INTRODUCTORY GUIDE TO AI AND CODING CONCEPTS

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Introduction

In today's rapidly evolving technological landscape, it is becoming increasingly important for young students to have a basic understanding of artificial intelligence (AI) and coding. These skills are not only relevant to the future job market but also play a crucial role in shaping our daily lives.

Incorporating AI and coding into primary education can help students develop critical thinking skills, problem-solving abilities, and logical reasoning. Students can learn to approach complex problems in a structured manner and find solutions by breaking them down into smaller, manageable pieces. They can also learn to think creatively and come up with innovative solutions to real-world problems. Moreover, it is becoming increasingly clear that understanding how coding and AI work will be an essential skill set in the future work environment. Therefore, it is crucial that pupils begin adapting to this knowledge at a young age. Even jobs that do not explicitly require coding skills often benefit from having employees who can understand and work with technology. Having a basic understanding of AI can be valuable, as AI is being integrated into many industries, from healthcare to finance.

Beyond the job market, understanding AI and coding is crucial for citizens in the digital age. AI-powered algorithms and systems play a significant role in shaping our lives, from the content we see on social media to the recommendations we receive from e-commerce websites. A basic understanding of how these systems work can help individuals make informed decisions and protect themselves from being manipulated or misled. Incorporating AI and coding into primary education can also help bridge the gender gap in STEM (Science, Technology, Engineering and Mathematics) fields. Historically, STEM fields have been male-dominated, and women have been underrepresented. By introducing coding and AI at a young age, we can encourage girls to explore these fields and break down gender stereotypes.

Therefore, this guide has the objective to provide a general but complete overview of AI and Coding in order to facilitate their understanding and use both on a daily basis and on education. While sharing simplified explanations of how these concepts work and interact with living human beings, this guide presents a comparative analysis based on national desk research conducted in 6 different countries within the scope of the Erasmus+ project AI-Cosmic . The different approaches, perceptions and best practices aim to support the preparation of a framework to introduce AI and Coding skills in various educational levels.

1. Understanding AI

Definition of AI and its limitations

Artificial Intelligence (AI) can be described as a field of engineering which was first mentioned by John McCarthy in 1956, referring to the creation of a system enabling the amplification of knowledge and understanding, and was later exploited by Alan Turing, referring to the ability of machines to simulate human beings' activity.

The objective of AI is to develop tools that can be used in various technologies to enable computers and machines to develop problem-solving and decision-making processes. Indeed, lists of instructions called algorithms aim to give computers and machines the ability to perform tasks usually done by living human beings. As it requires learning and thinking competences, AI tools use combinations of sets of programs to operate computers and physical elements, in other words softwares and hardwares. Therefore, it enables the ingestion of a lot of accessible data, and the identification of correlations between these data. By creating and using such patterns, as well as perceptual learning aspects, memory and critical reasoning capacities, AI is able to make predictions or suggestions.

AI has been used so far to improve the general way of living of the population and to facilitate daily tasks and development. For example, social networks or websites offer recommendations, based on previous searches and preferences learned by AI on platforms like Netflix, Google, YouTube, Amazon, and others. It is also involved in the realm of transportation, with autonomous vehicles and monitoring of real-life conditions, by Google maps for example. Artificial intelligence is also present in video games, spam emails management, voice assistants such as Siri or Alexa, autocorrect features, security and video surveillance, facial recognition (FaceID), and so on. Many companies nowadays use AI tools and invest to enhance its development, especially Apple, Amazon, Meta, Google and Microsoft.

However, there are still limitations in this field. As an example, tools show a lack of creativity, as well as a lack of emotions. Indeed, the algorithms and mathematical logics used are not able to create new patterns, but only to make predictions regarding existing ones. This aspect proves that AI is not likely to perform much in original thinking areas. Regarding the lack of emotion, the systems used by AI are based on data logical and structural analysis, which cannot be applied for the understanding of emotions and feelings. Therefore, it brings a lack of understanding of subjective actions and cannot take into consideration some living human beings' reactions. Similarly, the limited understanding of context by AI causes a lack of common sense, and might need human input to recognize something new, or understand subtleties, figurative language, sarcasm and nuances. AI's limitations also include biassed decisions. Indeed, AI will analyse only the information received, and if this information is biassed for any reason, showing a lack of equality, diversity or representation for example, AI will not be able to understand that this is not representative and will most probably give biassed answer, unfair and unjust decisions in the future. In addition to a lack of robustness, the need of human inputs in terms of maintenance and monitoring can be highlighted as a limitation, as AI tools cannot be entirely autonomous yet.

What is not AI?

