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2023-1-ES01-KA220-SCH-000151376 – CODEDU

Field Research

Comparative Synthesis Report

WP2 - Synthesis Report on Coding in Education & Training Materials

June 2024

Project information

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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. It is based on the field research done through questionnaires sent to both students and educators. It is also complemented by a second report which is based on a desk research conducted per partner country.

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.

2 Field Research

The initial target was to reach out to 63 Students and 126 Teachers. Within a short amount of time, the project partners received 161 answers from students and 193 teachers. The tables below illustrate the answers received by each target group per country.

Country	Survey Dates	Participating Students
Cyprus	15-18 March 2024	37
Greece	15-22 March 2024	18
Portugal	15-20 March 2024	49
Slovenia	15-22 March 2024	15
Spain	9-10 April 2024	32
Türkiye	March 2024	10
TOTAL	**Target: 63 students**	**161**

Table 1 – Number of students answering the questionnaire per country.

Country	Survey Dates	Participating Teachers
Cyprus	15-18 March 2024	21
Greece	15-18 March 2024	36
Portugal	14-22 March 2024	45
Slovenia	15-29 March 2024	19
Spain	26 March - 9 April 2024	52
Türkiye	March 2024	20
TOTAL	**Target: 126 teachers**	**193**

Table 2 – Number of teachers answering the questionnaire per country.

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In this report chapter 3 will analyse the answers received from the teachers and Chapter 4 the answers from the students. Each chapter provides an introduction on each target group, presents the questions and analyses the answers received through the online questionnaires which were shared by each partner country. Finally Chapter 5 tries to present a summary of the results and provides recommendations that will support the development of the teacher's training curriculum and the student's training course (Activity A2.4) led by CEPROF under the CODEDU Project.

3 Teachers Survey

Coding skills are increasingly recognized as essential for success in the 21st century. This report presents a comprehensive analysis of educators' experiences, perspectives, and needs regarding coding education across several European countries.

The report combines findings from six surveys conducted in March 2024, targeting a total of **193 educators** from Portugal, Cyprus, Slovenia, Türkiye, Greece, and Spain. The surveys focused on teachers from various educational levels, including primary, secondary, and vocational training (VET) schools. The surveys, all conducted anonymously using a 10-question format (7 single multiple-choice and 3 multiple-choice with multi-selection option), aimed to gather insights into a range of topics

This comparative approach allows us to identify trends and variations in educators' approaches to coding education across different educational contexts. The report explores key areas such as:

- Educators' prior experience with incorporating coding instruction.
- Perception of the value of coding skills for students at different grade levels.
- Awareness and understanding of coding tools and their classroom applications.
- Comfort level with integrating coding into existing curriculum and using educational technology.
- Preferred formats for training and support to enhance effective coding instruction.

By understanding these aspects, the report aims to:

- Inform the development of targeted programs to equip educators with the necessary knowledge and resources.
- Identify areas where educators require additional support to confidently integrate coding into their classrooms.
- Ultimately, empower educators to foster a generation of students equipped with vital coding skills for the digital world.

This comparative analysis offers valuable insights into the current state of coding education in these European countries. It serves as a foundation for developing

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effective strategies to promote coding education and empower educators to prepare students for the demands of the digital future.

The 10 questions used during the survey were developed under Work Package 2, Activity A2 "Field Research activities Questionnaires". It's important to acknowledge that this data is limited, drawn from a relatively small sample of teachers in a select few European countries. Further research is necessary to definitively pinpoint the reasons behind the discrepancies in teacher experience with coding education.

3.1 Question 1 - Have you previously taught any lessons that included coding or programming concepts?

The replies reveal a striking disparity between the countries regarding the number of teachers who have incorporated coding or programming concepts into their lessons. In Spain, a remarkably high percentage (94.2%) of teachers reported having included coding in their classes. This stands in stark contrast to the significantly lower percentages reported in Portugal (17.8%), Greece (16.7%), and Türkiye(30.0%).

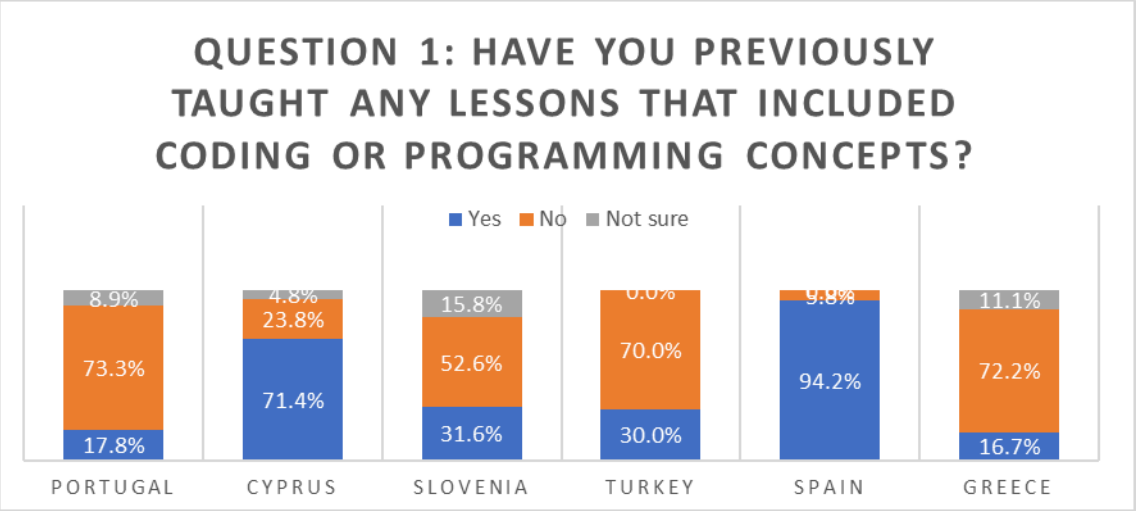

Figure 1 – Teacher Question 1

3.2 Question 1 - Comments

Several potential explanations exist for this observed difference. Firstly, national curriculum requirements may play a role. Countries might have varying degrees of emphasis on integrating computer science education into their school curriculum. Spain might have a national curriculum that mandates or strongly encourages the teaching of coding, while other countries like Cyprus, Greece, and Türkiye might not have such requirements.

Secondly, the availability of professional development opportunities could be a factor. Teachers may require specific professional development programs to feel confident and equipped to teach coding effectively. If Spain offers more comprehensive professional development options in coding compared to the other countries, this could contribute to the observed difference in teacher experience.

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Thirdly, the emphasis placed on computer science education within teacher training programs might also be relevant. Teacher training programs with a strong focus on computer science may produce graduates who are more likely to integrate coding into their lessons.
Teachers of older students might have a higher likelihood of having experience with coding compared to those teaching younger students.
It should be acknowledged that the data does nOt capture teachers' comfort level with teaching coding. Even teachers who have included coding in their lessons may not necessarily feel entirely comfortable doing so.

3.3 *Question 2 - Do you believe that coding is a valuable skill to teach at your educational level?*

Overall, a large majority of teachers (82.1%) surveyed believe that coding is a valuable skill to teach at their educational level. Spain has the strongest agreement with 100% of teachers responding that coding is valuable. Cyprus follows closely behind with 95.2% agreement. Portugal (62.2%), Slovenia (57.9%), Türkiye (75.0%), and Greece (69.4%) all show a majority agreement on the value of coding education.

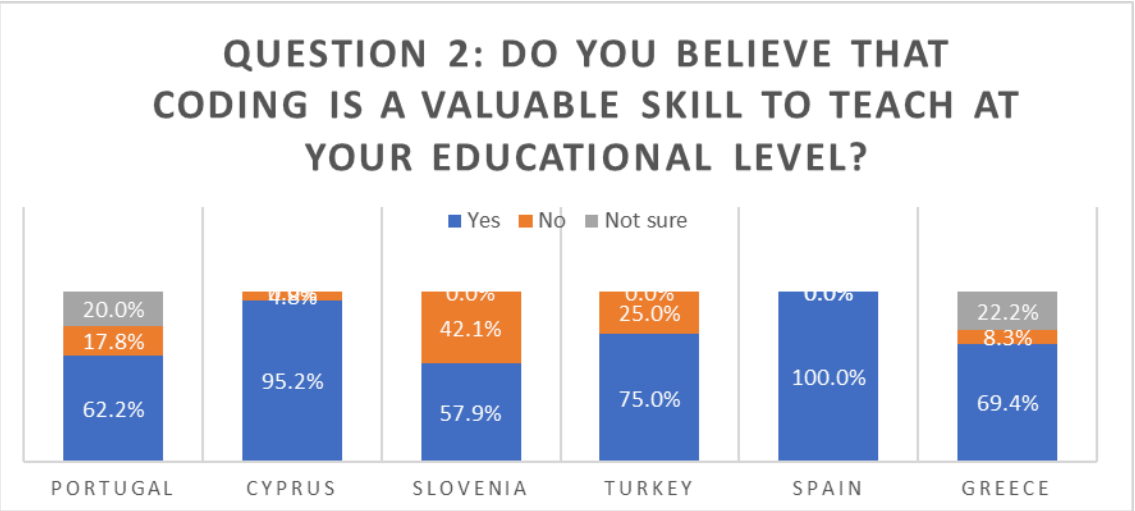

Figure 2 – Teacher Question 2

It is interesting to note that there is some variation in opinion between the different countries. Teachers in Spain and Cyprus are the most likely to believe that coding is valuable, while teachers in Greece are somewhat less likely to agree. There are a few possible explanations for this variation. It is possible that students in Spain and Cyprus have had more exposure to coding than teachers in Greece. Additionally, the job market in Spain and Cyprus may be more reliant on technology than the job market in Greece.

Overall, the survey results suggest that teachers across a variety of countries believe that coding is a valuable skill to teach at their educational level. This suggests that there is a growing recognition of the importance of coding skills in the 21st century.

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3.4 Question 2 - Comments

There are a few reasons why teachers might believe that coding is a valuable skill to teach. Coding helps people develop problem-solving skills, critical thinking skills, and creativity. These skills are valuable in many different fields, not just computer science. Additionally, coding skills are becoming increasingly important in the job market. Many jobs, even those that are not traditionally considered to be tech-related, now require some coding ability.

3.5 Question 3 - Are you aware of what an Arduino is and its use in education?

The answers to this question reveal a fascinating geographical disparity. Türkiye and Spain stand out with remarkably high awareness levels (74.5% and 65% respectively). This could be attributed to proactive government or educational institution initiatives that promote STEM education, often incorporating Arduino. National curriculums that include Arduino or dedicated professional development programs for teachers in these countries could be contributing factors. In contrast, Portugal, Greece and Slovenia fall under the category of low awareness (around 15%) and Cyprus (38.1%) exhibits a moderate awareness levels.

