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1 Introduction

This report was prepared in the framework of the Erasmus+ project CODEDU “Using new learning methodologies and coding with Arduino in Education” and delves into the approaches to coding education in the 6 project partner countries. Cyprus, Greece, Portugal, Slovenia, Spain and Türkiye (in alphabetical order). It is based on the desk research done by all project partners and is also complemented by a second report which is based on questionnaires sent to both students and educators.

Both reports fall within the CODEDU Project, Work Package 2 (WP2) which has the following objectives:

1. To build up a comprehensive picture of the current situation of educational coding, how it is implemented in the EU, and to investigate new learning methodologies
2. To supply educators with the knowledge, skills, training, and materials to implement educational activities to students on coding with Arduinos. These materials must be based on the most up-to-date data that accurately reflects the current situation.
3. To supply students with the relevant training course enabling them to create upskilling pathways towards new technologies.

The digital revolution has transformed nearly every aspect of our lives, and coding skills have become increasingly important for success in the modern world. Recognizing this need, many countries are actively integrating coding education into their school curriculums. This report analyses the methodologies, technologies, student engagement strategies, and innovative practices employed in each country, aiming to identify best practices and areas for potential improvement.

2 National Reports Summary

Each project partner prepared their own national report following a template developed by the Project Partner GoInno. The desk surveys were conducted within March and April 2024 and each partner country completed the survey. This chapter provides a summary from each country’s national desk report which was conducted by each project partner to address the first objective of WP2, aiming to build up a comprehensive picture of the current situation of educational coding, how it is implemented in the EU, and to investigate new learning methodologies. Each partner conducted thorough desk research within the national context to compile data on gaps and needs concerning digital transformation and innovation curricula in schools.

These reports delve into the current state of coding education examining methodologies, technologies, student engagement strategies, and innovative practices.



2.1 *Cyprus. A Landscape of Potential*

Cyprus demonstrates a commitment to fostering coding education. By addressing the identified needs and implementing the suggested best practices, Cyprus can empower its educators and prepare its students to thrive in the digital age.

Teacher Training: A Core Component

Cyprus established the Pedagogical Institute (PI) to spearhead teacher development. The PI offers various training sessions, including those focused on coding and digital skills. These sessions cover topics ranging from augmented reality to pedagogical uses of Micro:bit, catering to educators across all levels. For teachers specialising in Design and Technology, the PI provides training relevant to coding, including robotics (Lego EV3), control systems (CNC machines and 3D printers), and electronics (microcontrollers). While the curriculum specifies learning outcomes, teachers have the freedom to choose their teaching methods.

Technological Tools for Learning

Schools in Cyprus utilise various coding tools. Scratch, Python, and C++ are included in the curriculum, and schools are equipped with robots like Edison (secondary), Lego EV3, and Bee-bot (primary). Additionally, CISCO certification is offered as an elective in higher secondary schools. However, the use of equipment beyond those officially provided seems to be at the teacher's discretion. For instance, while Arduino boards are not officially available, teachers can incorporate them if they wish.

Strategies for Student Engagement

The current curriculum and tight schedules limit the use of specific hardware and software for student engagement. Furthermore, a lack of coding expertise among some teachers restricts the implementation of more engaging techniques like project-based learning or gamification.

Innovation Through Competition

Cyprus actively promotes student engagement in coding through external competitions. The Cyprus Computer Society (CCS) organises several events, including Robotex Cyprus Competition, First Lego League, and the World Robotics Olympiad. Other initiatives include the Cyprus Cyber Security Challenge, the Cyprus Olympiad in Informatics (with afternoon training sessions), and the Bebras Challenge, which introduces computational thinking to upper primary and secondary students. Additionally, programs like "Coding our Future" offer workshops to schools.

Comparative Analysis: Public vs. Private Schools

The Cyprus report highlights disparities between public and private schools. Private schools often establish academies and offer afternoon coding activities, while public schools lack dedicated equipment and rely on teacher initiative. Despite these differences, the PI actively works to inspire and educate teachers across the entire education system.

Recommendations for Best Practices

The report proposes valuable recommendations for integrating coding more effectively into school curriculums:



- **Equipping Educators:** The Ministry of Education should provide essential equipment and training to teachers.
- **Curriculum Updates:** Regular curriculum updates are necessary to keep pace with the evolving field of coding.
- **Interactive Learning Platforms:** Incorporating online and interactive learning platforms can enhance the learning experience.
- **Project-Based Learning:** Encouraging project-based learning fosters creativity and deeper understanding.
- **Competition Participation:** Engaging students in coding competitions can ignite their enthusiasm.
- **Hardware Integration:** Utilising hardware like Arduino boards can make learning more engaging and practical.