As AI and not AI tools might be seen as quite similar, it is important to highlight that AI tools work with learning and training data. Therefore, a machine using algorithms may not always belong to the AI field. Similarly, AI is able to make decisions and improve itself by learning from experience. As an example, automatic doors in stores that open when someone is nearby, are not AI, as they only use sensor technologies. Another example can be an automatic washing machine. Indeed, human input is necessary to select a washing program and the parameters, the machine is not able to do it itself. It is also the case for some smart devices. For example, a smart TV has a platform with various application softwares, such as games and videos softwares, that the user can install and unload, but it is not related to AI. However, AI TV learns about the user's usage and its habits in order to make recommendations, fasten the usage of the TV and create interaction. Indeed, it adds characteristics such as language recognition, natural language processing, image recognition, and so on. Finally, the concept of Internet of Things (IoT), which refers to the interconnectivity of objects or 'things' that can share data via the Internet such as thermostats, fitness trackers, security systems and so on, is also distinct from AI. IoT uses a lot of data and algorithms but still requires the human touch. However, mixing both concepts can improve the use of certain devices or machines and be more powerful.

The Big five Ideas in AI

In order to teach the field of Artificial Intelligence to primary and secondary level students, the joint project AI4K12[1] has created resources and defined the 5 big ideas in AI, which, through their understanding, enable the understanding of the field. By providing a framework, AI can be approached through the following 5 aspects:

1. **Perception**, involving the ability of machines and computers to perceive the world using sensors.
2. **Representation & Reasoning**, as AI uses different types of representation to support reasoning and problem-solving.
3. **Learning**, as AI uses networks of data to acquire knowledge and improve performance.
4. **Natural Interaction**, interactions being possible with various forms of knowledge such as consciousness and intuitions.

[1] The AI4K12 Initiative (AI4K12.org) is a National Sci-ence Foundation-funded project jointly sponsored by AAAI and CSTA.

5. **Social Impact**, which can be both positive and negative.

By exploring and comprehending these five dimensions, learners can gain a deeper understanding of artificial intelligence and its applications. The use of these five ideas and the way artificial intelligence is divided provides a framework for teachers aiming to familiarise their audience with artificial intelligence in general.

❖ Perception of AI

In order to perceive the world similarly to humans, machines are equipped with sensors that mimic human senses such as sight, hearing, smell, touch, and taste. These sensors, sometimes even more effective than human senses, come in various forms, such as optical cameras, microphones, tactile, olfactory and gustatory devices (electronic nose and tongue), infrared scanners, and others. Through algorithms, softwares, and hardwares, these sensors convert important external data into raw data that AI systems can analyse and recognise to enhance their understanding of the world. AI machines also possess artificial neural networks, which mimic the functioning of the human brain, allowing for data transmission.

❖ Reasoning of AI

AI tools come into valid conclusions thanks to knowledge and facts using different types of reasoning.

Deductive reasoning consists of making a decision using related valid known facts. If the general statements (facts) are true, so is the conclusion. *All birds have feathers. A penguin is a bird. Therefore, a penguin has feathers.*

Inductive reasoning involves limited sets of facts/ observations and uses generalisation, which means that even if the general statements are true, the conclusion might not be, and be only 'probable'. *Every crow I have seen is black. Every picture of a crow I have come across is also black.*

Every video I have watched featuring a crow shows a black bird. Thereofere, it is likely that all crows are black.

In **abductive reasoning**, the premises don't guarantee the conclusion, and the objective is to find the most plausible explanation of the premises. *The front door is open. You remember closing and locking the door before leaving in the morning. There are no signs of forced entry, and nothing else in the house appears to be disturbed. You may have forgotten to lock the door properly, someone with a key may have entered the house and forgot to close the door, an animal may have pushed the door open. Based on abductive reasoning, you conclude that the most likely explanation for the open front door is that someone with a key entered the house and forgot to close it behind them.*

Common sense reasoning refers to the human ability to make presumptions using good judgement and draw logical conclusions based on intuition. *You touch a hot stove and feel intense pain. Based on your common sense understanding of cause and effect, you conclude that touching a hot stove causes pain. You learn from this experience and develop common sense knowledge to avoid touching hot objects to prevent pain and potential injury.*

With **monotonic reasoning**, the conclusion stays the same, even if new information is added to the general statement. *All birds have wings. Tweety is a bird. As a conclusion, Tweety has wings.*

On the contrary, in **non-monotonic reasoning**, new information could make the conclusion invalid. *Birds can fly. Tweety is a bird. Tweety can fly. However, if we later discover that Tweety is a penguin (a flightless bird), we revise our conclusion and override the initial assumption, realising that not all birds can fly.*

❖ Learning of AI

AI uses learning models, training data and artificial neural networks with nodes connected to each other to learn. During a training phase, the connection between the nodes will be modified until the learning content is assimilated. The most common model is **supervised learning**, in which the training data are known and labelled (by humans) and will be used to create patterns and rules. In the

unsupervised model, the training data is not labelled at all. Therefore, the machine might tend to use statistics and groups similar data. The **semi-supervised learning model** has both labelled and unlabelled training data, and applies identified patterns from the labelled data to the large amount of unlabelled ones. Finally, **reinforcement learning model** methods, that use dynamics such as rewards and punishment to reinforce the knowledge, can be added.