Availability of Arduino boards at schools and supporting equipment could be a barrier for teachers in relation to acknowledging their existence. Additionally, access to workshops or training programs on Arduino could be another contributing factor. Teachers who have undergone such training are more likely to be aware of Arduino's potential to enhance learning experiences.

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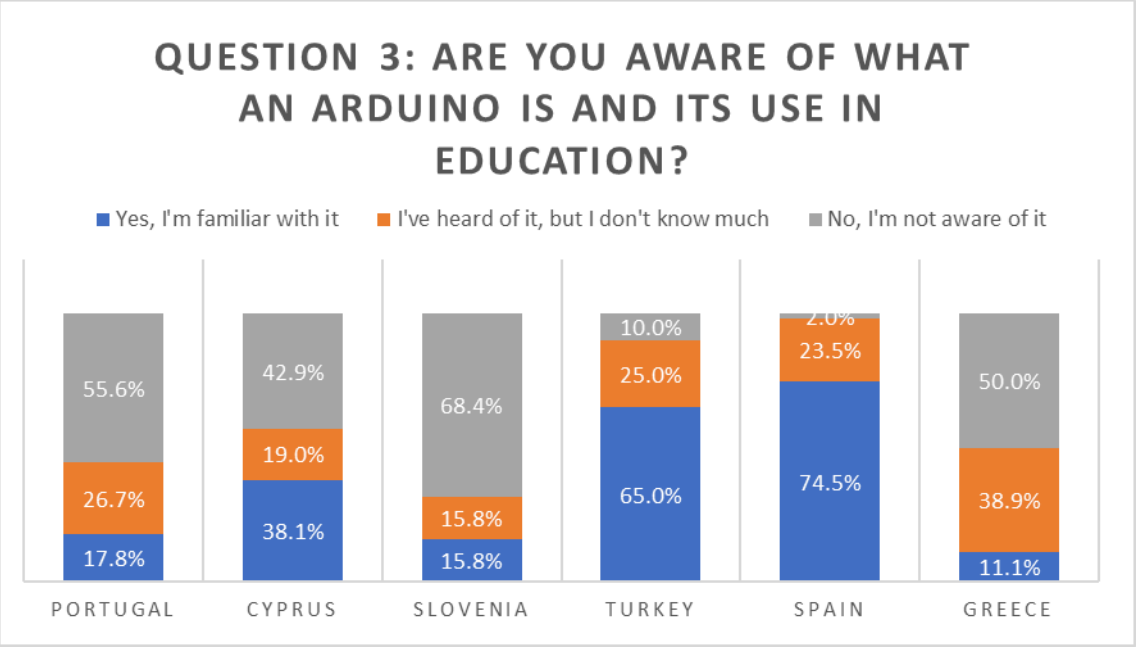

Figure 3 – Teacher Question 3

3.6 Question 3 - Comments

To gain a more comprehensive understanding of this situation, further research is recommended. Investigating government or educational initiatives related to STEM education that incorporate Arduino could shed light on best practices. Examining the availability and accessibility of professional development opportunities for teachers on Arduino in the countries would also be valuable. By gathering more data and exploring these potential reasons, policymakers and educators can develop targeted strategies to promote awareness and utilisation of Arduino in education programs across all the countries.

This knowledge would empower them to create effective strategies to bridge the awareness gap, potentially including initiatives to make Arduino boards and supporting equipment more affordable or developing online or in-person training programs to equip teachers with the necessary skills and confidence to integrate Arduino into their classrooms.

3.7 Question 4 - How comfortable are you with the idea of teaching coding to your students?

Once again there is a geographical disparity between the countries. Portugal has a very high percentage of 80% of teachers not being comfortable teaching coding, followed by Greece with 41.7% of the teachers feeling uncomfortable. The other 4 countries seem to be more open with either feeling very comfortable or somewhat comfortable teaching coding to their students.

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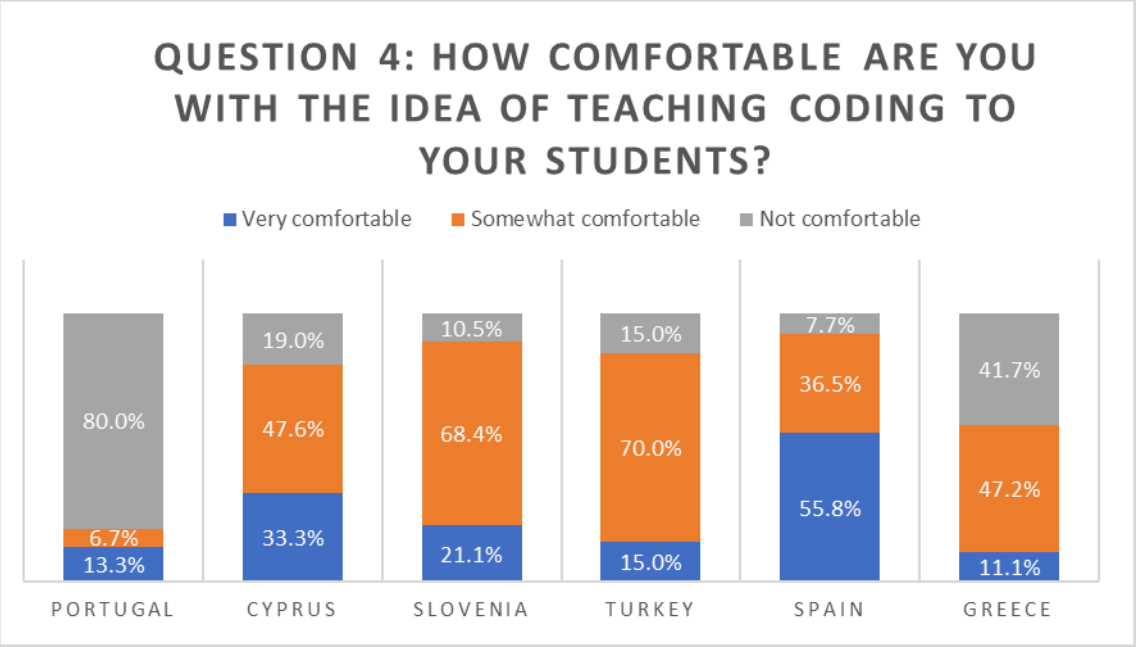

Figure 4 – Teacher Question 4

Several factors could explain this generally positive outlook towards teaching coding. One reason might be the growing recognition of coding's importance in the job market. Many jobs, even outside of technology, increasingly require some level of coding proficiency. Additionally, educational curriculums around the world might be placing more emphasis on computer science and coding, potentially leading to teachers being better prepared to teach these skills. Finally, the abundance of online resources and user-friendly coding platforms designed specifically for education could be making teachers feel more comfortable incorporating coding into their lessons.

3.8 Question 4 - Comments

The answers also reveal variations in comfort levels between the different countries. Unequal access to professional development programs on teaching coding could be a factor. Teachers who have undergone such training might feel more prepared and confident. Variations in how prominently coding is incorporated into national curriculums could also influence teacher comfort. A teacher's own general comfort level with technology might also play a role.

It's important to acknowledge limitations in the data. The sample size and demographics of the teacher population surveyed are limited as well as their subject field. A larger sample and data on teacher demographics, such as grade level or subject area, could provide more nuanced insights. The survey itself doesn't differentiate between basic awareness and in-depth knowledge of teaching coding.

Examining the availability and accessibility of professional development opportunities for teachers on teaching coding in these countries would also be valuable. By gathering more data and exploring these potential reasons, policymakers and educators can

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develop targeted strategies to enhance teacher preparedness and confidence in teaching coding across all the countries. This knowledge would empower them to create effective strategies to bridge the gap in comfort level, potentially including initiatives to provide more professional development or creating resources to make coding curricula more accessible and user-friendly for teachers.

3.9 Question 5 - Have you ever used educational technology or e-learning platforms in your teaching?

The teacher replies show a clear trend in the use of educational technology across most countries. In (Türkiye, Cyprus, Spain and Slovenia), a majority of teachers reported incorporating educational technology or learning platforms into their teaching practices, at least occasionally. Cyprus, for example, reflected this trend with 61.9% of teachers frequently using technology and 33.3% using it occasionally. Impressively in Türkiye 95% of the teachers occasionally use technologies. However, in Portugal and Greece, a percentage between 22-33% of the teachers did not report ever using educational technology, suggesting a different approach to education in those countries.

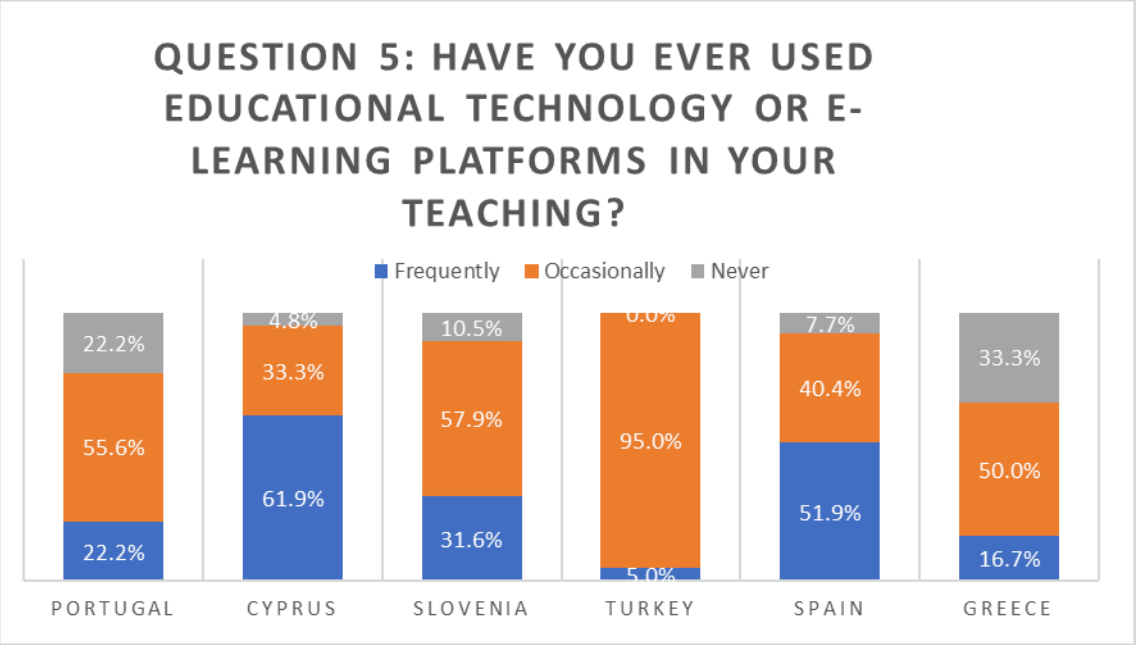

Figure 5 – Teacher Question 5

3.10 Question 5 - Comments

There are several potential reasons why teachers might choose to integrate educational technology into their classrooms. One reason could be to boost student engagement. Interactive and engaging learning experiences can be created through technology, motivating students and making the learning process more enjoyable.