Beyond Coding: Additional Considerations

The report emphasises the importance of addressing cyber safety, cyber security, and ethical concerns related to coding education. Furthermore, it suggests exploring the implementation of artificial intelligence (AI) topics and utilising AI for personalised learning experiences.

2.2 Equipping Students for the Digital Age in Greece

Greece is actively promoting coding education to equip its students with the digital skills they need to succeed in the 21st century. The Greek report explores various methodologies, technologies, and engagement strategies used to create a dynamic and enriching learning experience.

Teaching Methods for All Learners

A variety of coding methodologies cater to diverse needs and learning styles. Interactive tutorials and coding bootcamps offer online resources and intensive in-person programs for both students and educators. Project-based learning takes centre stage, allowing students to develop practical skills by designing and building real-world applications, websites, and games. This approach fosters creativity, collaboration, and critical thinking. Recognizing the importance of digital inclusion, Greece offers initiatives like coding clubs and workshops to bridge the digital skills gap and reach out to young people and those not currently in education or employment.

Technologies for Engaging Learners

Technology plays a crucial role in modern coding education. Scratch, a visual programming language with a user-friendly block-based interface, is ideal for introducing young children and beginners to coding concepts. Code.org, a non-profit organisation, provides a wealth of interactive coding tutorials and resources suitable for all ages. Its curriculum aligns with Greek educational standards and is used in schools to promote digital literacy. Kodable, an educational app, utilises games and puzzles to teach coding fundamentals to elementary school students in a fun and interactive way. For more advanced learners, Codecademy offers online courses with hands-on exercises, projects, and quizzes in various programming languages. Finally, GitHub



Classroom empowers educators to manage coding assignments and projects collaboratively in an online environment.

Strategies to Spark Student Interest

Keeping students engaged is key to successful coding education. Gamification techniques incorporate game elements like badges and leaderboards to make coding activities more interactive and enjoyable. Project-based learning, as mentioned earlier, fosters engagement by allowing students to apply their coding skills in practical contexts. Events like the EU Code Week Hackathon and the Greek National Olympiad in Informatics provide opportunities for students to showcase their skills, collaborate with peers, and compete for recognition. These competitions not only motivate students but also cultivate a sense of teamwork and accomplishment. Interactive workshops and coding clubs offer hands-on learning experiences and a supportive environment for students to explore coding further.

Innovative Practices for a Richer Learning Experience

Greece is embracing innovative practices to further enrich the coding education landscape. Coding summer camps offer intensive programs during school holidays, featuring workshops, project-based learning activities, and valuable mentoring support. Integrating robotics with coding allows students to learn coding principles through hands-on experiments and problem-solving activities using robotic kits like LEGO. Partnering with industry leaders allows tech companies to sponsor coding workshops, hackathons, and competitions. This provides students with access to real-world coding projects and connections with industry professionals. Digital Innovation Hubs (DIHs) serve as regional centres, offering workshops, training programs, and networking events to support individuals and organisations in developing digital competencies and utilising emerging technologies. Virtual reality coding environments like CoSpaces Edu add another dimension to learning. These platforms allow students to create and program virtual environments using block-based coding interfaces, making the learning process even more immersive and engaging.

Best Practices for a Successful Future

By implementing these best practices, Greece can ensure a successful future for coding education in its schools. Tailored programming courses cater to the diverse needs and skill levels of students. Interactive learning platforms like Scratch, Code.org, Kodable, and Codecademy provide hands-on learning experiences. Project-based learning opportunities encourage creativity, collaboration, and critical thinking skills. Gamification and competitions add a fun and motivating element to the learning process. Finally, incorporating innovative practices like robotics integration, partnerships with industry, and DIHs can further enrich the learning experience.

Additional Considerations for a Well-Rounded Education

Beyond the specific coding skills, creating inclusive learning environments that cater to diverse learning styles is essential. Offering a variety of coding courses, tools, and activities ensures that all students feel welcome and confident to explore and excel in coding. Teacher training and support are crucial for effective implementation. Equipping educators with the necessary coding knowledge and pedagogical skills allows them to inspire students and effectively teach coding concepts. Encouraging students to pursue



coding-related hobbies, projects, and online courses beyond the classroom fosters a lifelong love of learning and exploration in the ever-evolving world of technology. Finally, emphasising ethical coding practices, including cybersecurity and the societal implications of coding decisions, empowers students to become responsible digital citizens.