❖ Interaction of AI

As it is known, AI interacts with humans in different ways. As an example, voice assistants can conduct a dialog, which requires natural language understanding. Some AI machines are specifically designed to be social robots and communicate and interact with humans on a social level, one of the most famous being the humanoid social robot Sophia. Rapidly, the idea of an artificial consciousness, meaning that machines are aware of their own existence and think using their own mind, has appeared. Both **phenomenal consciousness**, which involves emotions, thoughts, sensations to have subjective experience, and **access consciousness**, which involves more reasoning, decision-making and verbal report with rational control, are still being developed and require a large amount of work and research. In general, several aspects such as nonverbal communication, facial expression or personality are important in how humans and AI machines interact, which is why AI tend to be attributed human characteristics to machines.

❖ Impact on society of AI

Artificial Intelligence has a significant impact on society, and has potential for even greater influence in the future. This field affects various aspects, such as: economy and employment with automation of many sectors; healthcare, with diagnostics methods; transportation, with autonomous vehicles and traffic management; education, with new learning methods. Although the impact of AI on society is generally seen as an improvement in people's lives, its use raises ethical questions in its design. AI enables machines and tools to make decisions, decisions that should be aligned with society's ethical principles, also regarding the challenges related to biases. The high impact of AI

indicates that, at various levels, a safe, human and environment friendly approach should be prioritised. To achieve this, it is crucial to incorporate several principles into its design:

1. **Privacy of user's data**: Ensuring the protection and confidentiality of users' personal information by adhering to national and international laws and giving users control over the use of their data at all times.

2. **Transparency in decision-making and robustness**: Making the decision-making process of AI systems clear and understandable to users. This can be achieved by developing explanations of the reasoning used by AI during the decision-making process.

3. **Inclusive representations**: Incorporating diverse perspectives and avoiding biases in data and algorithms by engaging open dialogues and feedback with users to identify potential challenges.

4. **Sensitivity to cultural norms, values and fairness**: Acknowledging and respecting the cultural diversity, values and norms of users. This can be achieved by working with Ethics Canvas to align AI with user values.

5. **Consideration of global challenges and consequences**: Taking into account the wider impact and potential consequences of AI decisions and establishing clear policies within companies to understand the extent of their responsibility.

The importance of AI teaching and using AI tools in education

Any student using AI principles / coding will grow in confidence in learning, by taking risks and making mistakes as part of a creative process. They will increase thinking and problem-solving skills, as well as creative stamina and learn how to navigate through mental blocks when brainstorming. Similar to real-world collaboration in any creative industry, students have the opportunity to give and receive constructive feedback and grow in their social skills.

In the same way, the introduction of tools using AI in learning and teaching methods would lead to improvements in the field of education. Primarily, these tools would facilitate the creation of a personalised learning path for each student, tailored to their individual needs and abilities. This would guide students towards exercises or methods that would be most beneficial for them. Furthermore, it facilitates various other aspects of the education domain, impacting Learning Management Systems, implementing plagiarism detection tools, promoting exam integrity, transcribing lectures, analysing student success metrics, and encouraging the creation of connected campuses, among other possibilities.

2. Coding and its application

Definition of coding

Coding, also known as computer programming, refers to the process of creating instructions related to ideas or solutions that a computer can understand and execute. It involves writing lines of code in a specific programming language, which can be used to create algorithms, software and hardware applications, websites, games, and more. Essentially, coding enables computers to perform specific tasks and automate processes. The purpose of coding is to create software applications that can perform specific functions and automate processes. By using coding languages such as Java, Python, and C++, programmers can create complex algorithms and systems that can solve real-world problems. This can include everything from creating mobile applications and video games to developing websites and enterprise-level software solutions. Additionally, coding plays a vital role in the technology industry, as it enables the development of new technologies and the improvement of existing ones. Indeed, coding is used to develop machine learning algorithms and plays an important role in the development of AI tools, which impacts various types of industries (healthcare, finance, transportation…).

