtual model has been created, printing preparations must be undertaken. Slicing is the process by which the target is accomplished; the model is divided into numerous layers. During the slicing process, specialised software divides the model into hundreds or even thousands of thin, horizontal layers.

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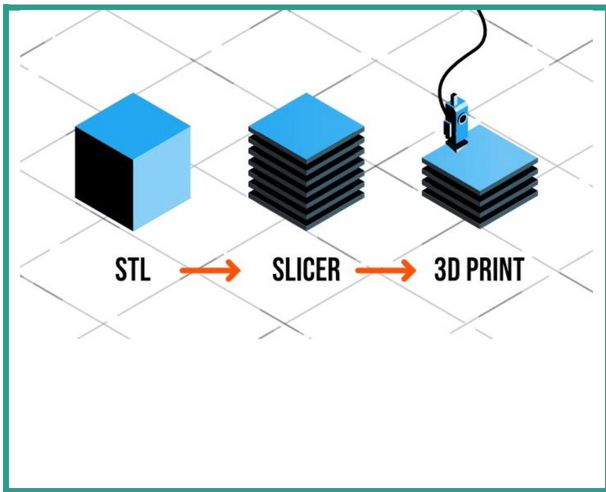
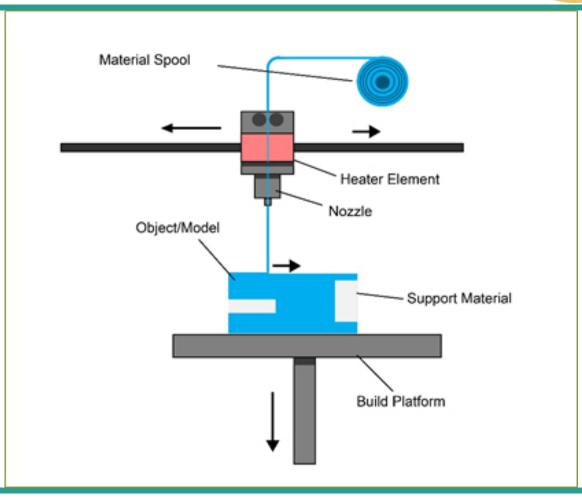


The role of slicing in 3D printing



Material extrusion

Following the slicing of the model, the segments are prepared for uploading to the 3D printer. By implementing either a Wi-Fi connection or a USB cable, the sliced model is transferred to the 3D printer. Once the file is transmitted to the 3D printer, each segment of the model is read and subsequently printed in a layer-by-layer manner.

The 3D printer will initiate the material extrusion procedure, which entails the production of the material layers. Numerous material extrusion techniques exist, each of which is dependent on the material and 3D printer type. Typically, a nozzle on the 3D printer will expel a semi-liquid substance such as molten metal, plastic, or cement. Following the layer-by-layer blueprint of the digital model, the extrusion nozzle is capable of horizontal and vertical motion while precisely positioning the material. Every layer of the digital model is replicated by the 3D printer using the extruded material, in this manner continuing until completion.
It is practically possible to transform any concept into a 3D-printable design. Using 3D printers, designers, engineers, and even regular people are producing complex objects that were previously impossible. Automobiles, tools, devices, tables, lamps, pottery, and even phone cases are all being produced with the use of 3D printers. The medical industry is also developing novel applications for 3D printing to benefit patients. Surgeons are able to perform a virtual operation on a patient's 3D model prior to the actual operation due to the capability of the physicians to fabricate such precise 3D medical models. Additionally, prosthetics that are more cost-effective, long-lasting, and aesthetically pleasing are being manufactured using 3D-printed models for limb- loss patients. The industry of 3D printed production is undergoing rapid developments and provides great promise for the future.

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Overview of the most common 3D modelling and 3D printing tools

Within the domain of digital fabrication, optimal 3D modelling software serves as a fundamental tool for converting imaginative conceptions into realistic, tangible models. Regardless of your fields – automotive, film, engineering, gaming, product design, or 3D printing – the appropriate 3D modelling software can transform your creative capacities. However, both individual effectiveness and industry standards have a significant impact on software selection. The most frequently used software includes:

1. **Autodesk 3ds Max:** This software is particularly preferred by architects, interior designers, and game developers who require expert modelling, texturing, and meshing tools. Skeletal models and inverse kinematics, cloth simulation, and texturing are all standard features.
2. **Blender:** Blender is the most effective free 3D modelling software for animators and animation. It is an open-source, free 3D creation tool that a user and developer community support.
3. **Autodesk Maya:** Autodesk Maya was among the first commercial 3D rendering systems to incorporate hair and fur, making it without a doubt the most outstanding 3D graphics software available.
4. **ZBrush:** ZBrush is an innovative approach to 3D modelling. It enables designers and artists to create sculptures with digital clay in real-time through the use of a brush system.
5. **SketchUp:** Due to its straightforward interface, SketchUp is among the most user-friendly 3D modelling programmes available. However, below its approachable exterior is a useful tool intended for designers, architects, and artists.
6. **Rhino:** Rhino is the best option for working with surfaces, as even the most advanced 3D modelling programmes could only handle simple geometry and a small number of then included splines with the tool initially introduced.
7. **Tinkercad:** Tinkercad is certainly the easiest to learn among all these tools. It relies on a modelling approach that involves the use of primitives (pre-made 3D shapes), which are used to compose the desired geometry. The software is available via browser and is the one considered for many of the activities outlined in this document.

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The ideal software for 3D modelling is dependent on a variety of factors, including the user's demands and usage, skill level, budget, and creative workflow. Consider how you intend to utilise the software, as artists and animators require distinct working conditions. The most effective 3D design tools and software are proficient in all aspects, including modelling, sculpting, and motion graphics. Certain programmes display superior efficiency in specific domains or are better adapted for particular industries, such as the most common architecture software. Certain programmes excel at 3D printing, whereas others are more suitable for 3D drafting and sketching.

Consider the level of expertise that you possess. Start with a tool that has a more manageable learning curve if you are unfamiliar with computer graphics and visualisations, as some 3D software may be too complex or challenging for beginners. Additionally, you need to ensure that your hardware can handle the demands of 3D software. Finally, be subjective. Select the software that aligns with your workflow and provides a sense of satisfaction.

With regard to 3D printing, some equipment and spare parts are essential components of any maker's workspace. Similar to CNC routers and other devices, 3D printers are complex devices that require a lot of specialised tools and equipment to operate. While some parts are extras of the parts that can break, wear out, or deteriorate (such as nozzles), you should refer to the tools as all the additional equipment required for your printing process to function efficiently. When anything goes wrong, having this equipment handy means you should be able to solve the issue immediately instead of waiting for a replacement component or specialised tool to be available.

Several tools that the majority of 3D printer users possess are listed below. These essential pieces of equipment guarantee optimal results and ensure that your printing processes operate efficiently. While it is not strictly necessary to acquire each tool at the same time, it is probable that you will eventually incorporate them into your collection.

Glue stick

Adhesion to the build plate is essential to produce high-quality 3D prints. When attempting to get a print to adhere, glue sticks are especially useful; merely coat the print substrate with soluble glue to achieve instantaneous improvement in adhesion. Although some people prefer hair spray, using glue is much more

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advisable. This is due to the increased precision that glue allows for during application and the reduced likelihood of inadvertently spraying the gantry or moving components.

Spatula or palette knife

You may occasionally discover that your 3D print adheres to your build plate a touch too tightly. In such situations, a spatula or palette knife can be used to resolve this issue. Merely position it subtly beneath the print and carefully raise it up.

Deburring tool/knife and cutting mat

Utilise a deburring tool to eliminate small plastic particles from your printed components, particularly brim, and to clear up modelled openings. A knife will be required to tidy up your prints, as they rarely turn out flawless. Unwanted plastic lumps or filament strings may be removed with a flick of the knife, leaving the finished product looking smoother and cleaner. In addition, buying a cutting mat and a knife with replaceable blades, like the X-Acto knife, is advised.

Pliers

Pliers may be utilised for a variety of purposes, including 3D printer repair and print core maintenance. Find a pair of pliers of high quality that feature a slip-resistant, rubberized handle. It is probable that you will require a variety of pliers; for instance, wire-cutting pliers and needle-nose pliers are exceptional for trimming filament and removing support material.