By adopting these comprehensive strategies and fostering a culture of innovation, Greece can equip its students with the necessary coding skills and critical thinking abilities to thrive in the digital age.

2.3 *Portugal's Approach to Coding Education*

Portugal is incorporating coding education into its educational system. It delves into the methodologies, technologies, and strategies used to engage students and foster innovative learning practices.

A clear picture of Portugal's commitment to integrating coding education into its curriculum is identified. The diversity of methodologies, technologies, and engagement strategies showcases a focus on making coding education accessible and engaging for all students. By providing students with opportunities to gain experience, experiment, and create, Portugal is equipping its future generation with the digital skills they need to thrive in a rapidly evolving world.

Methodologies for Effective Learning

The report highlights several popular methodologies used for coding education in Portugal. Project-based learning takes centre stage, where students tackle real-world problems by developing their own projects. This approach encourages students to apply their knowledge creatively and develop problem-solving skills. Collaborative learning fosters teamwork and knowledge sharing, as students work together on projects and learn from each other's approaches. Pair programming is another technique where students work in pairs to solve problems, promoting communication and collaboration. Beyond project-based and collaborative approaches, the report highlights the growing use of game-based learning. This method utilises educational games to introduce coding concepts in a fun and engaging way. Games like LightBot and CargoBot not only make learning enjoyable but also introduce students to the fundamentals of coding in a playful environment.

Technologies for a Digital Future

The report explores the diverse range of technologies used in Portuguese coding education. Various programming languages are employed, including C++, HTML, Java, JavaScript, and Python. For beginners, visual programming environments like Scratch, Kodu, Minecraft Edu, and Blockly offer a user-friendly platform to learn coding concepts through a drag-and-drop interface. These environments remove the complexity of syntax, allowing students to focus on the core logic of programming.

The report also acknowledges the growing role of hardware platforms like Arduino, Lego WeDo, and Lego Mindstorms. These platforms are used in robotics education, allowing students to not only learn coding but also see the tangible results of their programming.



efforts. Building robots with these tools brings coding concepts to life, making the learning process more engaging and rewarding.

Strategies to Spark Engagement

The report emphasises various strategies to keep students engaged in coding education. Project-based learning, as mentioned earlier, allows students to apply their creativity and knowledge to solve problems they find interesting. Gamification and competitions further enhance engagement by introducing an element of fun and friendly competition. Storytelling can also play a crucial role in making coding concepts more relatable and interesting for students. By incorporating narratives into coding projects, students can connect with the learning material on a deeper level.

Robotics is another powerful tool for student engagement. Building and programming robots allows students to witness the practical applications of coding in a real-world setting. Seeing their creations come to life through code provides a sense of accomplishment and motivates students to continue learning.

Fostering Innovation with Dedicated Spaces

The report highlights the growing trend of MakerSpaces in Portuguese schools. These dedicated spaces provide students with a platform to experiment with coding and build projects. With access to various tools and resources in a collaborative environment, students can unleash their creativity and explore the possibilities of technology. Initiatives like CodingFest and Apps for Good further encourage innovation by providing platforms for students to develop coding skills while addressing real-world challenges.

2.4 Coding Education on the Rise in Slovenia

While coding is not a mandatory subject in Slovenian primary schools, at least not yet, the country exhibits a growing emphasis on non-formal coding education. Innovative practices and a focus on student engagement hold promise for a future where coding literacy becomes a cornerstone of Slovenian education.

Optional Coding in Schools

Unlike some countries, coding is not mandatory in Slovenian primary schools. It's offered as an optional subclass within Computer Science (grades 4-6) or Multimedia, Editing of Texts, and Computer Networks (grades 7-9). As a result, many students graduate without exposure to coding.

Focus on Non-Formal Learning

Despite the lack of formal curriculum integration, Slovenia boasts a vibrant non-formal coding education scene. Teachers often use student-centred approaches like game development to introduce coding. Younger children might even participate in unplugged activities, like coding through movement on a designated floor grid.

Technologies for Every Age

Scratch and ScratchJr reign supreme for introducing coding to young minds. Other visual coding languages like Alice and Kodu cater to beginners. Educators leverage physical coding platforms like Lego Education WeDo, Sphero, Arduino, and MicroBit to bring coding to life. Upper grades and high school delve into Python, C, and C++ for more advanced programming concepts. Notably, kindergartens and younger primary school



classes can utilise Kubo robotics, a screen-free approach that introduces basic coding and robotics principles through play.