According to research, teaching coding in primary schools is important as it can help students develop essential skills for success, such as critical thinking and problem-solving skills, creativity, and collaboration abilities. Furthermore, coding is becoming increasingly essential for individuals and organisations alike, as demand for these skills is expected to continue to grow in the future, according to the World Economic Forum.

How coding can be applied in daily life of pupils

Coding skills can be applied in a wide range of daily activities and can help pupils improve their problem-solving skills, boost their creativity, and enhance their computational thinking abilities. For instance, coding can be used to create and design websites and applications, allowing pupils to express their creativity and share their interests with what surrounds them on a daily basis. Additionally, coding can be used to automate repetitive tasks such as data entry, which can save time and improve efficiency in school projects and assignments. Coding can also be used to develop various types of solutions to real-world problems, such as developing apps to track and reduce waste, creating games to raise awareness of environmental issues, or building robots to assist people with disabilities for example. Indeed, coding can be used to control and program various types of hardware, such as drones, robots, and microcontrollers. These applications of coding can help pupils develop an entrepreneurial mindset and a desire to make a positive impact in their community and the world. Pupils can become familiar with how to program various devices and use them to perform various easy tasks.

In summary, coding skills are highly valuable and can be applied in various aspects of daily life, from expressing creativity to developing solutions for real-world problems. By learning to code, pupils can develop essential skills and knowledge that can help them succeed in the 21st-century workforce and make a positive impact in their community and the world.

Importance of teaching coding in schools

In today's digital age, computer programming has become an essential skill, not just for professional programmers but also for people from all walks of life. With the growing demand for technology-related jobs, coding has become one of the most in-demand skills in the job market. As a result, teaching coding in schools has become increasingly important in preparing students for future success.

Firstly, learning to code helps students develop logical thinking and problem-solving skills that are valuable not only in programming but also in many other areas of life. As they write code, they learn to break down complex problems into smaller, more manageable pieces, and to use logical reasoning to find solutions. Secondly, coding teaches students creativity and innovation. When students learn to code, they gain the ability to create new software and applications, which can lead to innovation and entrepreneurship. For example, students can bring their ideas to life using coding knowledge and can create their own mobile apps or websites. Finally, teaching coding in schools helps bridge the gap between technology and society. Coding is a fundamental part of modern technology, and by teaching it in schools, we can ensure that more people are equipped with the skills needed to understand and work with technology. According to OECD, this, in turn, can lead to more diversity and inclusivity in the tech industry.

In general, it is suggested that educational institutions adjust their programs to introduce coding skills and prepare students to the new technologies that are being developed. According to the U.S. Bureau of Labor Statistics, "Overall employment in computer and information technology occupations is projected to grow 15 percent from 2021 to 2031, much faster than the average for all occupations; this increase is expected to result in about 682,800 new jobs over the decade." [2]. Furthermore, Code.org, a non-profit organisation, dedicated to expanding access to computer science, highlights the importance of teaching coding in schools. Additionally, the National Science

[2] U.S. bureau of Labor Statistics, publications on Computer and Information Technology Occupations, 2022, https://www.bls.gov/ooh/computer-and-information-technology/home.htm

Foundation has published research supporting the need for computer science education in K-12 schools, citing the benefits of increased access and opportunities for students.

In conclusion, teaching coding in schools is becoming increasingly important in preparing students for success in the digital age. By developing logical thinking, problem-solving skills, creativity, and innovation, students can gain a competitive advantage in the job market and be better prepared to work with technology in the future.