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Improved student learning outcomes are another potential benefit. Educational technology can provide access to a wider range of resources and materials, along with personalised learning experiences that cater to individual student needs.

Teacher productivity can be enhanced through the use of educational technology. Automating tasks like grading assignments and providing feedback frees up valuable teacher time that can be dedicated to lesson planning and offering individual support to students. It's important to remember that the data doesn't tell us how effective educational technology is in improving teaching and learning.

3.11 Question 6 - What training or professional development would you need to feel prepared to teach coding?

We can see a significant need for training in coding across the six countries surveyed. The percentage of teachers who feel prepared to teach coding without any additional training ranges from just 0% in Slovenia to 20% in Türkiye.

There are a couple of reasons why this might be the case. Coding is a relatively new subject that is not yet a standard part of the curriculum in many countries. This means that many teachers may not have had the opportunity to learn how to code themselves. Additionally, coding can be a complex subject that requires a strong understanding of computer science concepts. Teachers who do not have a background in computer science may feel unprepared to teach coding to their students.

The data also shows that the most common form of professional development that teachers need is in-person workshops. This suggests that teachers may feel that they would benefit most from learning from a qualified instructor in a face-to-face setting. The acceptance of having online courses varies from 24.4% in Portugal to 80% in Türkiye and the use of manual and educational materials varies again very much from a low of 8.9% in Portugal to 86.3% in Spain.

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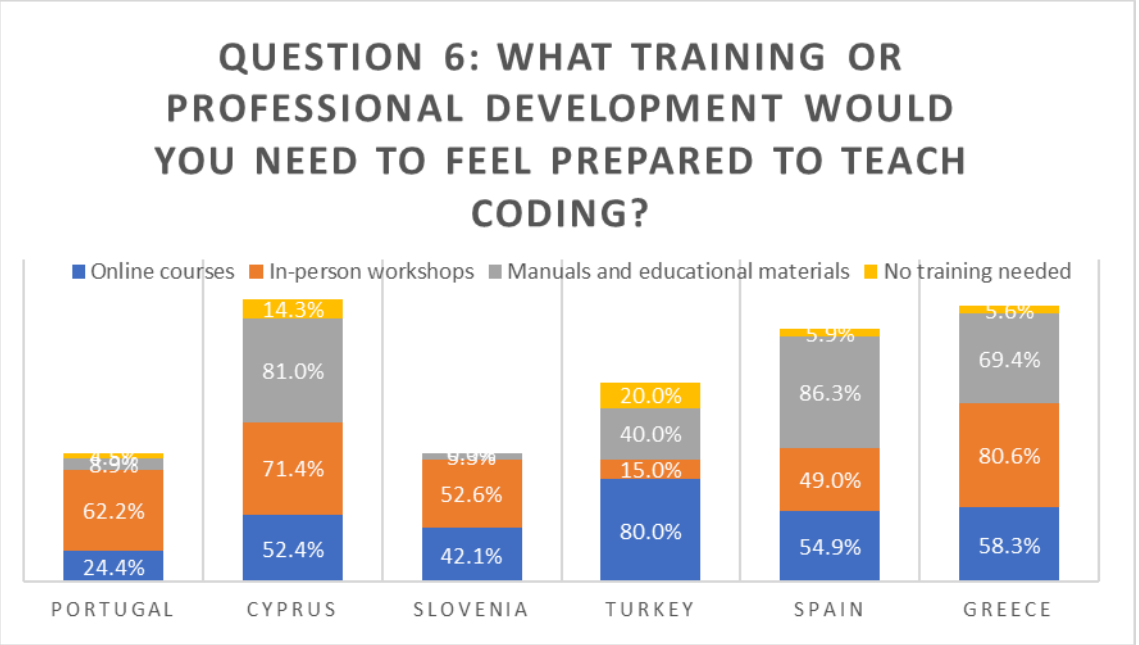

Figure 6 – Teacher Question 6

3.12 Question 6 – Comments

The data on teacher training preferences for coding reveals interesting variations across these countries. While there's a clear need for training, how teachers prefer to receive it differs significantly.

One factor influencing preference could be comfort with technology. Countries like Türkiye and Greece, with a high acceptance of online courses (80% and 80.6% respectively), might have a more tech-savvy teaching population comfortable with online learning's self-paced nature. In contrast, Portugal's lower preference (24.4%) suggests a need for more familiarity with online learning structures.

Learning style preferences also seem to play a role. The data shows some teachers value the interactive nature and immediate feedback offered in face-to-face settings. This is evident from the preference for in-person workshops in Cyprus (71.4%) and Greece (80.6%). This might be especially true for those who find hands-on learning more effective.

Resource availability also comes into play. The significant variation in preference for manuals and educational materials (Portugal: 8.9%, Spain: 86.3%) could be linked to access to high-quality resources in each country. Countries with readily available and well-regarded physical resources might see a higher preference for this method.

Cultural factors might influence preferences as well. Countries with a more collaborative learning style might favour in-person workshops for knowledge exchange and peer interaction. Conversely, cultures emphasising independent learning might see online courses or self-study materials as more appealing.

Finally, previous training experiences can shape future preferences. If past online courses were ineffective, teachers might be less likely to choose them again. Similarly,

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negative experiences with in-person workshops could lead to a preference for self-paced learning.

3.13 Question 7- Would you be open to incorporating a gamified coding platform into your curriculum?

The answers reveal a trend where teachers in some countries seem more enthusiastic about incorporating gamified coding platforms into their curriculum compared to others. Cyprus, Türkiye, and Spain show the highest percentage of teachers (71.4%, 55.0%, and 59.7% respectively) who are definitely interested in using this approach. Slovenia and Portugal show a lower percentage of definitive interest (26.3% and 24.4%).

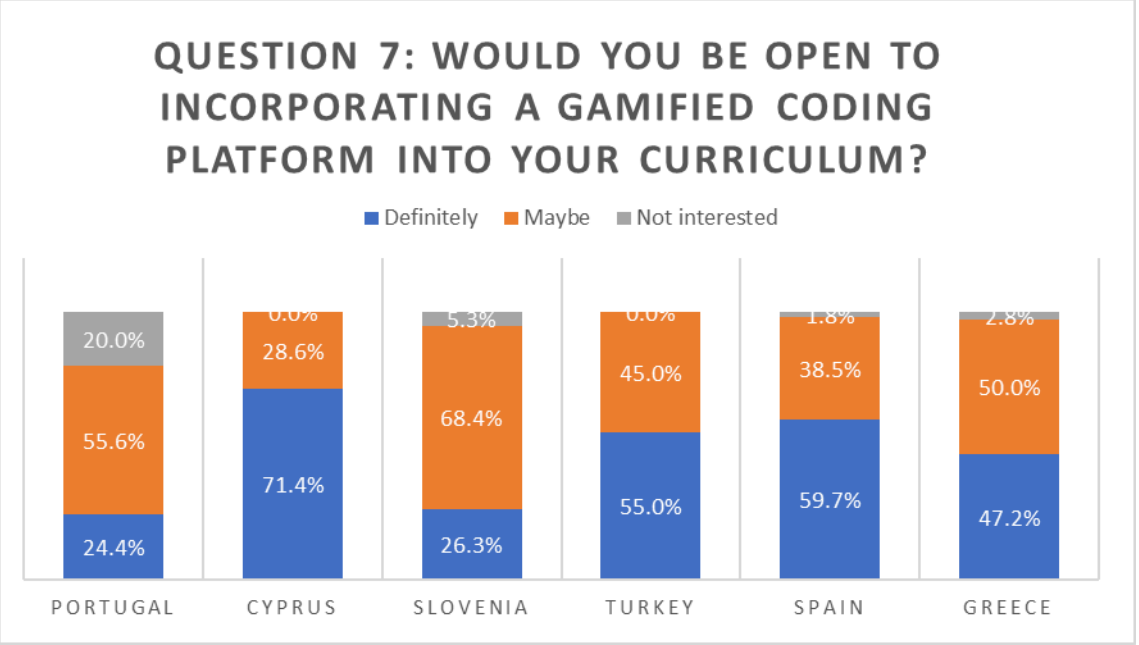

Figure 7 – Teacher Question 7

3.14 Question 7 - Comments

While the reasons behind this variation are unclear, it could be linked to several factors. Teachers who have had positive experiences with gamified learning in the past might be more open to this method. Additionally, countries with a strong emphasis on STEM education in their curriculum might have teachers who are more receptive to incorporating coding into their lessons. Finally, the availability of professional development opportunities around gamified coding platforms could also influence teacher interest.

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3.15 Question 8 - How do you envision coding fitting into your current subjects or curriculum?

In all six countries, a majority of teachers favoured incorporating coding into mathematics (ranging from 15.8% to 57.1%). Science and language arts were also seen as relevant subjects for integrating coding, with teacher endorsement ranging from 26.3% to 70.0% and 40.0% to 90.4%, respectively. Teachers from Cyprus (76.2%) and Greece (63.9%) advocated for coding as a separate subject.