Blue tape

Masking tape is one of the most basic tools you are likely to own and one of the most widely used. It is simple and efficient to improve the adhesion of a 3D-printed object to the print bed by applying masking tape to the bed. In addition, it reduces the difficulty of removing the completed print and protects the print bed from scratches.

Magnalube and Unilube

Occasionally, lubrication of the X and Y axles is required to maintain their proper operation. The most efficient lubricant is Unilube, and a single drop is sufficient to eliminate any dehydration issues. Use Magnalube on the Z trapezoidal leadscrew.

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A X-Acto knife	A digital calliper

Digital caliper

In 3D printing, a digital calliper has numerous applications. It measures components for replication in CAD software and is also useful for verifying the accuracy of your prints. Additionally, callipers are useful for verifying filament dimensions, given that filaments are seldom produced to precise specifications.

Tweezers

When printing, it is advantageous to have tweezers on hand. For instance, they are particularly useful for plucking oozing filament from the extruder nozzle before it starts printing. Furthermore, they might be helpful for post-print cleanup. It is recommended to invest in a pair of tweezers in a variety of sizes and forms.

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Sandpaper

Maintaining a supply of sandpaper encompassing a diverse range of grades is strongly advised. Upon post-processing your 3D prints, each of these will be beneficial. Invest in reputable brands, such as 3M, which range from coarse (220 grit) to fine (1000 grit), as they are more likely to withstand the test of time than less expensive, substandard alternatives.

Screwdrivers/hex key screwdrivers

It is advisable to acquire high-quality hex keys and screwdrivers, as you will need to re-tighten the stepper motors and gantry fasteners of your 3D printer on occasion. An assembly of 3D printers frequently involves hex nuts and bolts; it is also sensible to carry a set of hex key screwdrivers and wrenches.

Flashlight

It is highly recommended to have proper lighting on and around a 3D printer. It facilitates the use of your printer by allowing you to see its minute components more clearly. Moreover, a more precise observation of the development of your prints is possible. A flashlight is an excellent tool to have on hand, regardless of whether your 3D printer or another assembly is equipped with a lighting system. It may be used to illuminate and concentrate on hidden and small areas.

Rotary tool

A rotary tool is a multipurpose tool that serves an array of purposes and is indispensable in many circumstances. It may be employed for engraving, carving, grinding, sharpening, sanding, and cutting, among others.

Soldering iron

Including a soldering iron in your toolbox is an excellent addition of functionality. It can be utilised, for instance, to adhere and flatten 3D-printed models made of PETG or PLA. A soldering iron's generated heat may be applied to burnish a model's surface to obtain a smooth finish.

Nozzles

Nozzles are the tip of a fused deposition modelling printer's hot end and where the melted filament comes out. Over time, nozzles can deteriorate and abrade, resulting in inconsistent extrusion; therefore, it is essential to carry spares in case of jamming or clogging.

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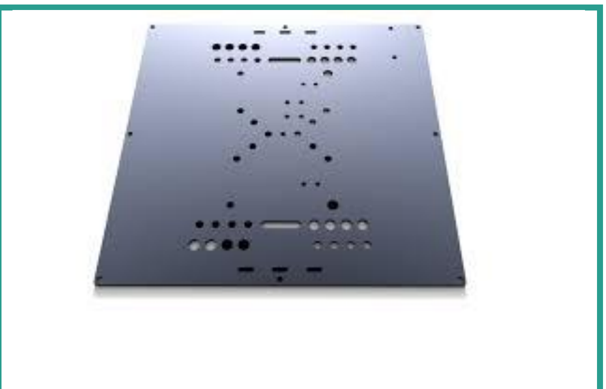
Build plates

The build plate serves as the printer's uppermost surface, upon which components are produced. Glass and steel are two of the many materials from which build plates are constructed (some plates even possess magnetic or flexible properties).

Wires and cables

Wear and tear can ultimately cause wires to break, so you might consider carrying spare wiring for your machines. Particularly on machines with numerous moving elements, such as 3D printers, wires can degrade due to friction, overstretching, or compression. Additional wires may be necessary if you intend to conduct minor tasks within your workstation, such as when using an SBC.

	
A rotary tool	A build plate

By implementing appropriate equipment, the likelihood of generating an impeccable 3D print is significantly enhanced. A 3D printer and a computer do most of the hard work, however, it is the tools that refine and perfect the models in the end.

User guide for hands-on 3D modelling end 3D printing activities for varying skill levels

3D modelling and 3D printing are activities that can be linked but can also be carried out independently. You can print using pre-existing 3D models, or you can model without worrying about the subsequent step of 3D printing. For these reasons, we will now look at the initial steps and potential progress in a learning path for 3D modelling. Separately, we will explore how to use slicing software and discuss the key parameters.

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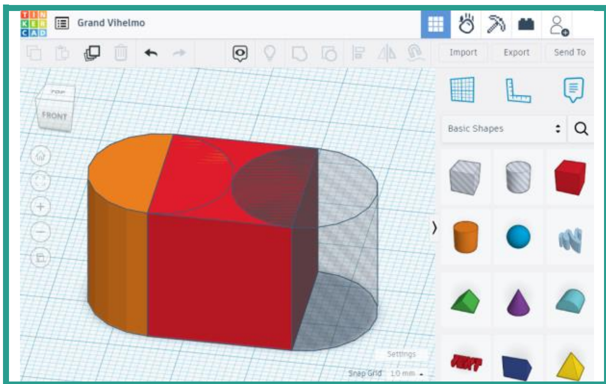
However, it is always a good practice, in function of the manufacturing technology used, including 3D printing, to be **aware of the technological constraints that can influence the geometry of the model.** A shape, with its geometric details, can be more or less optimised for subsequent 3D printing, and we will try to understand how and why.

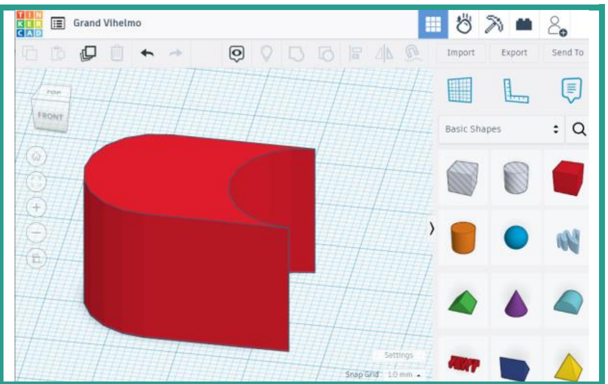
Primitive Modelling: A First Step into the 3D World

Primitive modelling is indeed an excellent way to embark on a journey into the world of three-dimensional modelling, especially suitable **for learners starting from the second grade**. It can be likened to using an abacus for learning arithmetic: essential and immediately understandable.

The initial approach could be a simple modelling exercise with Autodesk Tinkercad (https://www.tinkercad.com/): constructing a basic model by iterating through the following **fundamental steps as needed – adding a primitive (cube, cylinder, cone, etc.), scaling it, moving it, and rotating it according to the intended goal.** Repeat the process with other primitives, incorporating the ability, from the second one onward, to create monolithic objects by grouping two or more primitives. Also, consider that an "empty" primitive is subtracted from the rest of the group since it is treated as negative volume.



Tinkercad: “solid” and “hole” primitives before creating a group



Tinkercad: “solid” and “hole” primitives after creating a group

Increasing Model Complexity with Primitive Modelling

In addition to the fundamental tools of scaling, rotation, movement, and creating monolithic groups with primitives, Tinkercad offers the ability to mirror or duplicate shapes. In the case of duplication, it's possible to duplicate a shape along with its transformation, easily achieving circular or rectangular arrays of objects. Furthermore, the obtained models can be exported in various formats,

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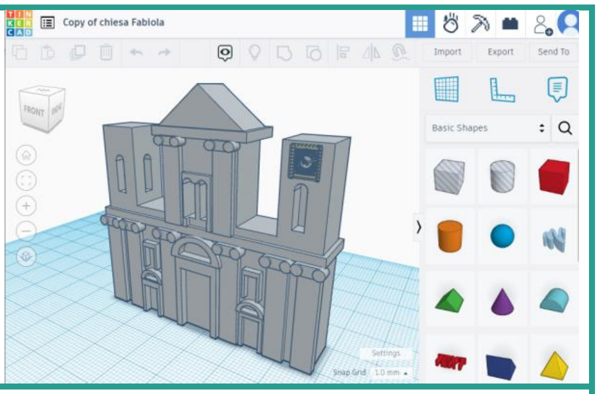
including ".STL," commonly used by slicing software for subsequent 3D printing. There is also the option to import external STL files or 2D SVG files to be extruded and converted into three-dimensional models.