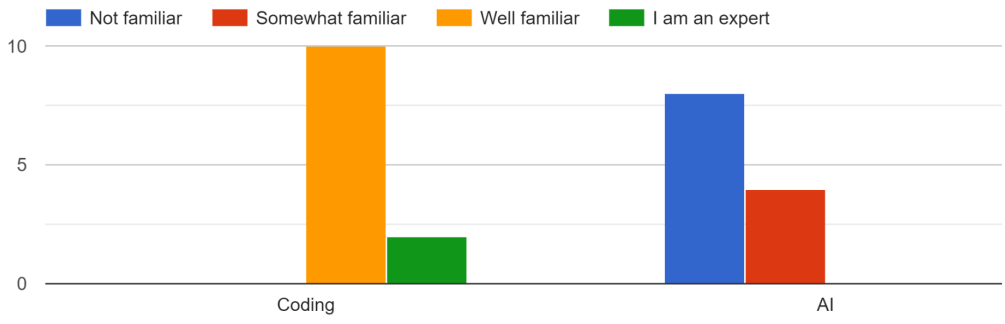
3. State-of-the-Art in AI and Coding

Comparative analysis of everyday practices of AI and coding in partner countries

a. The Netherlands

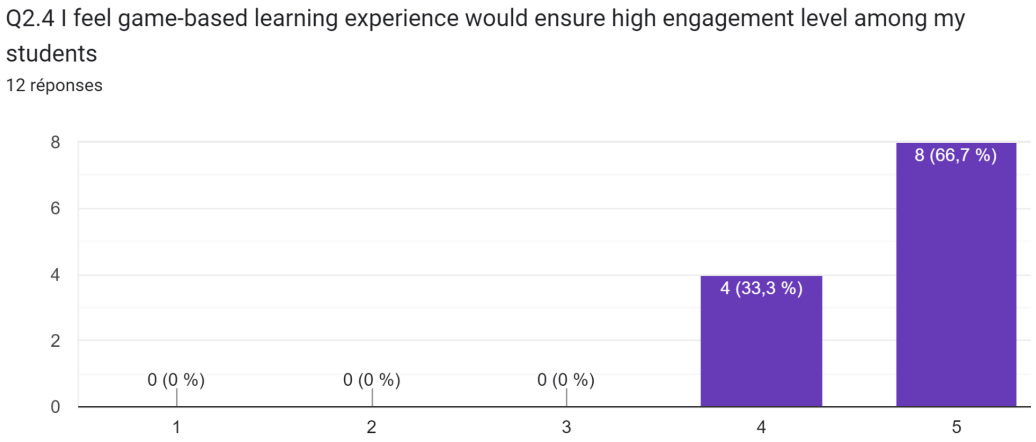
❖ GENERAL INFORMATION

Q1.3 How familiar are you with Coding and/or AI concepts?



The research made in the Netherlands is based on responses of 10 primary/middle school teachers and 1 children vocational program instructor, all being part of public funded institutions. In terms of familiarity with coding concepts, all participants reported being at least well familiar, suggesting a strong foundation in this area. However, when it comes to AI concepts, the majority of respondents admitted to having little to no familiarity, highlighting a potential knowledge gap. The results also indicate that all respondents from the Netherlands utilise digital game tools to enhance teaching and learning, mentioning block-based coding tools such as Scratch, Kodu, J2E, Tinkercad, Booklet, Kahoot, Minecraft Education, etc. Additionally, they reported being familiar with digital tools incorporating AI and coding elements for educational purposes, some respondents also using text-based coding tools and programming languages like Python and Java. Moreover, the respondents confirmed using digital tools to teach about AI and coding, as well as subjects like Math and Natural Sciences, as they stated it helps developing various skills, including problem-solving, logic, creativity, collaboration, resilience, and critical thinking.

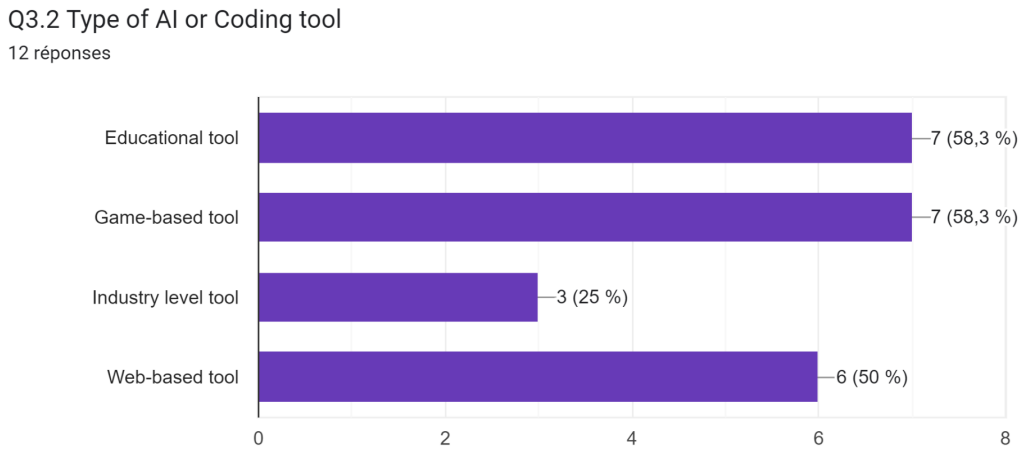
❖ PERCEPTION



The data from the Netherlands reveal that the respondents hold positive views regarding the use of digital tools, coding skills, AI concepts, and game-based learning as they widely agree that it is

essential for teaching and learning. The respondents express confidence in their students' interest in learning about AI and coding, with high levels of engagement. Moreover, they hold a positive outlook on the use of game-based learning with coding elements to teach various subjects and develop a range of skills, such as problem-solving, logic, creativity, collaboration, resilience, and critical thinking. Furthermore, the respondents display a strong interest/familiarity in digital game-based tools.