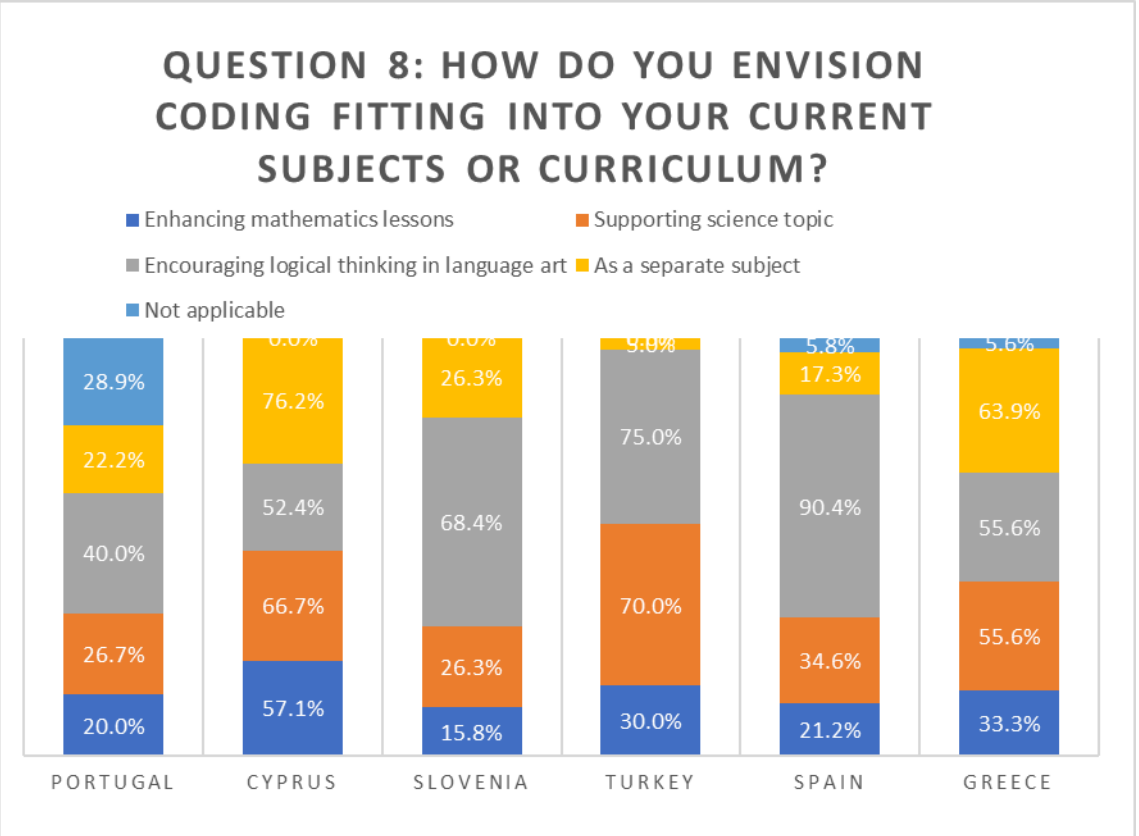

Figure 8 – Teacher Question 8

3.16 Question 8 - Comments

This trend suggests several possible reasons. Coding itself is increasingly recognized as a foundational skill, akin to reading, writing, and arithmetic. It requires critical thinking and problem-solving abilities, skills that are also fundamental to mathematics, science, and language arts. By integrating coding into these subjects, teachers may believe students can develop these crucial skills in a more engaging and relevant way. Teachers from Cyprus (76.2%) and Greece (63.9%) endorsed coding as a separate subject. At the same time teachers from Türkiye (9%) do not consider it as important. This may reflect a desire to avoid curriculum overload and leverage the natural connections between coding and other disciplines.

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3.17 Question 9 - What type of support or resources would make you more likely to teach coding?

Analysing the answers some interesting trends regarding the resources that would make teachers more likely to integrate coding into their curriculum are revealed. A significant barrier to teaching coding appears to be a lack of technology. In all these countries, a majority of teachers, ranging from 31.6% to a staggering 72.2%, indicated that having access to technology like laptops and computers would make them more comfortable teaching coding. This highlights the need for well-equipped classrooms with sufficient devices to facilitate coding education.

Beyond just the hardware, the data suggests that many teachers would welcome additional support in the form of instructional materials. Between 26.3% and 74.5% of teachers across the surveyed countries expressed that having access to online lesson plans and tutorials would be a valuable resource. This points to a potential need for readily available curriculum materials to help teachers feel confident and prepared when teaching coding.

Interestingly, the data also suggests that a sense of community and collaboration can play a role in encouraging teachers to embrace coding education. Between 26.3% and 66.7% of teachers expressed that being part of peer support groups would make them more likely to teach coding. This indicates that opportunities to connect and share experiences with other educators could be a valuable source of encouragement and problem-solving for teachers venturing into coding instruction.

Finally, some teachers may feel they lack the necessary expertise to teach coding effectively. Providing professional development opportunities in coding pedagogy could be an effective strategy to equip teachers with the knowledge and skills they need to feel confident teaching this subject.

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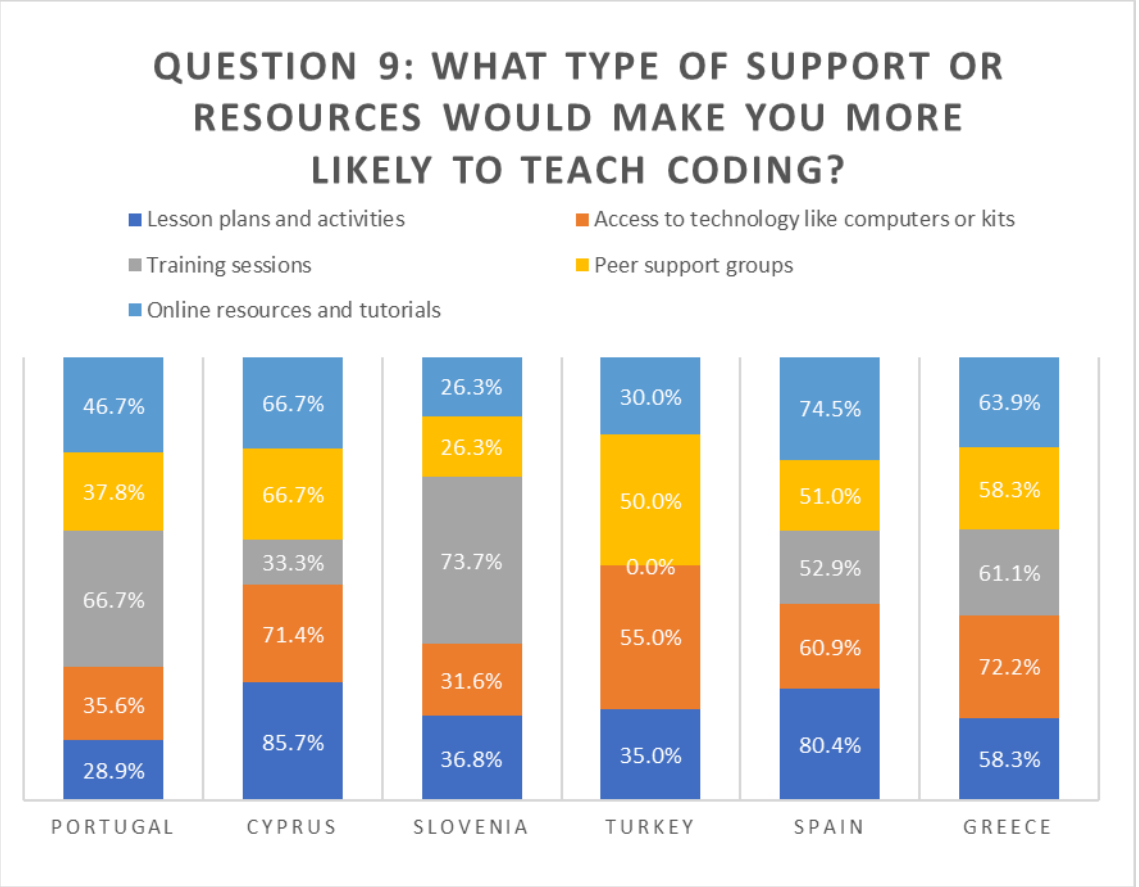

Figure 9 – Teacher Question 9

3.18 Question 9 - Comments

The replies provide a clear picture that teachers in these countries would likely be more inclined to teach coding if they had access to a combination of resources and support. This includes providing schools with sufficient technology, offering online lesson plans and tutorials, fostering collaboration through peer support groups, and investing in training programs to enhance teachers' pedagogical skills in coding education.

3.19 Question 10 - In which format would you prefer to receive training materials for coding education?

There is a clear preference for online materials over printed materials in all six countries. For instance, in Portugal, 55.6% of teachers prefer online videos and webinars, whereas only 31.1% prefer printed materials. This trend is consistent across all six countries.

Another interesting finding is that interactive online training courses are the preferred choice among the online options in most countries.

In-person training sessions as an option vary a lot from only 5.0% of teachers in Türkiye, to 63.2% in Slovenia. Once again there is a large variation in the teachers selected training formats.

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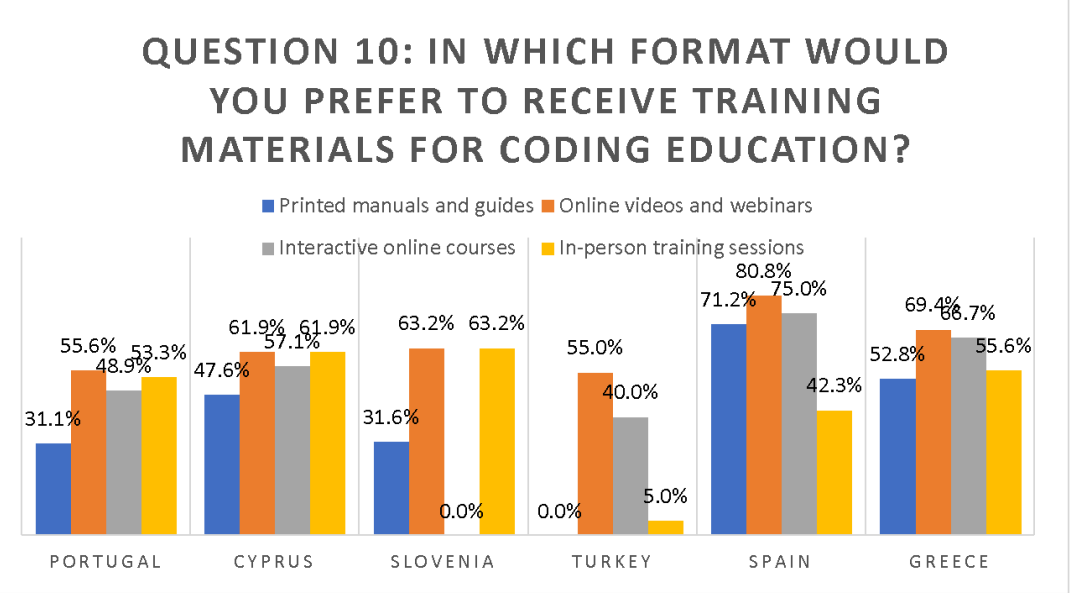

Figure 10 – Teacher Question 10

3.20 Question 10 - Comments

Online materials and courses were the clear favourite. This can be attributed to several factors. Convenience plays a major role – online resources can be accessed anytime, anywhere, eliminating the limitations of physical materials or scheduled in-person sessions. Cost-effectiveness is another advantage, with online options potentially being less expensive. Busy teachers also value the flexibility of online courses, allowing them to learn at their own pace. Finally, interactive online training offers a clear benefit – the ability to practise what's being learned, which can significantly improve information retention. Overall, the data suggests that online materials is the preferred choice across all countries for teachers when it comes to learning about coding education.

4 Students Survey

The results here present the combined findings of the surveys conducted in the six project partner countries - Spain, Portugal, Cyprus, Slovenia, Greece, and Türkiye - designed to assess upper-primary and secondary school students' interest and experiences with coding. Understanding student attitudes towards coding is crucial for developing engaging and effective coding education initiatives across Europe.