With these tools and through iterative processes, one can create almost any shape. The limitation, given its focus on geometric primitives, might primarily arise in realizing organic models (faces, statues, etc.), for which this software may be less suitable.

From a simple nameplate...



... to the facade of a church

Other Approaches to 3D Modelling

3D modelling has become an integral part of various disciplines, including education, production, and research. Therefore, there are numerous modelling software options optimized based on the desired shapes, the technologies used for object production, and the broader field of application (engineering, entertainment, medicine, art, etc.).

Tinkercad itself features a second modelling environment that allows the creation of geometries through the **use of block-based code programming: CODEBLOCKS**. In an educational setting, this facilitates the transfer of content related to shapes, geometry, algorithms, and computational thinking. In a learning context for adult learners, this approach can be very useful for introducing coding and an algorithmic and parametric approach to three-dimensional modelling.
Among the various modelling software dedicated to 3D printing or digital craftsmanship, especially in the educational context from high school classes onward, and suitable for adult learners as well, the following are worth mentioning: Autodesk Fusion 360 (https://www.autodesk.it/products/fusion-360/overview?term=1-YEAR&tab=subscription#personal), Rhinoceros (https://www.rhino3d.com/), and Sketchup (https://www.sketchup.com/). Some of

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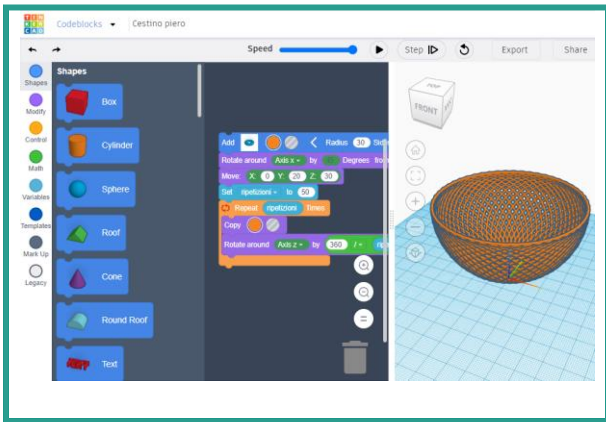
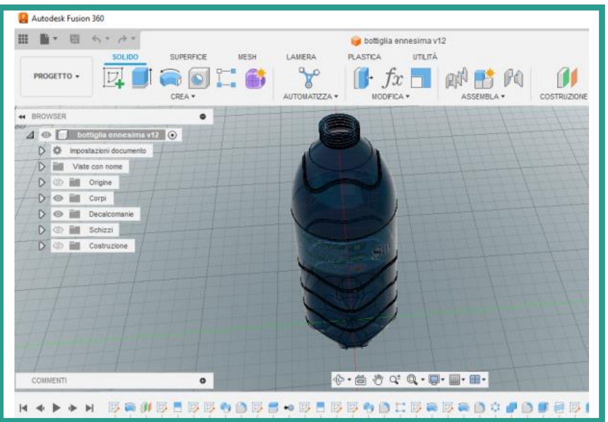
these may offer the possibility of accessing free or discounted educational licences.



A 3D Model Created Using Block Coding



A More Complex 3D Model Created with Autodesk Fusion 360

From the Three-Dimensional Model to Print Instructions: The Slicing Process

A 3D printer cannot directly interpret the three-dimensional model as generated by any modelling software. To proceed with the 3D printing of an object, a kind of **"translation" of the 3D model into a file containing a list of print instructions** is necessary. This step, known as **"slicing,"** also involves establishing the printing "parameters," a set of geometric and physical dimensions that will affect the quality and speed of printing. These parameters, in turn, are influenced by the geometry itself and the characteristics of the material being used.

The slicing process is carried out using specific software, many of which are free and easily accessible. In some cases, these tools are developed by the manufacturers of 3D printers themselves. The descriptions and images below specifically refer to the slicing software "Ultimaker Cura" (https://ultimaker.com/software/ultimaker-cura/) but the entire process is applicable to other similar filament 3D printing software like “PrusaSlicer” (https://www.prusa3d.com/it/pagina/prusaslicer_424/), “IdeaMaker” (https://www.ideamaker.io/download.html) etc.

The slicing procedure essentially involves these steps:

- Import the 3D model (.STL, .OBJ, etc.) into the slicing software.
- Make any necessary adjustments to the rotation and scaling of the model.
- Choose fundamental printing parameters: layer height (i.e., resolution), print speed, working temperatures, enable or disable support structures,

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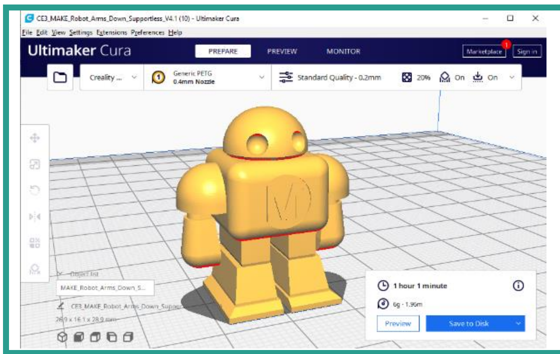
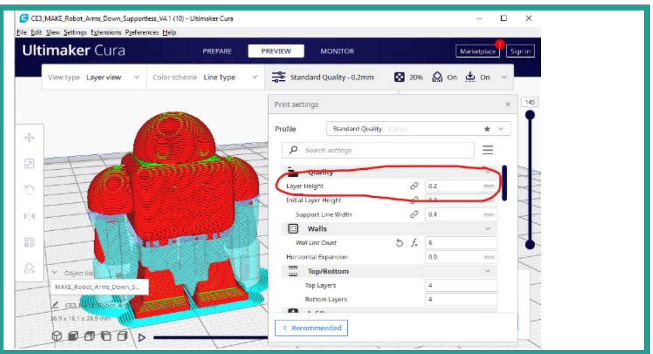
and other secondary parameters (this phase can also be encompassed in choosing a pre-set print profile).

- Allow the software to perform slicing and export the resulting file (.gcode or similar).
- Transmit the file to the printer via Wi-Fi or through physical storage media (USB drive, memory card).
- Start the printing process.
- After printing, remove any supports or proceed with finishing touches if necessary.



A 3D model ready for slicing



Slicing with the use of supports, and highlighted in red, the most important parameter: the "layer height."

There are various free online repositories where we can find ready-made 3D models designed for easy printing with a 3D printer, and many of these repositories also have dedicated sections for educational models. Here are some examples:

- Printables: https://www.printables.com/education
- Thingiverse: https://www.thingiverse.com/education
- Myminifactory: https://www.myminifactory.com/category/education

If, on the other hand, we want to create something from scratch, starting with modelling, it's important to keep in mind some fundamental rules in the design that will make the model more suitable for 3D printing:

- Always try to have at least one flat supporting surface in the model.
- Avoid details or thicknesses that are too small, less than about 1mm.
- Try to create shapes without overhangs or with overhangs that have angles less than 45°.
- Section the models to avoid excessively long prints.