Engaging Strategies to Spark Interest

Since coding is not mandatory, competitions serve as a powerful motivator. Events like Pišek and Bober, along with competitions organised by the Slovenian Association for Technical Culture (ZOTKS), cater to various age groups and coding languages. Summer schools organised by faculties and camps incorporating coding or robotics offer fun and engaging learning experiences. Online courses like Coding with Kids provide another avenue for children to explore coding at their own pace.

Innovative Practices: A Smooth Transition

Kubo robotics stands out as an innovative practice for introducing coding and robotics to kindergarten and early primary school children. A unique approach to bridge the gap between visual and text-based coding was piloted in a summer school program. Stencyl, a video game development tool, enabled students to write code while simultaneously visualising their creation. This method not only motivated students through game creation but also offered a glimpse into text-based coding.

Recommendations for the Future

The report emphasises the need for integrating coding into the mandatory curriculum, considering its crucial role in today's digital world. Kubo robotics' screen-free approach for early learners is recognized as a valuable starting point. Furthermore, Stencyl's application in transitioning from visual to text-based coding is highlighted as a promising practice. Game-based learning, as research suggests, is another effective method to boost student motivation and engagement.

Beyond the Curriculum: Teacher Training and Enthusiasm

The report underscores the importance of teacher recognition of coding's relevance and their willingness to incorporate it into their classrooms. EU projects like Code Week play a vital role in promoting such initiatives. Researchers point out the shift in teaching methodology required for coding – a move from teacher-centred to student-centred approaches. This necessitates enthusiastic teachers prepared to embrace new methods like hands-on learning, game design, and project-based learning, even if they are more time-consuming.

2.5 Equipping Spanish Students for the Digital Age

The current landscape of coding education in Spain includes a particular focus on innovative learning methodologies and the integration of Arduino in educational settings. It explores the various coding methodologies employed, the technologies utilized, strategies for student engagement, and groundbreaking practices being implemented. The report concludes with recommendations for best practices in integrating coding into school curriculums and additional observations on the significance of coding education.

Diverse Methodologies for Diverse Learners

Spanish educators are embracing a range of coding methodologies to cater to the varied needs and learning styles of their students. Project-Based Learning (PBL) has emerged as a popular approach, where students tackle real-world projects that require them to



apply coding and programming skills. This hands-on experience fosters creativity, collaboration, and problem-solving abilities as students design and build applications, websites, and games. Recognizing the importance of computational thinking from an early age, many Spanish educational policies highlight the value of methodologies like Design Thinking, which emphasises problem-solving skills from the perspectives of both humans and computers.

Technology: A Crucial Partner in Learning

Technology plays a vital role in modern coding education. Interactive online tutorials and platforms like code.org, Codecademy, Scratch, and Khan Academy provide students with engaging resources to learn various programming languages. The Arduino platform, open-source electronics prototyping board, is gaining traction as a valuable tool for hands-on learning. Studies have shown that integrating Arduino with Scratch creates a particularly effective learning experience. This combination allows students to apply coding principles in practical contexts, enhancing their problem-solving skills, understanding of computation, and interest in engineering professions.

Strategies to Spark Student Interest

Keeping students engaged is paramount for successful coding education. Gamification techniques that incorporate game elements like badges and leaderboards are being employed to make coding activities more interactive and enjoyable. Project-Based Learning, as discussed earlier, also fosters engagement by allowing students to apply their coding skills in practical contexts. Events like hackathons provide further opportunities for student engagement. These competitions not only motivate students to show their skills and collaborate with peers but also cultivate a sense of accomplishment through recognition.

A Landscape of Innovation

Spanish educators are constantly seeking innovative practices to further enrich the coding education landscape. Integrating robotics with coding allows students to learn coding principles through hands-on experiments and problem-solving activities using robotic kits like LEGO. Partnerships with industry leaders from tech companies offer valuable opportunities for students. These collaborations provide students with access to real-world coding projects and connections with industry professionals, fostering a sense of relevance and future career possibilities. Emerging research is exploring the use of physiological data analysis, such as heart rate, to show student anxiety levels during coding activities. This information can be used to develop better support mechanisms for students experiencing anxiety, creating a more inclusive learning environment.

Building a Strong Foundation for the Future

The report recommends a set of best practices for integrating coding into school curriculums. Tailored programming courses cater to the diverse needs and skill levels of students. Interactive learning platforms like Scratch, Code.org, Kodable, and Codecademy provide hands-on learning experiences. Project-Based Learning continues to be a valuable approach, encouraging creativity, collaboration, and problem-solving through real-world projects. Gamification and competitions add a fun and motivating element to the learning process. Finally, incorporating innovative practices like robotics



integration, partnerships with industry, and exploring physiological data analysis can further enrich the learning experience.