The surveys, all conducted anonymously using a 10-question format (8 single-choice and 2 multiple-choice with multi-selection options), aimed to gather insights into a range of topics:

- Students' prior exposure to coding
- Their familiarity with Arduino, a popular educational coding tool
- Their perceived importance of coding for their future careers
- Preferred learning styles (individual vs. group)
- Interest in using game-based platforms for learning

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- Preferences for specific coding applications (websites, games, apps, robotics)
- Desire to understand the inner workings of technology
- Perceptions of coding's appeal compared to traditional subjects
- Ideas for potential coding projects

By analysing this data from **161 students** from the partner countries, this part of the report aims to identify potential areas for curriculum development and tailor coding education to resonate with student interests, ultimately equipping them with the technical literacy they need to thrive in the digital age.
The 10 questions used during the survey were developed under Work Package 2, Activity A2 "Field Research activities Questionnaires". It is important to acknowledge that this report is based on a limited data set encompassing only a select few countries and a low number of participating students.

4.1 *Question 1 - Have you ever taken a class or lesson on coding before?*

The first question analyses data on the percentage of students in all participating countries who have taken a class or lesson on coding. The findings reveal a concerning trend: a relatively small proportion of students across the analysed countries have taken coding lessons.

Spain stands out as a leader, with a commendable 68.8% of students reporting prior coding experience. However, the data also demonstrates a significant disparity between countries. Cyprus and Türkiye follow with 43.2% and 40.0% respectively, while Greece falls behind 16.7% and Portugal even more behind at a mere 6.1%.

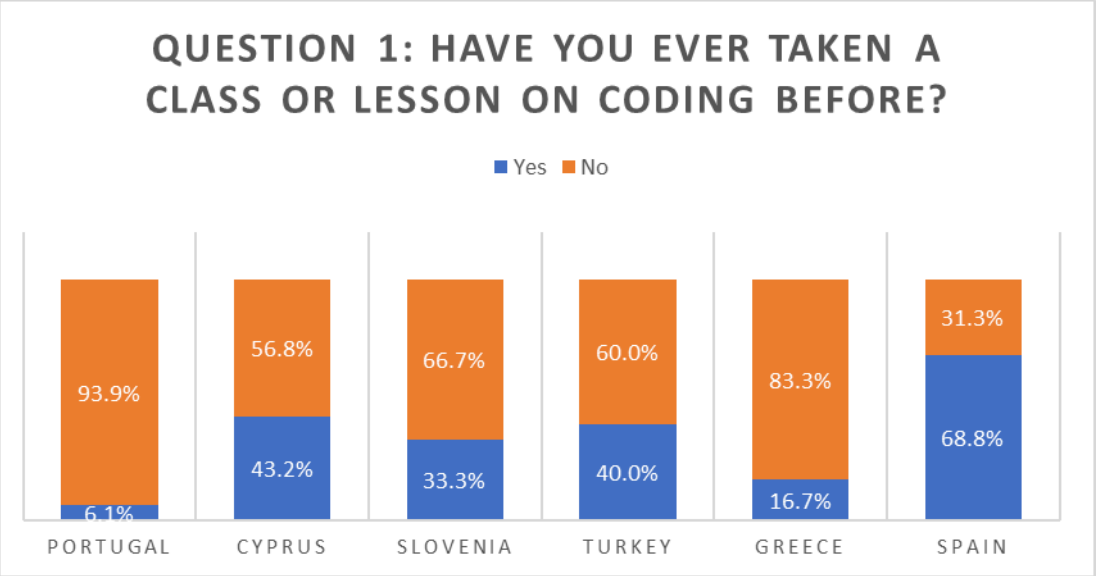

Figure 11 – Student Question 1

Several factors could contribute to this limited exposure to coding. Unequal access to computers and the internet, often referred to as the digital divide, may restrict

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opportunities for students in certain regions. Furthermore, students and parents might not be fully aware of the immense benefits of coding skills in the current job market and for future career prospects. Additionally, the national curricula of these countries might not sufficiently integrate coding education, potentially leaving students without crucial exposure at a young age.

4.2 Question 1 - Comments

To effectively address this gap, further research is recommended. This investigation should look deeper into the reasons behind the disparities in coding education across these countries. Understanding the specific obstacles hindering access in each region is a crucial first step. Initiatives aimed at raising awareness about the value of coding skills among students, parents, and educators would also be beneficial. Finally, exploring the integration of coding education into national curricula holds immense potential for providing broader exposure to coding at a younger age.

By acknowledging the disparity in current exposure and investigating the root causes, we can develop effective strategies to equip our students with valuable coding skills. This, in turn, will increase the chances of future generations being well-prepared to thrive in the ever-evolving digital world.

4.3 Question 2 - Are you familiar with what an Arduino is?

This question aimed at surveying the familiarity of Students with Arduino. The question asked was "Are you familiar with what an Arduino is?" with answer choices "Yes" and "No".

The results show a significant difference in Arduino familiarity across the surveyed countries. Spain has the highest percentage of respondents (93.8%) saying "Yes," followed by Türkiye (50.0%) where familiarity is equally split between those who know and those who do not. In contrast, Portugal (4.1%), Cyprus (2.7%), Greece (11.1%), and Slovenia (13.3%) have a much lower percentage of respondents familiar with Arduino.

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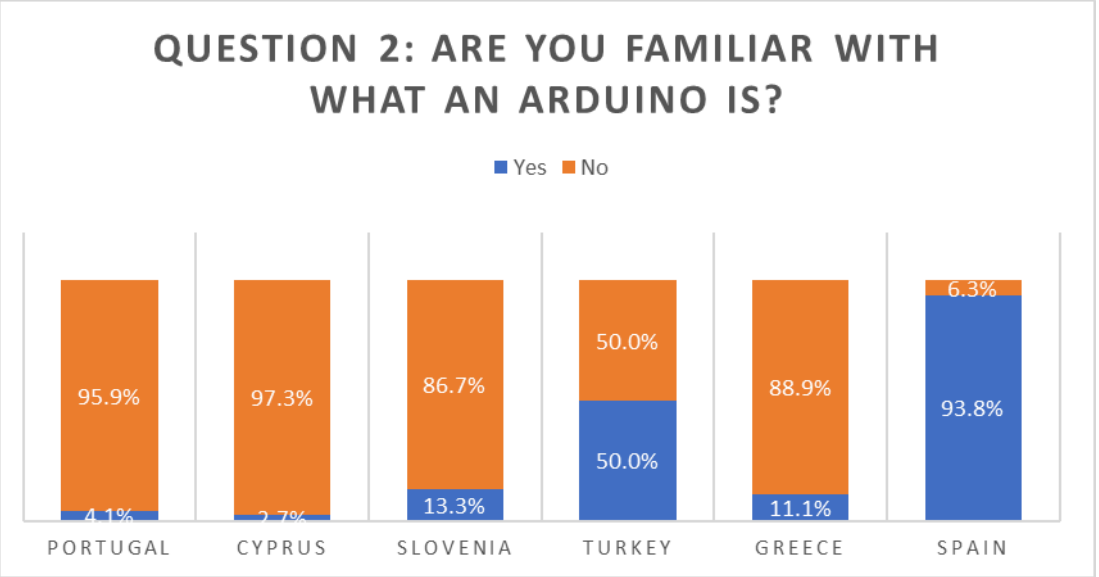

Figure 12 – Student Question 2

4.4 Question 2 - Comments

The low Arduino familiarity in some countries might be rooted in the educational environment. If STEM curricula do nOt include Arduino or similar platforms, there would be a gap in both awareness and practical experience amongst the general population. This could be due to a lack of emphasis on project-based learning or a shortage of resources and teacher training in these areas. Schools play a big role in sparking students' interests and equipping them with future-oriented skills. Without exposure in educational settings, Arduino literacy might remain limited.

4.5 Question 3 - Do you think learning to code is important for your future?

The survey results in Question 3 reveal that a significant majority across all six countries view coding as important for their future. The percentage of positive responses ranged from 40.0% in Slovenia to a high of 100 % in Türkiye.

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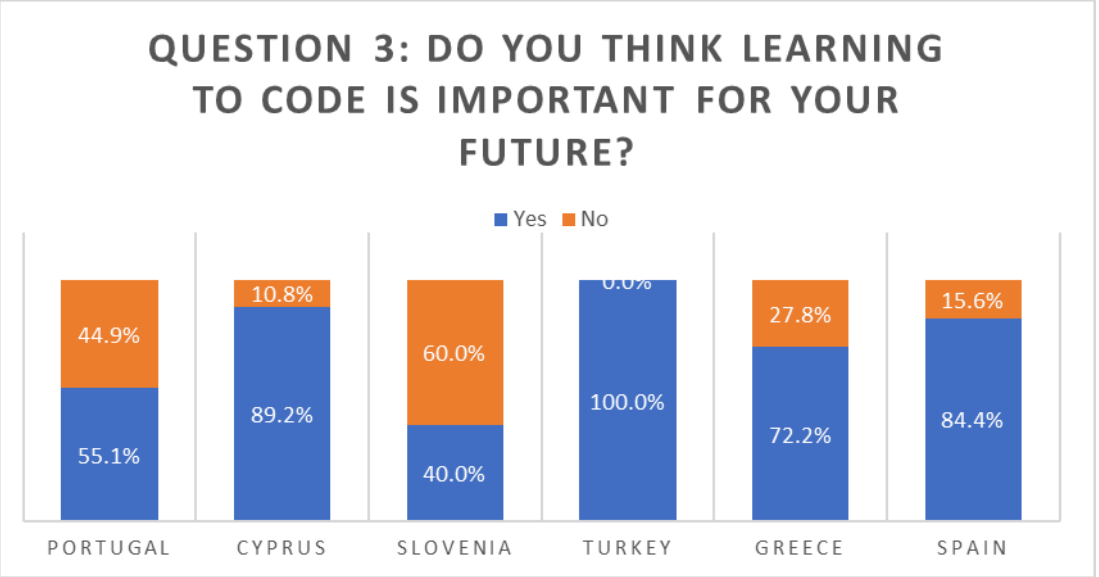

Figure 13 – Student Question 3

Several factors might explain these findings. The tech industry's explosive growth has created a high demand for workers with coding expertise. Recognizing this demand, individuals may be seeking to improve their job prospects by acquiring these skills. Additionally, technology's pervasive influence in daily life suggests that coding skills could become essential for navigating an increasingly tech-reliant society. Finally, recent years have seen a surge in awareness surrounding coding education, potentially due to government initiatives or private programs promoting it. This increased awareness could be leading people to recognize the opportunities coding offers.

4.6 Question 3 - Comments

These answers suggest that a significant portion of the population in several European countries views learning to code as crucial for their future. Potential explanations for this include the tech industry's growth, technology's growing importance, and a heightened awareness of coding education.

Further research is needed to delve deeper into why people perceive coding as important for their future. It would also be beneficial to investigate what people believe the benefits of learning to code are and what challenges they face when attempting to acquire these skills.