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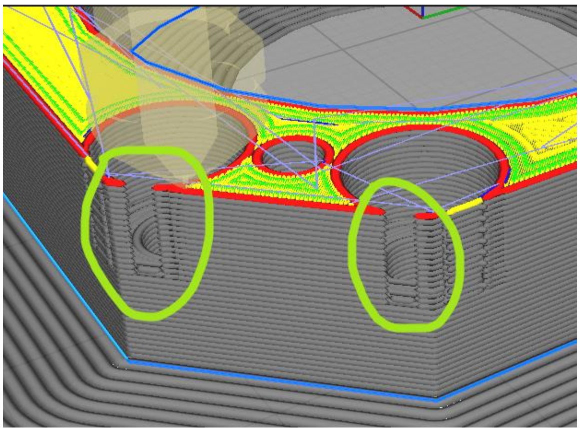
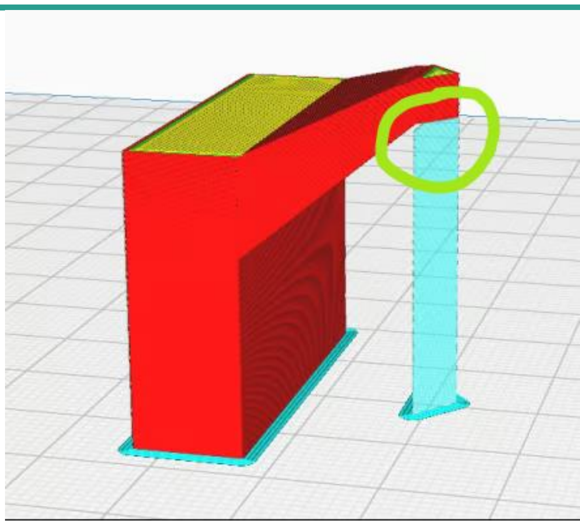
- Use modelling software and techniques that easily ensure the creation of a closed mesh.

	
Thin areas are not printed.	The need for supports depends on the overhang angle.

3.5 Web Development (4 hours)

Learning Objectives

- Define the basics of web development.
- Develop web-based projects at beginner, intermediate, and advanced levels.

Introduction to web development

The process of designing, creation and maintaining a web application or website is called web development. The web developers not only have to have a wide variety of technical skills in order to create a website, but they also have to invest time on the design in order to make them attractive, functional and easy to use for the final user.

Websites are tools that are used to communicate and perform tasks for the final user, so it is important for the developer to focus on the user needs when developing a new website. In this process skills like *communication, team-working and empathy* are crucial in order to create a web application that will fulfil in the best way possible all the needs of the final user.

In the last few years, web development has become increasingly important. This is because the web has become an essential part of our lives. Today, we use the

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web for everything, like buying and selling products, reading the news, communicating with friends and family and even at our homes as web interfaces for our smart-homes devices.

Basics of web development

As said before, not only technical skills (like knowing HTML, CSS and Javascript) are required to be a good web developer, but also transversals skills are needed, for example:

- **Problem-solving:** The skill to analyse and understand the needs of the final user and look for solutions using web development.
- **Communication:** Not only with the final user to understand the needs, but also with other colleagues in order to improve and implement the solution.
- **Teamwork:** Web development is a collaborative environment, where it is common to work with other developers in order to develop the website.
- **Continuous learning:** As with almost every digital area, web development is a constantly evolving field, so web developers must have the curiosity and the willingness to learn new things and update their knowledge.

To introduce the learners to web development, apart from the transversal skills mentioned above, some basic knowledge about how the web works and the programming languages used to create a website is required to be explained.

How the web works

Computers are able to exchange information between each other when they are connected to a network. The Internet is a network of networks, so it gives the possibility to two computers that are connected to the internet to exchange information between them. When a user opens a webpage on their browsers, what they are doing is accessing a specific address on the web and requesting to the server (a computer or system connected to a network that provides resources to other computers) a specific resource. The server has to process this request and respond with the specific resource. This resource can be different types of data, like a file, a video, or the content of the webpage.

This process of request and response of the server can be divided in the following steps:

1. The user inserts an address on the address bar of the browser.

2. The browser sends a request to the web server hosting the resource.

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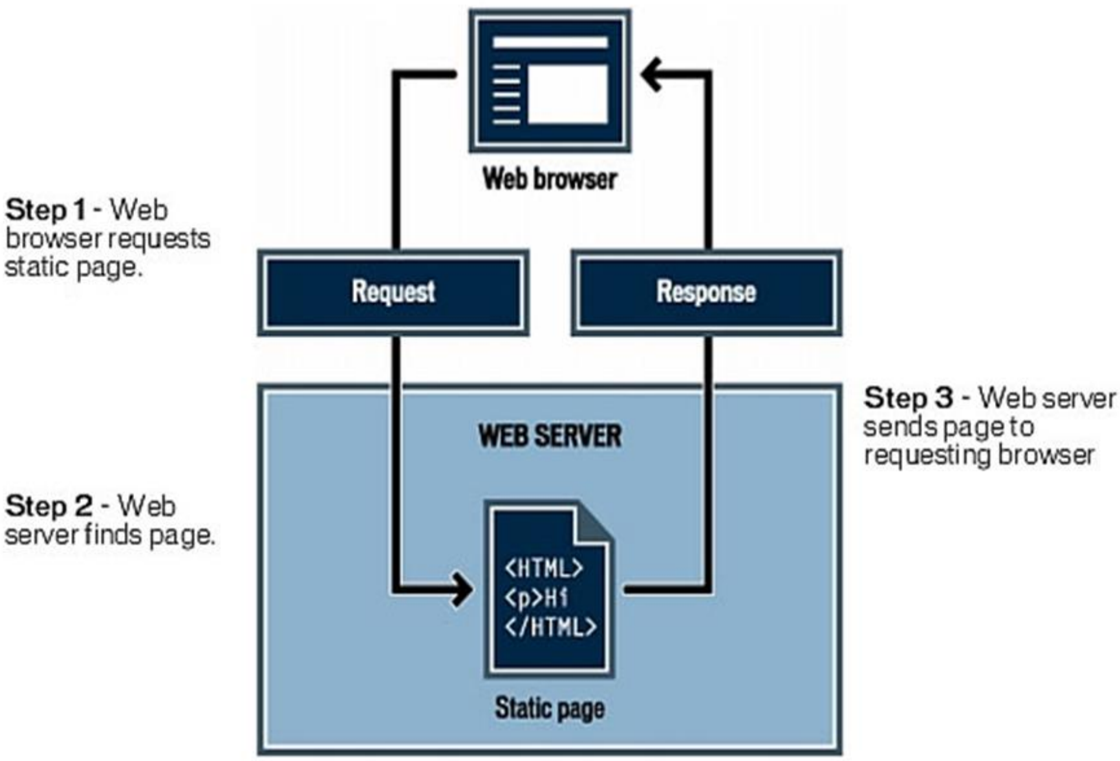
3. The web server receives the request, and determines which content has to be sent to the client.

4. The servers sends the content to the client

5. The client's browser receives the answer, if it is a web page, it will receive a file with the webpage code

6. The browser reads and interprets the code of the web page and shows it to the user, not showing the code directly but showing the interface that the developer designed for it.



https://www.linkedin.com/pulse/what-happens-when-you-type-googlecom-your-browser-press-okafor

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When we talk about web development, it is normally divided into two different kinds of development, frontend, and backend development.

- **Backend development** focuses on the server side of a website or web application. Backend developers are responsible for creating the logic of a website.
- **Frontend development** focuses on the client side. Frontend developers are responsible for creating the look and feel and functionality of a website.

In simple terms, the backend is what happens behind the scenes, while the frontend is what users see.

For example, when a user visits an e-commerce website, the backend is responsible for processing the user's order, storing the order data in a database, and sending a confirmation email to the user. The frontend is responsible for displaying the available products to the user, allowing the user to select the products they wish to purchase, and processing the payment.

In short, the backend is responsible for the functionality of the website, while the frontend is responsible for the appearance of the website.

In order to introduce the learners to web development, we are going to focus mainly on the frontend programming languages.

Markup languages

HTML: Used to define the structure of a web page. HTML code is used to create elements such as headings, paragraphs, lists, images, and tables.

CSS: cascade style sheet language used to define the appearance of a web page. CSS code is used to control the size, colour, font, and other aspects of the appearance of elements on a web page.

Programming languages

JavaScript is a general-purpose programming language used to add interactivity to web pages. JavaScript code can be used to create animations, games, interactive forms, and other functions.

User guide for hands-on coding activities for varying skill levels

Once the basics of web development are well established, the teacher/trainer can begin to provide learners with tools to start the learning process. The following

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are some interesting resources to support the introduction of web development in the classroom:

Code.org Web Development Course: As previously stated, Code.org offers a structured and sequenced learning path that empowers learners to progress at their own pace. This comprehensive course goes beyond the fundamentals of coding, imparting the most essential HTML and CSS tags and rules, while also encouraging learners to assume the role of a web developer and contemplate the diverse applications of the web for disseminating information, accomplishing tasks, and expressing oneself creatively and much more.