Beyond the Code: A Well-Rounded Education

Creating inclusive learning environments that cater to diverse learning styles is essential. Offering a variety of coding courses, tools, and activities ensures that all students feel welcome and confident to explore and excel in coding. Teacher training and support are crucial for effective implementation. Equipping educators with the necessary coding knowledge and pedagogical skills allows them to inspire students and effectively teach coding concepts. Encouraging students to pursue coding-related hobbies, projects, and online courses beyond the classroom fosters a lifelong love of learning and exploration in the ever-evolving world of technology. Finally, emphasising ethical coding practices, including cybersecurity and the societal implications of coding decisions, empowers students to become responsible digital citizens. By adopting these comprehensive strategies and fostering a culture of innovation, Spain can equip its students with the necessary coding skills and critical thinking abilities to thrive in the digital age.

2.6 Unveiling the Coding Landscape in Türkiye

The Turkish report underscores the importance of developing coding content suitable for all age groups, along with employing diverse teaching techniques. By implementing these recommendations and fostering a culture of innovation, Türkiye can empower its young people to become the future generation of coding experts.

Coding Instruction: A Two-Tiered Approach

Türkiye's coding education system is divided into primary/secondary and vocational education. While coding is mandatory in vocational schools, it is still an optional subject in primary and secondary schools. The Ministry of National Education sets the curriculum, but teachers have the flexibility to incorporate more applications. A key challenge lies in ensuring teachers have the necessary coding skills. In-service training programs are offered to address this need, particularly for Information Technology teachers.

A Range of Technologies to Spark Interest

Coding education in Türkiye leverages a variety of technologies. Scratch, a block-based programming platform, reigns supreme in primary and secondary schools, allowing students to create projects while mastering basic programming logic. As students' progress to middle and high school, Python enters the scene, offering a more in-depth exploration of software development concepts. For those looking to venture into physical computing and electronics, Arduino serves as a popular platform, enabling students to create interactive projects using sensors and motors. App Inventor caters to students interested in mobile app development, translating Python or C-based applications into mobile experiences. Finally, coding robots like mBot and Lego Mindstorms provide a hands-on introduction to robotics, particularly in primary and secondary schools.



Strategies to Engage Young Coders

With a centralised education system, teachers have the autonomy to choose their teaching methods. While some incorporate project-based learning or gamification, a common approach involves teacher-led instruction. This highlights the need for a wider range of engaging and effective teaching techniques. To bridge this gap, Türkiye actively participates in Erasmus+ projects, offering access to free coding training platforms.

Contests and Activities: Fuelling the Coding Passion

Several initiatives exist to cultivate student interest in coding. Coding competitions are held at various levels, providing a platform for students to highlight their skills and engage in friendly competition.

- **Scratch Day:** This global event, held annually in May, encourages children to create games, stories, and animations using Scratch. Turkish schools and communities actively take part in these activities.
- **Coding Clubs and Workshops:** Schools can set up coding clubs or workshops to introduce students to basic programming concepts through fun projects.
- **Science and Technology Centres:** Many such centres offer coding programs, providing a stimulating environment for children to learn and experiment.
- **High School Competitions:**
 - **CodeFest:** This inter-high school coding competition, set up in 2016, offers online team-based challenges and workshops.
 - **Science and Technology High Schools Inter-Secondary School Project Competition:** This competition fosters teamwork and innovation as students develop and present their own projects.

Innovative Practices: Inspiring the Next Generation

Türkiye demonstrates a commitment to exploring innovative practices in coding education:

- **Code Week Celebrations:** The Ministry of National Education organises Code Week activities across all educational levels, aiming to spark student interest in coding.
- **BTK Academy:** This online platform offers free training courses in various science and technology fields, including coding and robotics.
- **Turkish Open-Source Platform and Ecole 42:** This collaboration brings the world-renowned software school's unique training method to Türkiye.
- **Bloom coding:** This online platform caters to children, offering coding courses that not only teach game development but also cultivate problem-solving and creative thinking skills.

Comparative Analysis: Insights and Recommendations

The report highlights key observations based on case studies from different schools:

- **Coding Education Gap:** While vocational schools integrate coding, primary and secondary schools lack mandatory coding instruction.
- **Standardised Curriculum with Teacher Flexibility:** The Ministry sets the curriculum, but teachers can incorporate more elements.



- **Teacher-Centred Instruction:** The most common approach is teacher-led instruction, highlighting the need for more engaging methods.
- **Limited Lab Availability:** Access to well-equipped labs can enhance the learning experience.
- **Teacher Training Needs:** Not all schools have teachers equipped to teach coding effectively.