4.7 Question 4 - Would you be interested in using a game-like platform to learn coding?

This question explores student interest in utilising game-like platforms for learning coding. Data from the survey question directly asking students about their interest in this approach reveals a strong fascination with game-based coding education. In

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Türkiye, a remarkable 100% of students expressed positive interest. Slovenia, Greece, Spain and Cyprus closely follow, with interest levels ranging from a significant 80% to a very promising 88.9%. Portugal is the only country with a quite low interest of 40.8% which should be further investigated but it seems to be related to the low consideration of the importance of coding.

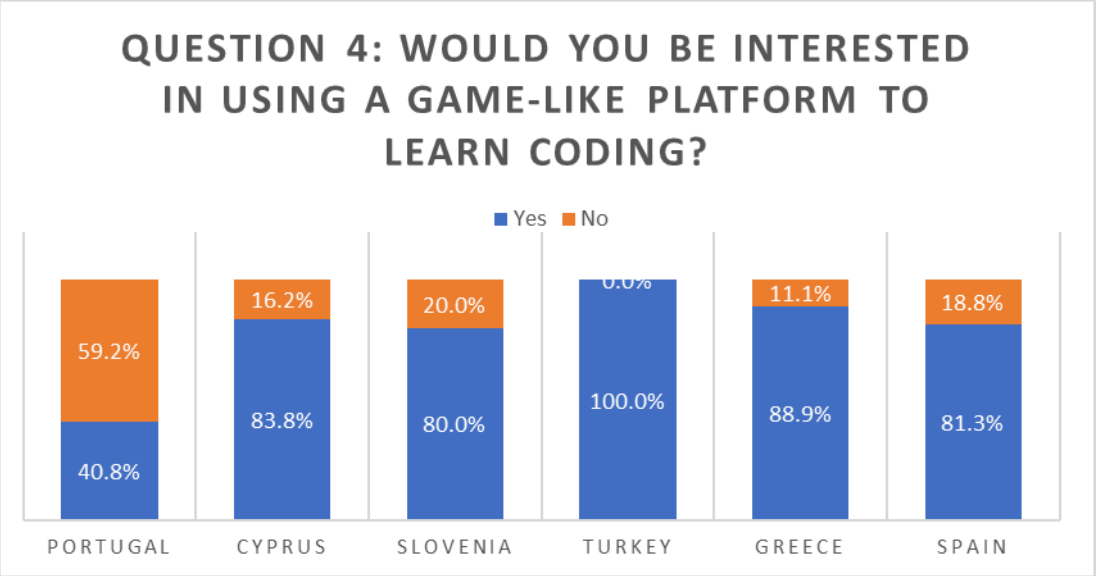

Figure 14 – Student Question 4

4.8 Question 4 - Comments

Several factors might explain this enthusiasm for game-based learning. Games often incorporate points, badges, and leaderboards, transforming coding from a tedious task into an engaging experience. These playful elements motivate users and track progress, fostering a sense of accomplishment. Furthermore, game-based learning can create simulated worlds where students can safely and playfully apply their coding skills. This immersive environment fosters deeper engagement with the material compared to traditional learning methods. Games can also be tailored to various learning styles and abilities. Students can progress at their own speed, revisiting challenges as needed. This flexibility caters to individual learning needs.

While the data suggests a strong preference for game-based learning, some additional considerations are crucial. The quality of the game-based learning platform is paramount for its effectiveness. A poorly designed game can be frustrating and hinder learning. Additionally, game-based learning should complement traditional instruction, not replace it altogether. Traditional methods offer valuable learning structures that game-based learning can enhance. Finally, providing diverse learning methods caters to different student preferences. Not all students thrive in game-based environments, and ensuring all students have access to effective learning approaches is essential.

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The data undeniably showcases a clear interest among European students in utilising game-like platforms for learning coding. This suggests that game-based learning offers significant potential as an effective method to engage students and enhance learning outcomes. However, for this potential to be fully realised, careful design and implementation of game-based learning programs are essential to ensure effectiveness and enjoyment for all students.

4.9 *Question 5 - If you had the chance to learn coding, which of these areas would you be interested in?*

The table below shows the percentage of students interested in each of five coding areas: Gamified Learning, Web Development, Mobile App Development, Learn Through Robotics and other.

Country	Web Development	Gamified Learning	Mobile App Development	Learn Through Robotics	None
Portugal	26.5%	63.3%	42.9%	24.5%	16.3%
Cyprus	16.2%	**89.2%**	**64.9%**	40.5%	2.7%
Slovenia	40.0%	40.0%	20.0%	33.3%	20.0%
Türkiye	**50.0%**	60.0%	10.0%	**90.0%**	0.0%
Greece	**50.0%**	55.5%	61.1%	22.2%	**55.0%**
Spain	36.0%	82.0%	55.0%	48.0%	0.0%

Figure 15 – Student Question 5

The results cannot lead to any direct conclusion since they vary too much. Some possible reasons for the differences in student interest by country could be:

- **Educational priorities:** If a particular country places a strong emphasis on a particular field, such as web development or educational robotics, this could lead to more students being interested in learning to code in that area.
- **Industry makeup:** The types of jobs available in a country could also influence student interest. For example, if a country has a large tech industry, students may be more interested in learning coding skills that would qualify them for jobs in that industry.
- **Student demographics:** The age, gender, and socioeconomic background of the students surveyed could also play a role. For example, younger students might be more interested in gamified learning, while older students might be more interested in web development.

4.10 *Question 5 - Comments*

Students in all six countries showed different interests which can be summarised to Portugal, Spain and Cyprus in Gamified Learning, Slovenia equally web development

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and Gamified Learning, Türkiye in Learn Through Robotics, Greece in Mobile App Development This preference to gamified learning could be because web development is a relatively broad field in the students daily life. Those in Cyprus, Greece and Spain showed a relatively high interest in Mobile App Development and this could be due to the growing popularity of mobile devices in these countries.

Overall, the data in this table suggests that there is a significant variation in student interest in coding by country. This variation is likely due to several factors, including educational priorities, industry makeup, and student demographics.

4.11 Question 6 - Do you prefer learning individually or in a group setting?

The results show student preferences for individual or group learning in six countries. In Portugal, Spain, Slovenia, and Türkiye, a majority of students prefer group learning. In Cyprus and Greece, a majority of students prefer Individual learning.

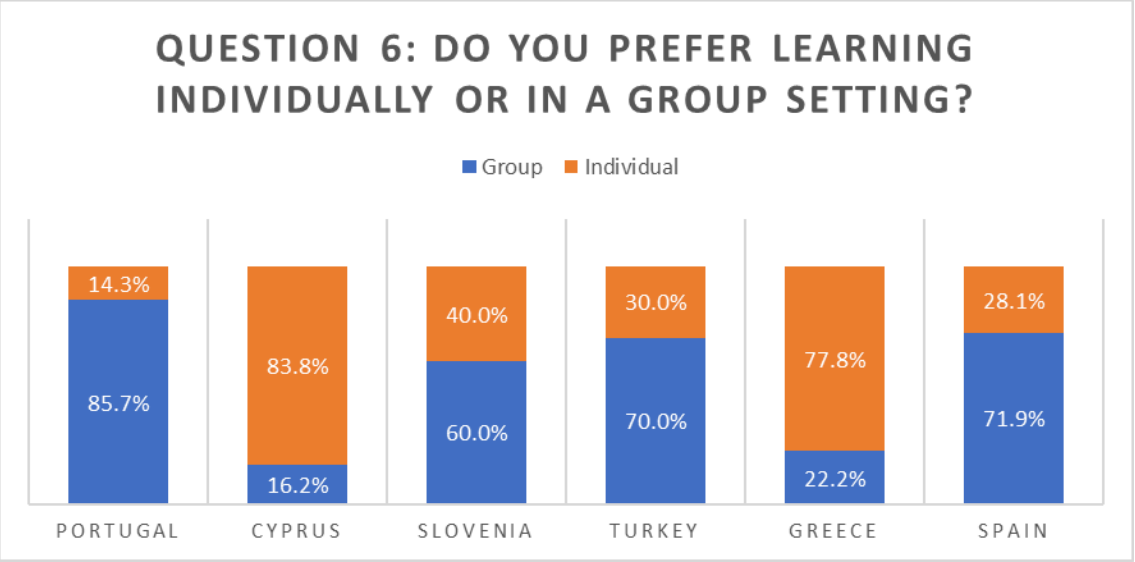

Figure 16 – Student Question 6

There are several possible reasons for these results.

- **Cultural factors:** Individualistic cultures tend to emphasise independence and self-reliance, while collectivistic cultures tend to emphasise interdependence and social harmony. Students from individualistic cultures may therefore be more likely to prefer individual learning, while students from collectivistic cultures may be more likely to prefer group learning.
- **Subject matter:** Some subjects may be better suited to individual learning than others. For example, maths and science subjects may require more focused attention, which can be easier to achieve in an individual setting. On the other hand, subjects such as history and literature may benefit from group discussion and debate.

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- **Learning style:** Some students are simply more introverted or extroverted than others. Introverted students may prefer to learn independently, while extroverted students may prefer to learn in groups.
- **Teacher instruction:** The way that teachers instruct students can also influence their learning preferences. Teachers who use a lot of lectures and teacher-centred instruction may make students prefer individual learning, while teachers who use more group activities and discussion may make students prefer group learning.

4.12 Question 6 - Comments

It is important to note that the above are just some possible reasons for the results in the table. The actual reasons why students prefer individual, or group learning are likely to be complex and vary from student to student.

The results do not allow us to draw any conclusions about cause and effect. For example, we cannot say whether students from individualistic cultures prefer individual learning because their culture emphasises independence, or whether students who prefer individual learning are more likely to develop individualistic values.

4.13 Question 7 - Have you used a computer to create or build something?

This question examines if students have utilised computers for creative endeavours. The data reveals an encouraging trend, with many students across all countries having used computers for creation. Spain stands out with the highest percentage (71.9%), followed by Portugal (51.0%) and Slovenia (53.3%). These figures suggest a strong emphasis on integrating technology into creative learning processes in these educational systems. The rest of the countries have a lower percentage of students (between 33%-44%) engaged in computer-based creation.