CodeDragon.org: Sometimes starting to write coding for the first time without visual support can be difficult. This website offers the possibility to create a website from scratch using block-codes, as the same way that we saw previously on Scratch.mit.edu. It can be used as a beginner lesson where the teacher/trainer explains each one of the HTML basic tags, like headings, paragraphs, links, and images and invite the learners to create a website of their likings. Step by step the teacher/trainer will guide on the use of these html elements and depending on the level of the learners more advanced tags can be used or even CSS can be also explained to introduce the learners on how to change the style of the website. This website offers also the possibility to see the code as the blocks are being added, in this way, even if it is the first time for the learners experiencing HTML and CSS coding, he/she/they will start to get use to at least see it and be more comfortable for the next lessons.

Getting into coding for the first time without a visual guide can be discouraging for many learners. This website provides an easy-to-use interface for building websites using block-based coding, similar to the approach employed by Scratch.mit.edu.

This platform can be used effectively in introductory classes where teachers and trainers can explain in detail fundamental HTML tags such as headings, paragraphs, hyperlinks, and images. Learners can then embark on creating their own websites, guided step-by-step by instructors who will introduce advanced HTML tags based on the learners' level of competence. In addition, CSS concepts can be introduced to teach learners how to customise the look of their websites.

The website also offers a feature that allows learners to view the corresponding code as they add blocks, allowing even those with little coding experience to gradually become familiar with the syntax. This gradual exposure encourages comfort and preparation for later lessons.

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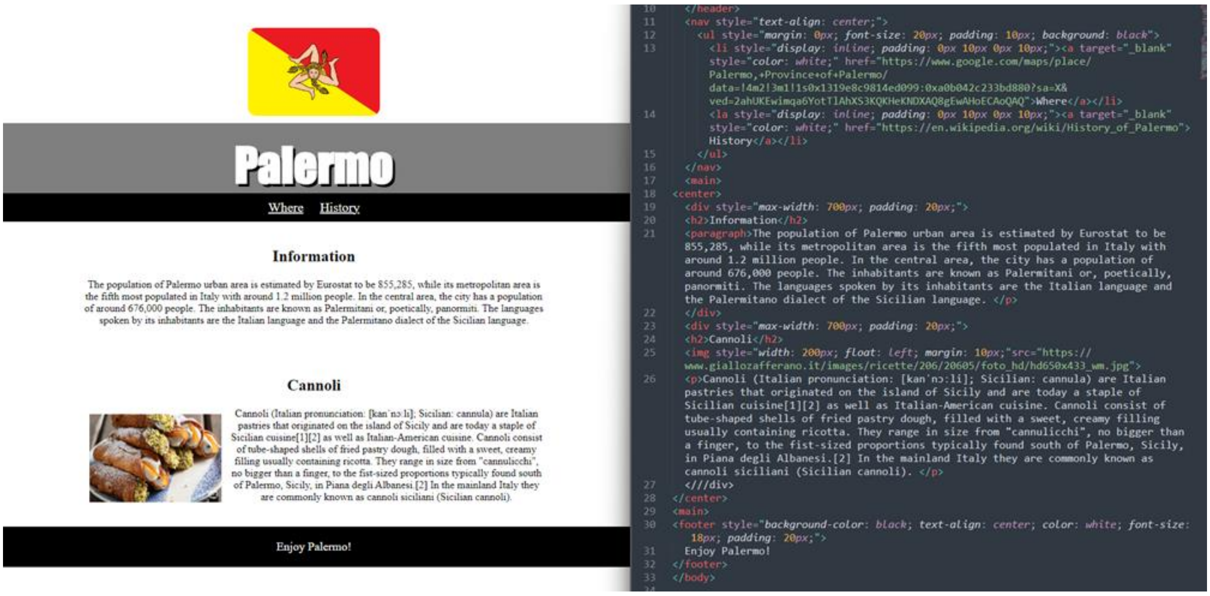
After the initial sessions with the learners and the basics of web programming are solid, different approaches can be taken.

It is important to, at a certain point, abandon the block-coding and start working directly with code and make them comfortable writing and modifying it. This can be done by reusing the code created through CodeDragon or by writing an HTML file from scratch.

If the learners create a file in their computer with the '.html' extension, they will have the possibility to write the code on this file and open it locally in their browsers.

In order to edit the code, a code editor with HTML syntax highlighting is advised, for example [Sublime Text](#) or [Visual Studio Code](#).



In this way, the learners can start to work on the code locally and see the changes immediately by refreshing the browser.

Different activities can be done in order to help the learners get confident in modifying the code:

- Correcting HTML and CSS errors in a simple website provided by the teacher/trainers.
- Modifying a website already provided by the teacher to change it based on the learner's hobbies.
- If the learners have enough knowledge, adding JavaScript to the website to add more features.

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It is also important to pay attention to how to implement the transversal skills mentioned before in the lessons. Here are some approaches:

- Make the learners work in pairs on the same project, encouraging them to communicate and improve their teamwork skills.
- Organise interviews between the learners, in which one learner plays the role of the final user and the other the one of the developer. The developer must identify the user's needs and apply them to the website, changing the content and the look and feel accordingly.
- Apply the design thinking process to create a website, following the steps of empathy, definition, ideation, prototyping, and testing, going back, and doing more than one cycle to see how continuous improvement can be applied.

By implementing these approaches, the learners will gain confidence in modifying code, improve their teamwork skills, and understand how the design part of a website is as important as the coding part.

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Module 4: Practical Task Development (1.5 hours)

Learning Objectives

- Formulate practical tasks aligned with transversal and digital skills.
- Collaboratively design and refine practical tasks.
- Provide constructive peer review and feedback.

Guidance on designing a practical task aligned with the skills covered.

The purpose of incorporating practical tasks is to enable learners to apply theoretical knowledge in a hands-on context. Practical tasks should reinforce theoretical concepts but also enhance problem-solving, critical thinking, and creativity. The following sections provide guidance on designing practical tasks for each STEM area.

Collaboration:
Encourage collaboration among learners during all the activities described below. Working in teams cultivates teamwork and communication skills, vital attributes in real-world design and engineering scenarios. Collaborative problem-solving adds an extra layer of complexity to the task.

Online repositories
For all the following activities, it is essential to bear in mind that there are numerous **online repositories full of well-developed and tested projects** and challenges by teachers, trainers, and learners. By sacrificing a bit of originality, one can more easily find some valuable resources for our goal, which is to propose well-studied and optimised activities.

Task Design Considerations:

Clearly define the learning objective. **Having a well-defined objective guides learners towards achieving specific outcomes.**
In general, two main types of objectives can be distinguished for all these activities, namely, distinguishing between the goal of **learning about the technology and techniques** used through the proposed challenges **or**, at a later level, using the acquired skills in using the tools to summarise and **leverage them** to the fullest in order **to tackle a more complex challenge**.

For Robotics, for instance, the task could focus on **understanding basic robot movements or solving a specific challenge with movements and sensors.**
For 3D modelling and 3D printing, the learning objective could be **understanding basic 3D modelling techniques or addressing a specific design challenge**.

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For Microcontrollers, challenges could be focused on **creating basic electronic circuits** and implementing control logic **or** on applying acquired skills in microcontroller programming to efficiently design and **execute specific tasks**, emphasizing real-world applications and problem-solving.

For Coding, challenges could cover algorithms aiming to **enhance overall programming proficiency or** utilize coding skills to **analyse complex problems, design efficient solutions.**

For web Development, challenges could explore HTML, CSS, and JavaScript, emphasizing the **creation of visually appealing and interactive web pages or** applying web development skills to **design and implement dynamic websites**, focusing on user experience and responsive design.

Resources:

Knowing the available resources helps tailor the task to the technological tools at hand, ensuring a seamless learning experience.
For web development and coding, the analysis of available resources primarily involves the availability of devices such as **computers/tablets and access to the internet and necessary software** for block or text-based code development, depending on the languages used.