The report proposes valuable recommendations for integrating coding into the curriculum:

- **Introduce Mandatory Coding:** Making coding compulsory, particularly in middle school, can ensure broader exposure to this critical skill.
- **Engaging Teaching Methods:** Supporting coding education with techniques that motivate and make learning fun is crucial for success.
- **Embrace Innovation:** Teachers are encouraged to explore innovative techniques to keep students engaged and motivated.

3 Methodologies for Effective Learning

This section dives into the various approaches and technologies employed in coding education across the six analysed countries. We will explore how these countries are fostering coding through project-based learning, gamification, and competitions, while acknowledging the importance of teacher training and addressing the challenges of resource availability and curriculum development.

3.1 Project-Based Learning (PBL)

A cornerstone of coding education across many countries, project-based learning allows students to apply their coding skills to solve real-world problems. This approach fosters creativity, collaboration, problem-solving skills, and critical thinking as students design, develop, and present their projects.

- **Greece** prominently features PBL, allowing students to develop practical skills by designing and building real-world applications, websites, and games. This approach fosters creativity, collaboration, and critical thinking.
- **Portugal** takes PBL a step further by incorporating design thinking and computational thinking into their curriculum. Design thinking equips students with a human-centred approach to problem-solving, while computational thinking helps them understand the logic behind computers and algorithms.
- **Slovenia** uses student-centred approaches like game development, where students learn coding concepts by creating games. Additionally, they employ unplugged activities, such as coding through movement on a designated floor grid, to introduce basic programming logic without relying on technology.
- **Spain** is increasingly adopting PBL methodologies, recognizing the benefits of hands-on learning and application of coding skills in practical contexts.

3.2 Teacher-Centred Instruction

While PBL and student-centred approaches are gaining traction, teacher-centred instruction is still prevalent in some countries.

- **Cyprus** faces similar challenges, with teacher training and resource availability affecting the implementation of a wider variety of methodologies beyond traditional classroom instruction.
- **Türkiye** acknowledges the need for a wider range of engaging methodologies to move beyond traditional teacher-led instruction and cater to diverse learning styles.

4 Technologies for a Digital Future



4.1 Scratch

A user-friendly visual programming environment with a block-based interface, Scratch serves as a popular choice for introducing beginners to coding concepts in most countries analysed. Beyond scratch countries are adopting various technologies to cater to different learning styles and advancement levels.

- **Cyprus** incorporates robots like Edison in High school, Lego EV3 and Bee-bot in primary schools.
- **Greece** uses Scratch, Code.org (a non-profit organisation offering interactive tutorials), Kodable (an educational app for elementary students), and Codecademy (providing online courses with hands-on exercises).
- **Portugal** uses a wider variety of visual programming environments like Kodu, Minecraft Edu, and Blockly.
- **Slovenia** prioritises hands-on learning through platforms like Lego Education WeDo, Sphero, Arduino, and MicroBit.
- **Spain** uses a range of tools, including Scratch, Python, and Arduino, depending on the educational level and program focus.
- **Türkiye** uses Python for more advanced students and App Inventor for students interested in mobile app development.

5 Strategies to Spark Student Engagement

5.1 Gamification

A popular strategy across many countries, gamification uses game elements to make coding tasks more interactive and enjoyable. This approach uses students' natural competitive spirit and intrinsic motivation associated with games.

5.2 Collaborative Learning

Portugal emphasises collaborative learning through pair programming and teamwork activities. Other countries, like Spain and Greece, are also incorporating collaborative learning approaches.

5.3 Competitions

Encouraging healthy competition and providing a platform for students to highlight their skills is a valuable strategy employed in all countries.

- **Cyprus** has many national coding competitions in Cyprus coordinated by the Cyprus Computer Society. These include initiatives to spark student participation in international events like the Bebras Challenge, the Cyprus Olympiad in Informatics, the Cyprus Cyber Security Challenge and many Education Robotics competitions.
- **Greece** actively promotes student participation in both national and international coding competitions. The annual Greek National Olympiad in

Informatics (OI) shows and prepares talented students for international competitions like the IOI. Additionally, events like the EU Code Week Hackathon provide a platform for students to collaborate, solve real-world problems through coding, and display their creativity.