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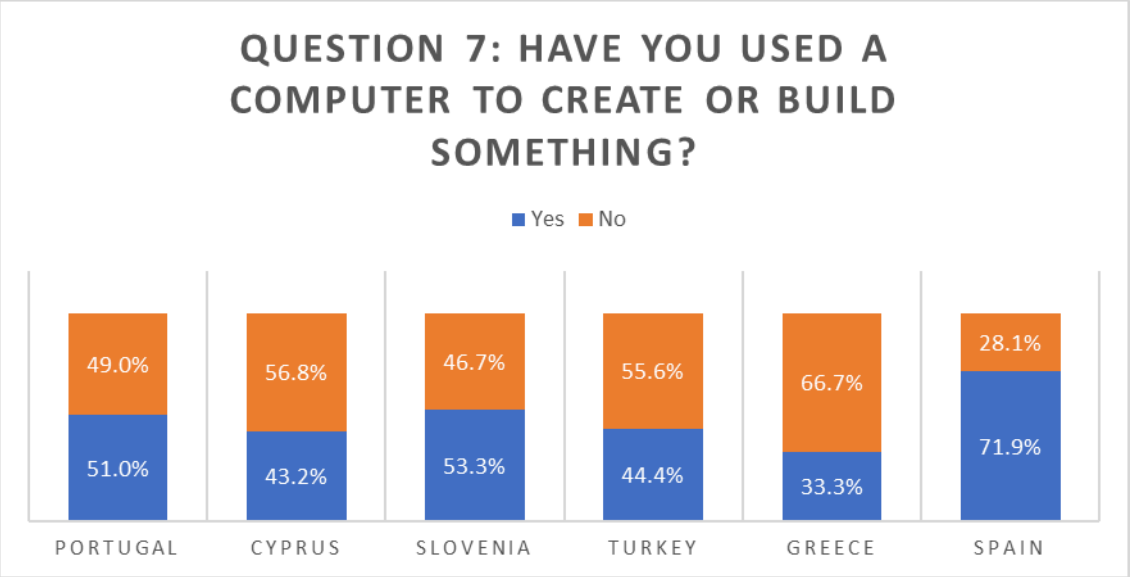

Figure 17 – Student Question 7

4.14 Question 7 - Comments

Several factors could contribute to these variations. National educational policies might prioritise computer-aided creation in some countries more than others. Countries like Spain, Portugal and Slovenia may have implemented stronger initiatives to equip schools with relevant technology and train teachers in integrating it into the curriculum. Access to technology infrastructure could also play a significant role. Schools in Spain, Portugal, and Slovenia might have a better allocation of computers and related resources compared to Greece, Türkiye and Cyprus.

Socioeconomic disparities within and between countries could further influence computer ownership and internet access at home. Students from well-off backgrounds might have more opportunities to develop digital creation skills outside of school, potentially impacting the overall national figures. Cultural attitudes towards technology could also be a factor. Some cultures might place a greater emphasis on traditional forms of creation, leading to less focus on computer-based tools.

While the data provides a valuable snapshot, it's important to acknowledge limitations. The specific definition of "create or build something" used in the data collection process could influence the results. Additionally, the data doesn't reveal the nature of the computer-based creations. Future research could delve deeper by investigating the types of creative activities students engage in using computers. This would provide a more nuanced understanding of how technology is being used for learning and creation across these countries.

This analysis highlights the potential of computer technology to empower student creativity. By addressing potential disparities in educational policies, resource availability, and cultural attitudes, and ensuring equitable access to technology, all

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countries can create a learning environment that fosters digital creation skills in the next generation.

4.15 Question 8 - Would you like to learn how technology works, not just how to use it?

The data reveals a strong interest among students in going beyond simply using technology and delving into how it actually functions. This fascination is particularly noticed in Spain and Türkiye, where almost all of the students surveyed expressed a desire for deeper technological knowledge.

Several factors could explain these results. Our world's growing dependence on technology might be fuelling a desire for empowerment. By understanding the inner workings, students might aim to become self-sufficient in troubleshooting issues or even build their own devices. The evolving job market, where many new positions demand technological expertise, could also be a motivator. Students with career aspirations in these fields may be actively seeking a deeper understanding. Additionally, plain curiosity likely plays a role. Students might possess a natural inquisitiveness about the mechanisms behind the devices they interact with daily.

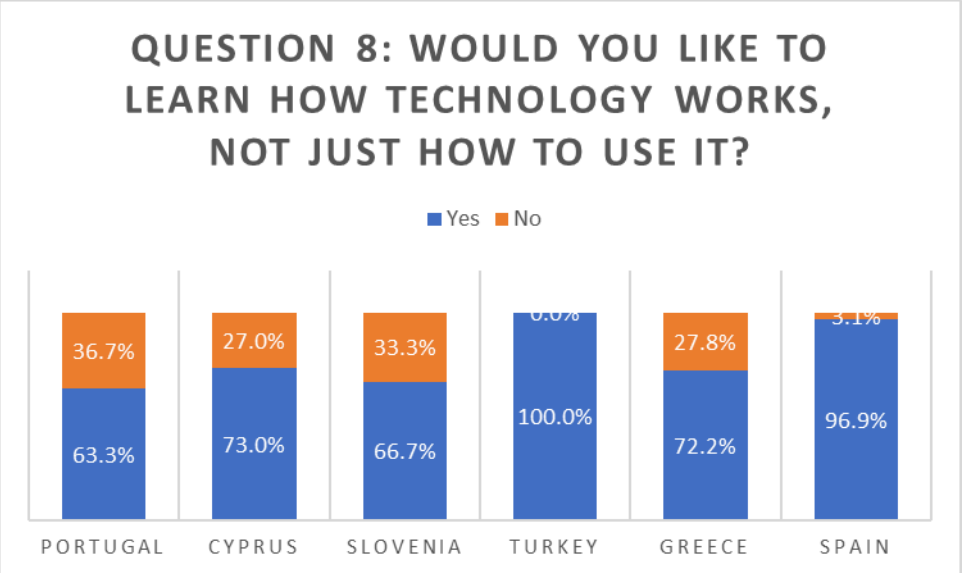

Figure 18 – Student Question 8

4.16 Question 8 - Comments

It's important to acknowledge that this data is limited to a small sample of students across six countries. Further research is necessary to determine if these findings hold true for a broader population. Future studies could explore additional factors that might influence student interest:

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- Age: Perhaps older students demonstrate a stronger inclination towards understanding the technical aspects of technology compared to their younger counterparts.
- Gender: Investigating potential gender disparities in interest could be insightful.
- Socioeconomic Background: Students from more affluent backgrounds might have greater access to opportunities for learning about technology.

By examining these considerations, a more comprehensive picture of student interest in the inner workings of technology can be developed.

4.17 Question 9 - Do you think coding can be as interesting as other subjects like sports, languages or science?

The data shows that a majority of students in all six countries believe that coding can be as interesting as other subjects. The percentage of students who agree ranges from 59.2% in Portugal to 90.0% in Türkiye.

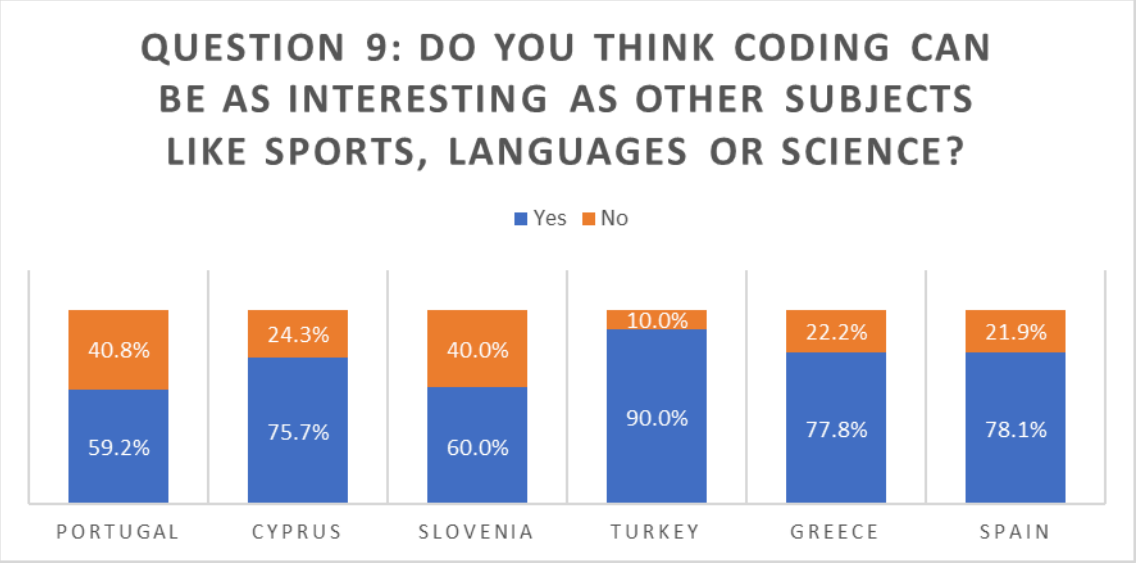

Figure 19 - Student Question 9

4.18 Question 9 - Comments

There are several possible reasons why students might find coding interesting. Coding can be a creative outlet, allowing students to build things and solve problems. It can also be a social activity, as students can work together on coding projects. Additionally, coding can be a powerful tool that students can use to make a difference in the world. For example, students can code apps to address social or environmental issues.

Some additional reasons why students in these particular countries might find coding interesting:

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- Cyprus and Greece have a long history of innovation and technological development. This could explain why students in these countries are more interested in coding than students in other countries.
- Türkiyeis a rapidly developing country with a growing tech sector. The Turkish government has placed a lot of emphasis on STEM education in recent years. This could explain why Turkish students are more likely to find coding interesting.
- Spain, Slovenia and Portugal are countries with a growing tech sector. The Spanish government specifically has also made efforts to promote STEM education in recent years. This could explain why Spanish students are more likely to find coding interesting.

4.19 Question 10 - If you created a computer program, what would you want it to do?

The question wants to check the interest of students on what a computer program can do, considering that they already have experience in creating a computer program. Looking at the results we see that depending on the country the percentage of interest varies to a great extent. For example students wanting a computer program to play games starts from 0% (Portugal) and reaches 100% (Türkiye), or a program showing videos varies from 6.7% (Slovenia) to 80% (Türkiye). What is clear though is that a program for chatting with friends is not a preferred option since either the already existing ones cover the students or they prefer face to face communication. In Figure 20 with red are the lower percentages per option and with blue the highest percentages.

Country	Play Music	Show Videos	Solve math problems	Learn how to code to create or modify games	Talking with friends	Play a game
Portugal	**57.1%**	18.4%	32.7%	59.2%	**0.0%**	**0.0%**
Cyprus	40.5%	37.8%	**51.4%**	5.4%	**5.4%**	70.3%
Slovenia	6.7%	**6.7%**	26.7%	0.0%	**0.0%**	60.0%
Türkiye	**0.0%**	**80.0%**	**0.0%**	**0.0%**	**0.0%**	**100.0%**
Greece	11.1%	22.2%	33.3%	0.0%	**0.0%**	33.3%
Spain	41.0%	28.2%	25.0%	**84.0%**	**0.0%**	72.0%

Figure 20 – Student Question 10

4.20 Question 10 - Comments

This difference may be due to several factors beyond the scope of this analysis could also be influencing these preferences.