Concerning **3D modelling**, it is essential to note that **having a mouse** will be very useful, or in the case of tablet use, opting for software that can be easily used even without a mouse, such as *Tinkercad Codeblocks*.
For **3D printing**, it is necessary to be familiar with the **type of printer**, its dimensions, available printing materials, and slicing software if a specific one is required.

In **educational robotics**, everything depends on the **brand and model of the kits** used, which may or may not have **certain sensors and actuators**. For example, a colour recognition challenge is not feasible if the robotics kit lacks the necessary sensor. Additionally, it's important to know if the programming software for the robot is block-based.

For **microcontrollers**, detailed knowledge of all available devices (**boards, sensors, actuators**) is even more crucial than for the technologies listed above. Furthermore, if we want to program microcontrollers using block resources like *Tinkercad Circuits*, we need to ensure that the microcontroller we use is part of those available on the platform.

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Example Tasks

Robotics:

Design a robot capable of **navigating a predefined course autonomously**, utilising sensors to detect and respond to obstacles. This task integrates various skills, including **programming the robot's movements**, configuring sensors, and troubleshooting potential issues. Additionally, learners can enhance their problem-solving skills by optimising the robot's performance through iterative testing.

3D Modelling and 3D printing

Design a **functional object** using 3D modelling software and print it using a 3D printer, **considering specific design constraints and technical requirements**. For example, producing a **desktop stand for a mobile phone or a greatly reduced-scale model** to represent a **building in miniature**.

This task integrates various skills, including creating a 3D model, optimising design for printing, and troubleshooting potential issues. Additionally, learners can enhance their problem-solving skills by iteratively refining the design based on test prints.

Coding

Create block code to enable some **historical figures to speak about themselves** and their era, moving across various backgrounds with images representing their time. Challenge learners by **requiring the characters to ask questions** and react differently based on the responses.

Microcontrollers

Program a microcontroller to **control an LED light**, allowing learners to turn it on and off using a button. Challenge learners to enhance the project by **adding a sensor**, such as a light sensor, to automate the light based on environmental conditions. Encourage problem-solving by troubleshooting any issues with the sensor integration.

Web Development

Task learners with building a **basic webpage** that introduces themselves, including sections for personal information and interests. Challenge learners to add a simple contact form and an image gallery. **Encourage problem-solving by refining the webpage** layout and functionality based on user feedback.

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Using the Activity Kit ICT Challenges

In the "Activity KIT" document, there are **50 potential challenges**, presented as individual worksheets, 10 for each of the technologies: 3D modelling and 3D printing, Coding, Robotics, Microcontrollers, and Web development. Each set of 10 challenges is further divided into 4 beginner, 3 intermediate, and 3 advanced levels.

The challenges are designed to be completed in a time frame ranging from 30 to 50 minutes. **Beginner-level** challenges are intended for **initial approaches** to these activities, while progressing to the advanced level allows tackling more elaborate tasks, never reaching the complexity of robotics contests or similar events.

It is crucial to note that **these are not tutorials**, so there are no step-by-step descriptions of how to perform the activity and solve the challenge. Instead, there are suggestions and considerations regarding necessary resources, learning objectives, etc. In this regard, it is important to emphasise that **educators/trainers** intending to use them for educational activities with their learners or learners **must already possess the necessary technical skills related to the respective technology**, as described above in this document.

The worksheet for **each challenge starts with** a title, usually presented as **a question**, followed by a brief description of the objective to achieve. Next is the "Getting started guide" paragraph, providing a general overview of the challenges, including different levels and the skills expected to be transferred through the activities.

The "Learning objectives" are then listed, describing **both the technical aspects and potential curriculum-related contents**. For example, in a robotics challenge, this might involve understanding how a traffic light functions, providing insights for lesson plans or further exploration.

Each worksheet includes a **list of necessary materials** and one containing suggestions on how to adapt to different learners, including those with special needs. Finally, the worksheet concludes with a paragraph offering suggestions on the possible outcome of the challenge, often accompanied by images illustrating the suggestion.

It is important to **note that the final suggestions** and related images **are** necessarily **linked to specific solutions**. In the case of robotics, they refer to the "Lego Spike Prime" kit, for coding to "Scratch," for 3D modelling to "Autodesk Tinkercad," and for microcontrollers to "Micro:Bit" and "Arduino Uno" with block-based circuits and programming done through “Tinkercad Circuits”.

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Adapting activities to the specific context of formal and non-formal education

In formal education, STEM activities are typically conducted through specific projects that engage learners in hours that may be outside of the curriculum. However, **it is appropriate** and usually desired by teachers that STEM **activities be aligned with** the content of the **curriculum**. This correlation is easy and immediate to imagine and build when, for example, it comes to doing an activity with Robotics or Microcontrollers in a technical or vocational institute (the ideas for physics, technology, and electronics are countless), while it can be more difficult to imagine when dealing with disciplines such as history or literature: in these cases, it is easier to imagine activities such as 3D modelling and printing (think of the modelling and printing of a monument) or with coding (think of the classic "storytelling" to convey the story of a summary of a novel or the recitation of a poem).

The worksheets of the challenges mentioned above, **provide suggestions** for possible links with curricular activities.
In any case, it is important to consider two fundamental factors:

- Regardless of the direct connection with the curricular subject, the development of **computational thinking** and the soft skills typically associated with STEM activities (problem-solving, teamwork, etc.) can already represent an excellent focus to help the student in all learning paths.
- The vast majority of teachers who embark on STEM paths with their learners, regardless of the subject of instruction, believe that these activities are an incomparable tool in relation to their **ability to capture** the attention of learners and make learning more fun.

In order to list the fundamental aspects of the decline of STEM activities and the use of ICT challenges in a formal context:

- Set a learning objective (curricular or soft-skill or both)
- Provide activities to cover time periods of about 2-3 hours maximum per meeting.
- Use the suggestions of the challenges to identify any relationships with the curricular programs
- Use, for each meeting, one or more challenges worksheets of the preferred level, even ranging between one technology and another, keeping in mind the pre-set learning objective
- **Focus on the ability of these activities to capture attention**, without the need to find an identical parallelism between the curricular subject and that

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of the challenge but using it even as a starting point and to leverage the aroused interest.

In a non-formal context, the duration of the activities has no constraints related to having to prioritise curricular lessons or to correlate the content to certain topics of the school program.

In these contexts, it is therefore usually preferred to build **paths** to address the individual **technologies in a complete way**, starting from the basic notions up to more complex activities, perhaps with in mind the development of intermediate projects that are then part of a more complex final project of the path, such as the construction and programming of a complex robot or a 3D printed model consisting of multiple parts to be assembled.

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Module 5: Assessment Strategies (2 hours)

Learning Objectives

By the end of this module, participants will be able to:

- Identify and differentiate Assessment Types: Clearly understand the roles of diagnostic, formative, and summative assessments in digital learning.
- Implement Assessment Strategies: Apply practical tools and techniques for effective assessment, including real-time feedback and personalised instruction.
- Create Personalised Learning Paths: Use diagnostic data to adapt learning experiences to individual student needs.
- Boost Engagement and Achievement: Employ strategies that enhance engagement and monitor progress to improve learning outcomes.

In the following sections, we will explore the key concepts and strategies associated with each type of assessment, focusing on their unique functions in the context of digital learning environments. All will provide practical ideas and tools for effective assessment practices. Examples will be real-time feedback and continuous monitoring in formative assessments, strategic use of diagnostic data for personalised instruction, comprehensive assessment of learning outcomes through summative assessments, among other options.

Diagnostic assessment for digital learning

Definition and purpose

Diagnostic assessment in digital learning refers to the process of assessing learners' prior knowledge, skills, and learning needs before instruction begins. It is important because it allows educators to understand individual learner profiles, identify potential challenges, and adapt instructional strategies to meet specific learning needs.

Examples of Diagnostic Assessments in Digital Education

Pretests and surveys

Pre-tests and surveys administered at the beginning of a digital course help assess learners' knowledge, learning preferences, and expectations. This information guides teachers and trainers in designing personalised learning paths and adapting content to the diverse needs of learners. This type of pre-test could easily be created using free online tools such as Google Forms, Survey Monkey, etc.