- **Portugal** national coding vents like CodingFest an activity within the Code Portugal Movement project that consisted of an "Hour of Code" session followed by a set of challenges that supported a nationwide competition between primary schools.
- **Slovenia** actively promotes student engagement through established competitions like Pišek (focusing on algorithms and programming), Bober (a computer science competition for primary and secondary school students), and competitions organised by Slovenian Association for Technical Culture (ZOTKS) where students compete in coding in Logo (for the youngest children, from kindergarten on), in Scratch, C, C++, Python, and in Pascal (for older primary students to high school students).
- **Spain** is building a culture of coding competitions. Events like the Spanish Programming League (Liga Española de Programación) and initiatives like "Cansat," a space systems programming competition, are gaining traction and encouraging student engagement.
- **Türkiye** has a strong tradition of coding competitions, with events like CodeFest, Science and Technology High Schools Inter-Secondary School Project Competition, and individual student participation in international competitions like the International Olympiad in Informatics (IOI).

6 Fostering Innovation with Dedicated Spaces and Practices

- **MakerSpaces:** Portugal takes a unique approach by incorporating MakerSpaces into schools. These dedicated spaces provide a collaborative environment for students to experiment with coding, build projects, and explore their creativity.
- **Bridging Visual and Text-Based Coding:** Slovenia piloted a unique approach using Stencyl, a game development tool that allows students to write code while simultaneously making transition from visual to text-based coding easier.

7 National Initiatives and Innovative Practices

- **Cyprus:**
 - **Emphasis on Cyber Security and Ethics:** Cyprus emphasises the importance of addressing cyber safety, cyber security, and ethical considerations in coding education.
 - **Exploring AI Integration:** The report suggests exploring the implementation of artificial intelligence (AI) topics and using AI for personalised learning experiences.
- **Greece:**



- **Coding Summer Camps:** These camps offer intensive programs during school holidays, featuring workshops, project-based learning activities, and valuable mentoring support.
- **Robotics Integration:** Greece integrates robotics with coding, allowing students to learn coding principles through hands-on experiments and problem-solving activities.
- **Digital Innovation Hubs (DIHs):** These regional centres offer workshops, training programs, and networking events to support individuals and organisations in developing digital competencies and using emerging technologies.
- **Virtual Reality Coding Environments:** Platforms like CoSpaces Edu add another dimension to learning. Students create and program virtual environments using block-based coding interfaces, making the learning process more immersive and engaging.
- **Portugal:**
 - **CodingFest and Apps for Good:** These initiatives encourage students to develop coding skills while addressing real-world challenges.
 - **Focus on Teacher Training:** Portugal prioritises teacher training, recognizing the importance of equipping educators with the necessary coding knowledge and pedagogical skills.
- **Slovenia:**
 - **Kubo Robotics:** This innovative program introduces screen-free coding and robotics principles through play to kindergarten and early primary school children.
 - **EU Projects:** Slovenia actively takes part in EU projects like Code Week, promoting coding education initiatives.
- **Spain:**
 - **National Plan for Digital Competence of Schools:** Launched in 2018, this plan aims to integrate digital competence development into Spanish education, including coding skills.
 - **Innovative Technological Tools:** Initiatives like "Robotix" introduce students to robotics and coding through competitions and workshops.
 - **Focus on Teacher Training and Support:** Spain recognizes the importance of teacher training and support in effectively implementing coding education. Programs are being developed to equip educators with the necessary skills and resources.
- **Türkiye:**
 - **Code Week Celebrations:** The Ministry of National Education organises Code Week activities to spark student interest in coding across all educational levels.
 - **BTK Academy:** This online platform offers free training courses in various science and technology fields, including coding and robotics.



- **Turkish Open-Source Platform and Ecole 42 Collaboration:** This collaboration brings a renowned software school's unique training method to Türkiye.
- **Bloomcoding:** This online platform caters to children, offering coding courses that not only teach game development but also cultivate problem-solving and creative thinking skills.

8 Comparative Analysis:

8.1 Key Findings and Recommendations

- **Integration into Curriculum:** All six countries see value in mandatory coding education, particularly in middle school. However, the level of mandatory integration varies.
- **Teacher Training:** Equipping teachers with the necessary coding skills and pedagogical approaches is crucial across the board.
- **Engaging Methodologies:** Implementing project-based learning, gamification, collaborative activities, and student-centred approaches is essential for student motivation and effective learning.
- **Hardware Integration:** Providing access to well-equipped labs with tools like Arduino boards and robots can significantly enhance the learning experience.
- **Curriculum Updates:** Regularly updating the curriculum is necessary to keep pace with the evolving field of coding.
- **Interactive Learning Platforms:** Utilizing online and interactive platforms like Scratch, Code.org, Kodable, and Codecademy can enrich the learning experience and cater to diverse learning styles.