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- **Curriculum:** The curricula in different countries may place a varying emphasis on computer science education. Countries with a stronger emphasis on computer science education in their curriculum are likely to have a higher percentage of students who have previously created a program that included coding or programming concepts.
- **Teacher Training:** There may be variations in the amount of training that teachers receive on how to teach coding or programming concepts. Teachers who have received more training on how to teach coding or programming concepts are more likely to integrate these concepts into their lessons.
- **Student Experience:** Students who have had more experience with coding or programming themselves may be more likely to code something in specific known topics.

5 Discussion and Conclusions

5.1 Teachers Key Findings

Aiming to summarise and combine the data from the survey completed by the educators the following key findings can be extracted:

- **Experience with Coding:** There is a significant variation in teacher experience with incorporating coding into lessons. Spain has the highest percentage (94.2%) of teachers reporting prior experience, whereas Greece, and Türkiye have significantly lower percentages.
- **Value of Coding:** A large majority of teachers (82.1%) believe coding is valuable to teach at their grade level. Spain and Cyprus have the strongest agreement, while Slovenia has a lower percentage.
- **Awareness of Arduino:** Awareness of Arduino and its educational applications is uneven across countries. Türkiye and Spain have the highest awareness levels, whereas Cyprus has moderate awareness, and Portugal, Slovenia and Cyprus have the lowest.
- **Comfort Level Teaching Coding:** There is a geographical disparity in comfort level. Portugal has the highest percentage of teachers not comfortable teaching coding, while other countries seem more open.
- **Use of Educational Technology:** Most countries show a trend of teachers integrating educational technology into their teaching. However, Portugal and Greece have a higher percentage of teachers who do not report ever using it.
- **Training Needs:** A significant need for training in coding exists across all countries. The form of professional development requested are thrgouh in-person workshops in 3 countries (Portugal, Slovenia, Greece), Manuals and educational materials in 2 countries (Cyprus, Spain) and Online courses in Türkiye.

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- **Incorporating Coding:** A majority of teachers favour incorporating coding into existing subjects like mathematics, science, and language arts. There is less support for coding as a separate subject (in Greece and Cyprus).
- **Support for Teachers:** To encourage teachers to embrace coding education, they need access to technology, instructional materials, peer support groups, and professional development opportunities.

Overall, the survey highlights a growing recognition of the importance of coding skills. However, it also identifies disparities in teacher experience, comfort level, and access to resources. The report recommends strategies to address these gaps and promote effective coding education across Europe.

5.2 Student Key Findings

Analysing the data from the survey completed by the students the following key findings can be extracted:

- **Limited Exposure to Coding:**
  - A concerningly low percentage of students across all countries have taken coding classes. Spain has the highest (68.8%), while Portugal has the lowest (6.1%).
  - Potential reasons include unequal access to technology (digital divide), lack of awareness about coding benefits, and limited integration of coding education in national curriculums.
- **Importance of Coding:**
  - A significant majority across all countries view coding as important for their future (40.0% to 100%).
  - Reasons might be the tech industry's growth, technology's pervasiveness, and increased awareness of coding education.
- **Strong Interest in Gamified Learning:**
  - Students across all countries showed strong interest in using game-based platforms to learn coding.
  - This could be due to the engaging nature of games with points, badges, and leaderboards, offering a sense of accomplishment and fostering deeper engagement compared to traditional learning methods.
  - However, the quality of game design and its effectiveness as a supplement, not a replacement, for traditional instruction are crucial aspects to consider.
- **Varied Interests in Coding Areas:**
  - No clear trends emerged regarding preferred coding areas (Web Development, Gamified Learning, Mobile App Development, Robotics).
  - Potential reasons for these variations include:
    - Educational priorities in a particular country
    - The types of jobs available in a country's industry

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        - Student demographics (age, gender, socioeconomic background)
- **Learning Preferences:**
    - Students in Portugal, Spain, Slovenia, and Türkiye prefer group learning, while those in Cyprus and Greece prefer individual learning.
    - Reasons for these variations could be:
        - Cultural factors (individualistic vs collectivistic cultures)
        - Subject matter suitability for individual or group learning
        - Student learning styles (introverted vs extroverted)
        - Teacher instruction methods
- **Computer Usage for Creation:**
    - An encouraging trend shows many students across all countries have used computers for creative endeavours (Spain: 71.9%, Portugal: 51.0%, Slovenia: 53.3%).
    - Disparities exist with Greece (33.3%) and Türkiye (44.4%) having lower engagement. Reasons for this could be:
        - National educational policies prioritising computer-aided creation in some countries more than others
        - Access to technology infrastructure (schools with better allocation of computers and related resources)
        - Socioeconomic disparities impacting computer ownership and internet access at home
        - Cultural attitudes towards technology
- **Coding Seen as Interesting as Other Subjects:**
    - A majority of students believe coding can be as interesting as other subjects.
    - The reasons for finding coding interesting could be:
        - Creativity and problem-solving outlet
        - Social activity through collaboration on coding projects
        - Powerful tool to make a positive impact (e.g., addressing social or environmental issues)

Overall, the student survey results highlight a growing interest in coding education but also reveal disparities in exposure, resources, and integration within national curriculums. These findings can inform the development of a teacher training curriculum that addresses these gaps and equips educators with the necessary skills and knowledge to effectively integrate coding education and empower students for the digital age.

5.3 General recommendations for the development of the teachers' training curriculum and the students' training course

Based on the analysis of the surveys, a list of recommendations to support the development of effective teacher training curriculums and engaging student training courses in Arduino based coding education is provided.

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Teacher Training Curriculum:

- **Address the digital divide:** Equip teachers with strategies to bridge the gap in student access to technology by incorporating low-tech or offline activities into coding lessons.
- **Raise awareness of coding benefits:** Help teachers understand the relevance of coding skills in various career paths and everyday life. Motivate them to integrate coding education into their teaching.
- **Incorporate best practices in gamified learning:** Train teachers on designing or selecting effective game-based learning platforms that complement traditional instruction and cater to diverse learning styles.
- **Differentiate instruction based on student interests:** Provide guidance on tailoring coding lessons to address the varied interests students have in web development, app development, robotics, etc.
- **Promote collaboration and individual learning:** Equip teachers with strategies to facilitate both individual and group learning approaches based on the subject matter and student needs.
- **Creative technology use:** Train teachers on integrating computer-aided creative activities into the curriculum across various subjects, not just computer science.
- **Understanding technology's workings:** Provide teachers with opportunities to deepen their understanding of how technology functions to empower them to teach these concepts effectively.

Student Training Courses:

- **Cater to different age groups and experience levels:** Design age-appropriate courses with varying difficulty levels to cater to beginners, intermediate, and advanced learners.
- **Make coding fun and engaging:** Incorporate game-based elements, puzzles, and interactive activities to make learning enjoyable and motivating.
- **Focus on practical application:** Provide students with opportunities to apply their coding skills to create real-world projects, websites, apps, or games.
- **Offer opportunities for collaboration:** Encourage teamwork and peer learning through collaborative coding projects.
- **Highlight career opportunities:** Inform students about the various career paths that benefit from coding skills to inspire them and demonstrate the relevance of their learning.
- **Address cultural considerations:** Develop course materials that are sensitive to the cultural backgrounds and learning styles of students.

Additional Considerations:

- **Teacher-student collaboration:** Encourage collaboration between teachers and students in the development of coding lessons and projects to leverage student interests and address specific needs.
- **Ongoing professional development:** Provide teachers with ongoing professional development opportunities to stay updated on the latest trends and advancements in coding education.

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- **Parental and community involvement:** Engage parents and the community in supporting coding education by organising workshops and awareness campaigns.

By implementing these recommendations, teacher training curriculums and student training courses can be designed to effectively address the identified gaps and provide a comprehensive and engaging coding education experience for students, preparing them with the necessary skills to thrive in the digital age.

5.4 Arduino specific recommendations

Teacher Training Curriculum:

- **Integrating Arduino:** Train teachers on how to effectively integrate Arduino boards into their coding lessons. This includes:
    - Familiarisation with Arduino hardware and software components.
    - Lesson planning that utilises Arduino boards for various coding concepts (e.g., sensor input, output control, programming logic).
    - Troubleshooting common issues students might encounter while working with Arduino.
    - Safety considerations when using electronic components.
- **Project-based learning with Arduino:** Equip teachers with strategies to develop project-based learning activities that utilise Arduino boards. This allows students to apply their coding skills in practical ways, building real-world prototypes and gaining hands-on experience.
    - Examples of Arduino projects could include:
        - Building a temperature sensor and data display system.
        - Creating a light show controlled by code.
        - Designing a robot with basic movement capabilities.
- **Arduino resources and online communities:** Introduce teachers to valuable online resources and communities dedicated to Arduino education. These platforms offer ready-made lesson plans, tutorials, project ideas, and forums for peer support and troubleshooting.
    - Examples of resources:
        - Arduino Education website (https://www.arduino.cc/education)
        - Online communities like the Arduino Project Hub (https://docs.arduino.cc/arduino-cloud/guides/cloud-editor)

Student Training Courses:

- **Hands-on experience with Arduino:** Design student training courses that provide ample opportunities for hands-on experience with Arduino boards. This could involve:
    - Introductory workshops on setting up the Arduino development environment and basic coding exercises.
    - Guided projects with increasing complexity, allowing students to build upon their skills and explore different functionalities of Arduino.
    - Opportunities for independent exploration and project development using Arduino, encouraging creativity and problem-solving.

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- **Learning by building:** Emphasise a "learning by building" approach where students learn coding concepts through the process of constructing and programming Arduino projects. This fosters a deeper understanding of the practical applications of coding.
- **Arduino for different interests:** Offer student training courses that cater to diverse interests by showcasing how Arduino can be used in various applications:
    - For students interested in robotics, courses can introduce them to building basic robots with Arduino and sensors.
    - For those interested in game development, courses can explore using Arduino to create interactive game controllers.
    - For students who enjoy creative expression, courses can delve into using Arduino for light shows, sound effects, or interactive art installations.

Additional Considerations:

- **Cost-effectiveness:** Highlight the cost-effectiveness of Arduino boards as an educational tool compared to other platforms. This can be a deciding factor for schools with limited budgets.
- **Open-source nature:** Emphasise the open-source nature of Arduino, allowing for greater flexibility, customization, and a vast community of resources available for learning and problem-solving.
- **Scalability:** Showcase the scalability of Arduino projects, allowing students to start with simple projects and gradually build upon their skills to create more complex applications as they progress.

By incorporating these recommendations and focusing on the use of Arduino, teacher training curricula and student training courses can provide a practical and engaging learning experience in coding education. This equips students with valuable skills in electronics, programming, and problem-solving, preparing them for the technologically driven world.

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