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Diagnostic tools for digital learning platforms

Many digital learning platforms incorporate diagnostic tools that assess learners' proficiency in specific skills or subjects. These tools generate detailed reports that allow educators to identify strengths and weaknesses and areas that require additional support. Some of the most useful tools for this purpose are Class Dojo, Google Classroom, etc.

Using diagnostic data for personalised instruction

Identifying learning gaps

Diagnostic data provides detailed insight into individual learning gaps. Educators can use this information to design targeted interventions, address critical knowledge deficits, and create personalised learning plans for each learner.

Adapting instructional strategies

With the information obtained from diagnostic assessments, teachers and trainers can adapt their teaching strategies to the different needs of learners. This may involve adjusting the pace of instruction, incorporating varied resources, or adopting alternative teaching methods.

Addressing individual learner needs

Diagnostic assessments allow educators to address the specific needs of individual learners. By identifying specific areas of challenge or strength, teachers can offer personalised support, differentiate instruction, and create an inclusive learning environment that accommodates diverse learning styles.

Formative assessment in digital education

Definition and purpose

Formative assessment in digital education involves continuous evaluation processes that occur during the learning experience to gather real-time feedback and guide instructional decisions. The primary goal is to improve learning outcomes by providing continuous feedback on learners' progress, understanding, and engagement. Unlike summative assessments, formative assessments focus on the learning process itself, helping educators adapt their teaching methods to meet the immediate needs of learners.

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Types of formative assessments for digital learning

Questionnaires and online surveys

Online questionnaires and surveys are effective tools for assessing learners' understanding of digital content. They provide instant feedback, allowing educators to assess comprehension, identify misconceptions, and adjust instruction accordingly. These assessments can be integrated into digital platforms and are especially useful for assessing factual knowledge and concept retention. Some of these assessments could be conducted using free online tools such as Educaplay, Ducksters, Genially, etc.

Discussion and Feedback Forums

Learner participation in online discussion forums encourages collaboration and critical thinking. Formative assessment occurs through participation, allowing educators to assess comprehension, communication skills, and the ability to articulate ideas. Providing timely feedback in these forums encourages ongoing dialogue and supports the development of higher-order thinking skills. Learner-to-learner forums can be easily created using simple tools such as Blogger, Google Classroom, etc. Similarly, if we use a platform, it will have options for forums.

Interactive simulations and games

Interactive simulations and educational games offer immersive learning experiences. They allow learners to apply knowledge in a practical context, providing valuable insights into problem-solving skills. In this context, formative assessment consists of observing learners' interactions with simulations or games, identifying problem areas, and addressing them through targeted interventions. One of the best tools for developing these customised simulations and games is Genially, which offers many possibilities.

Strategies for effective formative assessment

Real-time feedback

Providing real-time feedback during digital activities allows learners to immediately correct misunderstandings. This instant feedback loop fosters a supportive learning environment, encourages active participation, and guides learners toward a deeper understanding of the material.

Continuous monitoring

Continuous monitoring involves regularly tracking learners' progress throughout a lesson or digital activity. Educators can use data analysis and dashboards to

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identify trends, measure engagement levels, and pinpoint areas where additional support may be needed.

Student Engagement Techniques

To improve formative assessment, the incorporation of various learner engagement techniques is crucial. Strategies such as online surveys, gamification elements, and interactive discussions help to maintain learner interest, ensuring their active participation and facilitating a more accurate assessment of their learning progress.

Summative assessment in digital education

Definition and role

Summative assessment in digital education involves assessing the overall performance of learners at the end of a learning period. Its function is to measure the extent to which learning objectives have been achieved, providing an overall picture of learners' knowledge and skills.

Although summative assessments focus on final results, it is still important to provide constructive feedback. Feedback should highlight strengths and areas for improvement, guide learners on their continued learning journey, and help them understand how to improve their performance on future assessments.

Types of summative assessments for digital learning

Online Final Exams

Online final exams assess learners' overall understanding of the digital course content. These exams may include a mix of multiple-choice questions, essays, and hands-on problem-solving scenarios. The results help determine overall learner performance. Again, applications such as Moodle, Google Forms or Survey Monkey can be used to create this immediate feedback.

Digital Project Presentations

Digital project presentations allow learners to showcase their skills and knowledge in a practical context. These summative assessments can involve creating multimedia presentations, websites, or other digital artifacts that demonstrate mastery of key concepts. Canva or Genially are some of the best tools to use for developing these digital projects. Both offer free options and can be easily used.

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Incorporating Rubrics and Criteria

In the case of rubrics, we will consider the following:

(a) *Alignment with learning objectives.* To ensure the effectiveness of summative assessments, educators should develop clear rubrics and criteria aligned with the learning objectives. This alignment ensures that the assessment accurately reflects the intended outcomes of the digital learning experience.

b) *Ensure fair and transparent assessment.* Fair and transparent assessment is essential to maintaining the integrity of summative assessments. Educators must clearly communicate grading criteria, use consistent and unbiased assessment methods, and provide learners with a clear understanding of how their performance will be assessed.

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Module 6: Extra Resources Integration (1.5 hours)

Learning Objectives

- Identify and explore additional resources for self-study.
- Evaluate the relevance of books, articles, apps, e-courses, videos, and podcasts.
- Clarify questions and concerns regarding extra resources.

This module deals with identifying and exploring additional resources for self-study, how to evaluate their relevance and how to integrate them in digital education lessons. The "Activity Kit" document contains a list of recommendations for books, articles, apps, e-courses, videos, and podcasts on the ICT topics Robotics, Coding, Microcontrollers, 3D modelling and printing, and web-development. The extra resources presented in the "Activity Kit" have several purposes as well as advantages:

Enhanced Learning Experience: The resources in the "Activity Kit" provide additional explanations, examples, and perspectives that can enhance the overall learning experience for learners.

Catering to Different Learning Styles: Learners have different learning preferences. Integrating various types of resources allows teachers or trainers to provide to visual, auditory, and kinaesthetic learners suitable material.

Deepening Understanding: Extra resources can explore in more detail specific topics, providing in-depth explanations, case studies, or practical examples to help learners develop a deeper understanding of the respective topic.

Current Information: Digital education is a rapidly evolving field. Extra resources such as websites, podcasts, and online articles can provide the latest information, trends, and developments in the field, ensuring that learners are up to date with knowledge on digital skills.

Self-Paced Learning: Learners can access extra resources at their own pace, allowing them to review materials as needed and reinforcing their understanding of concepts covered in the lesson.

Flexible Instructional Design: Teachers or trainers can use a variety of resources to design flexible lessons that accommodate diverse learner needs and preferences. For example, a mix of videos, readings, and interactive activities might be included to keep learners engaged and motivated.

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Promoting Critical Thinking: Extra resources can challenge learners to think critically about the respective topic by presenting different viewpoints, contradictory evidence, or thought-provoking questions.

Identifying, exploring and evaluating additional resources for self-study and enrichment

Identifying, exploring, and evaluating the relevance of the extra resources in the "Activity Kit" requires a systematic approach. Below is a comprehensive guide on how to conduct this process effectively and ensure a selection of high-quality resources that align to the learning objectives and contribute to the overall educational experience. The guide is divided in four sub-sections dealing with identifying the relevant resources, exploring their content, evaluating their relevance in terms of content alignment, accessibility, and usability, and up-to-dateness.

1. Identifying

- **Define Learning Objectives:** Start by defining the learning objectives and identifying the specific digital skills or topics you want the learners to focus on in their self-study.
- **Research the Extra Resources in the Activity Kit:** Identify resources in the activity kit that match with the learning objectives and digital skills or topics you want to cover.

2. Exploring

- **Review Content:** Evaluate the content of the resources to determine their relevance to your learning objectives. Look for materials that cover the topics, tools, and technologies you want to incorporate.
- **Check Samples or Previews:** If available, explore samples, previews, or free trials of the resources to assess their quality, structure, and alignment with your needs.

3. Evaluating Relevance

- **Assess Content Alignment:** Evaluate how closely the content of the resources aligns with the learning objectives and desired outcomes. Consider whether the materials cover the necessary concepts, skills, and knowledge level.