❖ TOOLS AND PRACTICES



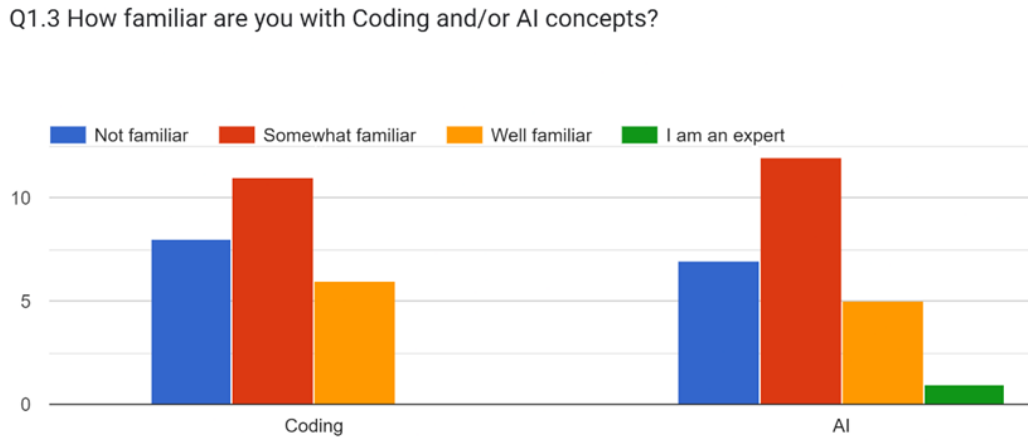
The data from the Netherlands provides insights into the usage of AI or coding tools in educational institutions, particularly primary schools and secondary schools, with age groups from 5 to 12 years old. Regarding the types of tools being used, these include educational tools designed to facilitate learning and understanding of AI and coding concepts, game-based tools that offer interactive and engaging experiences, industry-level tools that provide a more advanced and specialised approach, and web-based tools that leverage the power of online platforms. This diverse range of tool types reflects the flexibility and adaptability of AI and coding resources in catering to different educational needs and objectives.

One notable tool is Minecraft, a familiar game that offers creative freedom and concepts to be explored. It has different versions, some have embedded lesson plans and the challenge here is familiarising students with the game controls. A valuable version would be Minecraft Education, that is specifically designed for classroom teaching. Other tools can be Kranker Online, a web-based tool that can effectively be used for game-making and coding instruction. Also, Articulate 360 is a course maker tool that is not specifically tailored for teaching coding but stands out for its ease of use. Other tools such as Roblox, Scratch, iSpring and Krunker.io were mentioned.

Analysing the data, the majority of the tools are considered user-friendly for the target group but most of them are provided by the institution and require a licence. Teachers believe that these tools are effective for teaching and learning, as they contribute to the development of problem-solving, creativity, collaboration, resilience, and critical thinking skills. The number of users usually is estimated between 1 to 30 users and teachers also express a willingness to recommend these tools to other educators, highlighting their positive experiences and potential benefits. Among the tools that receive interest from the educators, the data name a high interest to become familiar with Minecraft Education Edition or web apps, and there is an interest in exploring other coding tools and block-based programming outside of a game environment, and considering editor-type coding lessons for older children.