8.2 Additional Considerations for a Well-Rounded Education

- **Focus Beyond Coding:** Creating inclusive learning environments that cater to diverse learning styles is essential. Offering a variety of coding courses, tools, and activities ensures all students feel welcome and confident to explore and excel in coding.
- **Importance of Ethics:** Emphasising ethical coding practices, including cybersecurity and the societal implications of coding decisions, empowers students to become responsible digital citizens.
- **Encouraging Lifelong Learning:** Encouraging students to pursue coding-related hobbies, projects, and online courses beyond the classroom fosters a lifelong love of learning and exploration in the ever-evolving world of technology.

8.3 Challenges and Opportunities

While considerable progress has been made, some challenges remain in implementing effective coding education across all six countries. Here's a closer look:



- **Teacher Training and Support:** Equipping teachers with the necessary coding skills and pedagogical approaches to effectively deliver coding education remains a critical challenge. Programs that provide ongoing training and support are crucial for successful implementation.
- **Resource Availability:** Access to high-quality equipment, software, and learning platforms can vary depending on the school district and socioeconomic factors. Initiatives to bridge the digital divide and ensure equitable access to coding education resources are essential.
- **Curriculum Development and Standardization:** The level and scope of coding education integration vary across countries and even within school districts. Developing standardised or national frameworks for coding education can ensure consistency and progression in learning outcomes.
- **Shifting Traditional Mindsets:** Integrating novel approaches like project-based learning and gamification may require a shift in traditional teaching methods. Creating a supportive environment and fostering collaboration among educators are key to successful change management.
- **Assessment and Evaluation:** Developing effective assessment strategies for coding skills requires careful consideration. Moving beyond traditional testing methods to evaluate critical thinking, problem-solving, collaboration, and creativity is important.

8.4 Looking Forward: Building a Collaborative Future

The international community plays a vital role in advancing coding education globally. Here are potential avenues for collaboration:

Sharing Best Practices: Creating platforms and opportunities for educators from different countries to share best practices and innovative approaches in coding education can foster cross-cultural learning and knowledge exchange.

Developing Collaborative Online Resources: Joint initiatives to develop online coding curriculums, interactive learning platforms, and teacher training materials can offer valuable resources for all countries.

Organizing International Coding Competitions: Global coding competitions can encourage healthy competition, drive student engagement, and provide a platform for showcasing skills on an international stage.

Promoting Research and Development: Collaboration on research and development projects can advance coding education pedagogy, assessment strategies, and the utilization of emerging technologies like AI in teaching and learning.

9 Conclusion

All six countries analysed acknowledged the value of integrating coding into the curriculum, particularly in middle school, but the extent of this integration varies. Regularly updating curriculums is vital to keep pace with the ever-changing field of coding.



Project-based learning (PBL) emerged as a powerful approach, allowing students to grapple with real-world problems using coding skills. This fosters creativity, collaboration, and problem-solving abilities. Gamification techniques that leverage game elements and healthy competition through national and international coding competitions further enhance student engagement. Additionally, collaborative learning through teamwork and pair programming enriches the learning experience.

Technology plays a vital role. Interactive online platforms like Scratch and Code.org provide enriching and diverse learning experiences. Hands-on learning is fostered through the use of hardware like Arduino boards and robots alongside coding instruction, leading to a deeper understanding of computation.

However, challenges remain. Equipping teachers with the necessary coding skills and pedagogical approaches is crucial, and ongoing training and support programs are essential for their success. Creating inclusive learning environments with a variety of tools and activities is vital to ensure all students feel welcome and confident to explore coding. Ethical coding practices, including cybersecurity and the societal impact of coding decisions, should be emphasised to cultivate responsible digital citizens. Encouraging students to pursue coding-related hobbies and projects beyond the classroom fosters a lifelong love of learning and exploration in technology.

The report concludes by calling for international collaboration to move coding education forward globally. Sharing best practices and innovative approaches, developing collaborative online resources, organising international coding competitions, and promoting research and development projects are all highlighted as areas for fruitful collaboration. By working together and implementing these recommendations, countries can equip their students with the necessary coding skills and critical thinking abilities to flourish in the digital age.

All six project partner countries demonstrate a commitment to improving coding education in their schools. **Portugal** stands out for its diverse methodologies, technologies, and focus on fostering innovation through Maker Spaces. **Slovenia** and **Türkiye** actively promote student engagement through competitions and innovative practices. **Cyprus** emphasises ethical considerations in coding education, while **Spain** and **Greece** are implementing national plans and innovative initiatives.

By addressing the identified challenges, fostering collaboration, and continuously adapting to the evolving technological landscape, countries can empower their students with the necessary skills to thrive in the 21st century.