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- **Assess Accessibility and Usability:** Evaluate the accessibility and usability of the resources, considering factors such as navigation, clarity of explanations, interactivity, and requirements for using the resource.
- **Examine Currency and Relevance:** Determine whether the resources are up-to-date and relevant to current trends, technologies, and best practices in digital education.

4. **Finalising**

- **Create a Comprehensive Resource List:** Choose the relevant extra recourses and create your own list with extra resources that fit your needs.

Integrating extra resources in digital education courses

The integration of the extra resources listed in the "Activity Kit" can significantly enhance the learning experience as well as promote deeper understanding and engagement among learners. The extra resources also ensure a diverse range of learning materials for the learners, also covering their different needs in terms of learning styles or skill set. Below is a comprehensive guide on how to integrate these resources by aligning the relevant resources to the identified learning objectives as well as organising, introducing, and incorporating these resources into the lessons. The guide also includes further steps on how to integrate the resources effectively, encourage learners and evaluate their learning outcomes as well as the success of the resources integration.

1. **Identify Learning Objectives:** Start by identifying the specific learning objectives of the digital education lesson. Determine what knowledge, skills, or competencies you want the learners to acquire or demonstrate by the end of the lesson.

2. **Select Relevant Resources:** Choose extra resources that align closely with the learning objectives and content of the lesson. Consider the diversity of the learners and select resources that align to different learning styles, preferences, and levels of proficiency.

3. **Organise Resources:** Organise the selected resources in a clear and accessible manner. Create a centralised location, such as an e-learning platform, course website or cloud storage, where learners can easily access, download, and navigate the resources.

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4. **Introduce Resources to Learners:** At the beginning of the lesson, introduce the extra resources to the learners and explain their relevance to the topic being covered. Provide guidance on how learners should use the resources, whether it's for pre-reading, supplemental material, or further exploration of specific concepts.

5. **Incorporate Resources into Lesson Activities:** Integrate the extra resources into various lesson activities to reinforce learning and engagement. Depending on the nature of the resources, incorporate them into lectures, discussions, assignments, group projects, or self-paced learning activities. Alternatively, a flipped classroom approach can be adopted by assigning extra resources for learners to review independently before the lesson. Use class time for active learning activities, discussions, and hands-on projects based on the concepts covered in the extra resources.

6. **Create Interactive Learning Experiences:** Design interactive activities that encourage students to engage actively with the extra resources. For example, assign tasks such as watching a video, listening to a podcast, or reading an article, followed by discussions, quizzes, or reflection prompts to deepen understanding and critical thinking.

7. **Provide Guidance and Support:** Offer guidance and support to learners as they navigate the extra resources. Monitor their progress, provide feedback on their engagement with the resources, and offer assistance or clarification as needed.

8. **Encourage Collaboration and Discussion:** Foster collaboration and discussion among learners by incorporating opportunities for peer interaction around the extra resources. Encourage learners to share insights, ask questions, and exchange ideas with their peers through online forums, group discussions, or collaborative projects.

9. **Encourage Exploration and Creativity:** Encourage learners to explore additional resources beyond those recommended in the lessons, fostering a culture of curiosity and creativity.

10. **Assess Learning Outcomes:** Assess learning outcomes of the learners related to the extra resources through various assessment methods, such as quizzes, exams, projects, or presentations. Evaluate learners' understanding, application, and synthesis of the concepts covered in the extra resources as part of their overall performance in the lesson.

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11. **Reflect and Recapitulate:** Reflect on the effectiveness of integrating extra resources into the lesson. Ask for feedback from learners to gather insights into their experiences and perceptions. Use this feedback to recapitulate and improve your approach for future lessons.

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Lessons Learnt (1 hour)

Learning Objectives

- Summarise key concepts and skills covered.
- Encourage participants to implement the Our Digital Village Activity Kit.
- Provide information on ongoing support, community forums, and follow-up sessions.

Key concepts and skills

This training outline is structured into 6 modules that form a course with 30 hours duration targeted at teachers and trainers in formal and non-formal education. The training provides the necessary skills and knowledge to implement the Our Digital Village Activity Kit, fostering the development of transversal and digital skills in both formal and non-formal educational settings. The main concepts and skills addressed in this training outline are:

- Transversal and Digital skills: definition, differences, and importance in our days.
- Development and evaluation of transversal and digital skills by using the Our Digital Village Activity Kit.
- Forward-looking attractive technologies and how they can be used with different levels of proficiency:
    - Robotics: educational robotics, robotics kits, robots' operations and activities.
    - Coding: educational coding, tools for educational coding, hands-on coding activities.
    - Microcontrollers: microcontrollers and their applications, educational microcontroller boards, hands-on activities.
    - 3D modelling and printing: understanding, applications and approaches to 3D modelling; from 3D modelling to 3D printing.
    - Web Development: introduction and basics of web development, types of web development, markup and programming languages, hands-on activities.
- Designing practical tasks to apply the technologies and skills proposed: tips for task design, required resources, examples of tasks, challenges proposed by the Our Digital Village Activity Kit, adaptation to each context.
- Pedagogical application of the contents and resources proposed: integration of learning objectives, teaching methods and approaches for

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digital education training, learners-based approaches, structuring and organising training implementation.
- Assessment strategies for digital learning environments and tools for their application: diagnostic assessment, formative assessment, summative assessment.
- Additional resources for self-study.

The Our Digital Village Activity Kit

Do you know the Our Digital Village Activity Kit? This Kit includes a set of resources addressed to teachers and trainers in formal and non-formal education. We invite you to check it and use it in your educational activities to promote and develop digital and transversal skills among your learners.

What does the Activity Kit include?

- introductory part that underlines the importance of digital skills in the contemporary digitalised world, and the importance of the acquisition of digital and transversal skills for teachers/trainers to make teaching more interactive and engaging
- a pool of min 50 activities presented as ICT challenges using digital and creative technologies and computing such as Robotics, Coding, Microcontrollers, 3D modelling and printing, and web-development. The ICT challenges contain different activities for a certain theme or digital competence, which increase levels of difficulty which will make the activities interesting and stimulating for different levels and ages.
- general pedagogical guidelines to support teachers and trainers to implement the activities based on the local needs, desires and context
- extra resources for more self-study.

You can access the Activity Kit free of charge from the Our Digital Village website.

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Further support

The activities of Our Digital Village are implemented in 7 countries: Austria, Cyprus, Greece, Italy, Poland, Portugal, and Romania. In each of these countries, Our Digital Village partner is available to support you and promote the contact with the local community involved in the project's activities.

You can get involved and obtain support through:

- The info-sessions that are being organised in each country until the end of 2025 addressing relevant aspects related to digital skills.
- The 4 ICT courses that will be organised in each implementing country to increase the digital and transversal skills based on the ICT challenges presented in the Our Digital Village Activity Kit.
- The helpdesks that will be available in each community during the implementation of the ICT courses.
- The public sessions to be held in each community to present the projects developed during the ICT courses.

Stay updated by following our News section and LinkedIN page, learn more about the communities involved and contact the local partner of your country to know more!

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This exercise can be done in several ways: as a simple conversation (face-to-face or online) between trainer and trainees; via written form; using support materials/tools such as post its, online collaborative tools such as Miro, etc.

1. Please name **3 new concepts that you have learnt** or that you know more about after attending this course. Can you talk a bit about at least one of these concepts and why you remember them?
2. How do you see the **connection/interaction between transversal skills and digital skills in education**? Are they dependent on each other? Can they be addressed separately? Can you name activities/tasks that imply both transversal and digital skills?
3. Among the **new technologies** that you learnt about in this course, which one or which ones do you think **you will use more in you lessons/**training/education context? Can you give some examples on how you will use them?
4. Among the **new technologies** that you learnt about in this course, which one or which ones do you think **you will use more in the "outside" world**? E.g. in your personal life, in other activities you have. Can you give some examples?
5. What did you **appreciate the most** in this course? Please indicate **up to 3 aspects**, e.g. a specific content you learnt, the training group, the trainer, the results achieved, one specific activity that you liked a lot...
6. What **would you change for next editions**? Please indicate up to 3 aspects, e.g. a specific content, the materials provided, the timing and/or format of the sessions, the trainer, etc.
7. Please choose or draw and 1 to 3 emoticons (or another image) that reflect your feeling about having attended this course.

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