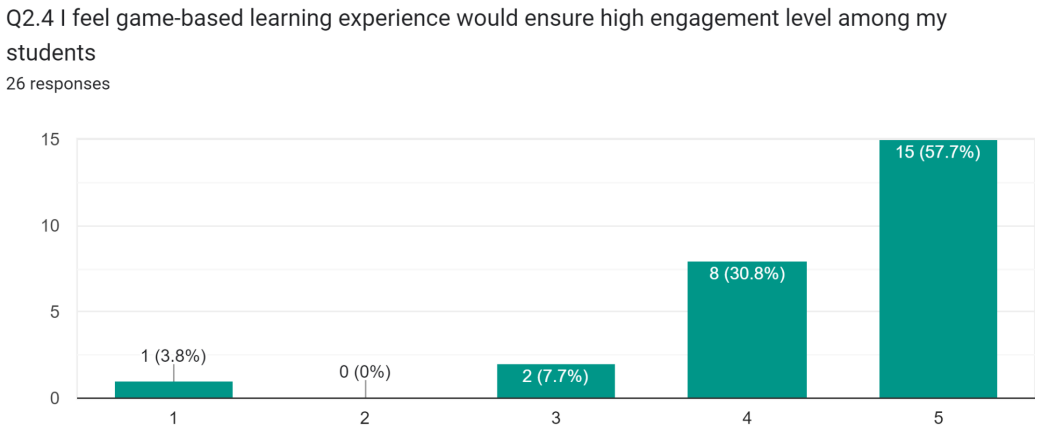
b. Croatia

❖ GENERAL INFORMATION



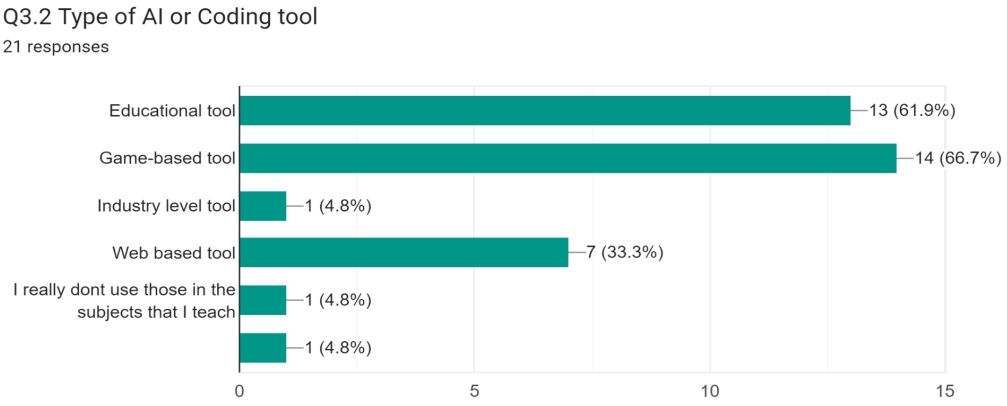
The data provided indicates varying levels of familiarity with coding and AI concepts in Croatia. Regarding coding, most of the educators are familiar with concepts related, but a significant portion of respondents are lacking familiarity. As far as AI concepts are concerned, similar results can be described. The analysis reveals a diverse landscape of familiarity with AI concepts. In the same way, the majority of respondents rated their familiarity with AI and Coding elements for teaching and learning purposes as either 1 or 2, indicating a low level of expertise in utilising these tools. However, among the respondents, the data reveals that a majority of them reported using digital game tools, which shows a favourable trend in their usage for teaching and learning. Among those tools, educators tend to use game-based tools and web-based learning platforms. When 70% of the respondents indicated not using digital tools to teach AI and Coding, 84% of the educators declare using it for teaching other subjects, particularly Languages, Math and natural Sciences. Croatians respondents have highlighted a wide range of skills that are more likely to be developed, such as problem-solving, critical-thinking, logic, creativity and collaboration.

❖ PERCEPTION



The data from respondents in Croatia indicates that the majority of participants (73%) agreed or strongly agreed that digital tools are essential for teaching and learning nowadays. A similar percentage of respondents believe that basic coding skills and understanding of AI concepts are essential, even for kids. There was also a consensus that students would be interested in learning about AI and coding. The respondents were even more optimistic when the level of engagement from their students is concerned, with almost 2/3 of the participants targeting students from 9 to 13 years old. The second age group elected by the respondents is a younger one, from 5 to 9 years old students. In the same way, respondents mostly agree on the fact that game-based learning with coding elements can be used to teach and learn about various subjects and develop different skills. As for the familiarity or interest in learning how to use digital game-based tools to teach about AI and coding, the responses varied, with a majority of participants expressing a low level of familiarity and interest.

❖ TOOLS AND PRACTICES



The respondents from Croatia provided information showing a wide range of institutions incorporating these tools, mostly primary schools, and including kindergarten and vocational education programmes. The type of tools mentioned include mostly game-based tools, educational tools and web-based tools. The target audience for these tools spans different age groups, primarily 9-12 years old with no interest in the 18+ years old group. Regarding the accessibility of tools, 80% of the participant educators share using free to access tools. The respondents from Croatia provided insights on various tools used for AI and coding education, their accessibility, challenges faced, useful features, and user-friendliness for the target group.

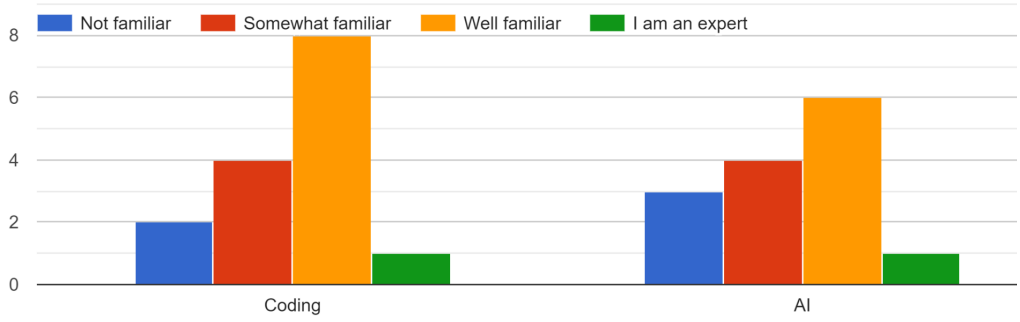
Specific tools were mentioned, such as Kahoot, a game-based learning platform that makes it easy to create, share and play learning games or trivia quizzes; Scratch, a visual programming language that allows students to create their own interactive stories, games and animations, designed for education in a classroom settings; PhET interactive simulation, which provides fun, free, interactive, research-based science and mathematics simulations; mathletics, that gives personalised learning, exciting games and mastery challenges through an online maths program; Reading eggs, which focuses on a core reading curriculum of phonics and sight words using skills and strategies essential for sustained reading success. Other tools were also mentioned, like Code.org, Tinker, photo editing tools, Wordwall, VR class.

Challenges reported by some respondents included the reliability of technology, setup time, lack of preview mode, time requirements for preparation, and potential distraction caused by game competition. Useful features highlighted by participants included tutorials, logical names and colour coding of blocks, ease of use, effectiveness, animation, and the ability to change variables. Overall, respondents generally considered the tools to be user-friendly for the target group and effective for teaching and learning with possibility to develop skills such as problem-solving, critical thinking and creativity, which is why most of the educators would recommend using digital tools. Regarding the number of users, 44 % of the respondents report more than 100 users at their institution and a low percentage of them report less than 30 users. The access to the tools was predominantly provided by the respondents' own institutions or through personal search for free access tools online. When asked about other tools they would like to include in their toolkit, some respondents mentioned specific tools such as J2E.com, Quiziz, and Unity.

c. Italy

❖ GENERAL INFORMATION

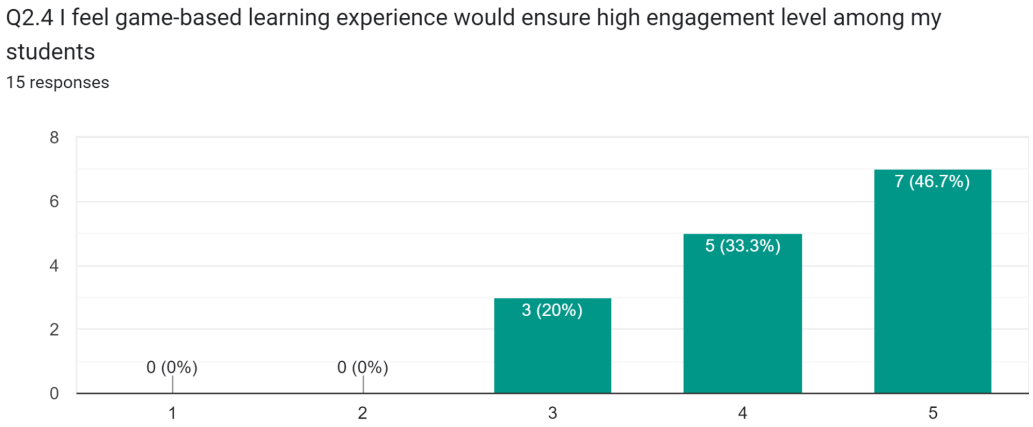
Q1.3 How familiar are you with Coding and/or AI concepts?



The scientific research led in Italy using a survey filled by 15 teachers, instructors or lecturers from mostly public funded primary/middle schools, children vocational programs and higher institutions highlights that Italian educational professionals are more likely to be well familiar with AI

and Coding. Indeed, the chart demonstrates that only a few of the respondents were not familiar with both of these tools. Even though approximately 2/3 of the respondents are at least partly familiar with the purposes of these digital tools, the survey shows that only a bit more than half of the respondents use digital game tools to enhance the teaching and learning process with their students, showing a low familiarity. The mostly used tools are game-based tools such as Blooket or Kahoot and web-based learning platforms, followed by programming languages like Python or Java and Block-based coding tools such as Kodu or Tinkercard. The data collected indicates that less than half of the respondents use digital tools to teach AI and Coding or subjects other than computing, the other subjects being Math and Technology. According to the respondents, the understanding and use of AI and coding principles can positively impact the gain of various skills and more specifically logic, creativity and problem-solving.

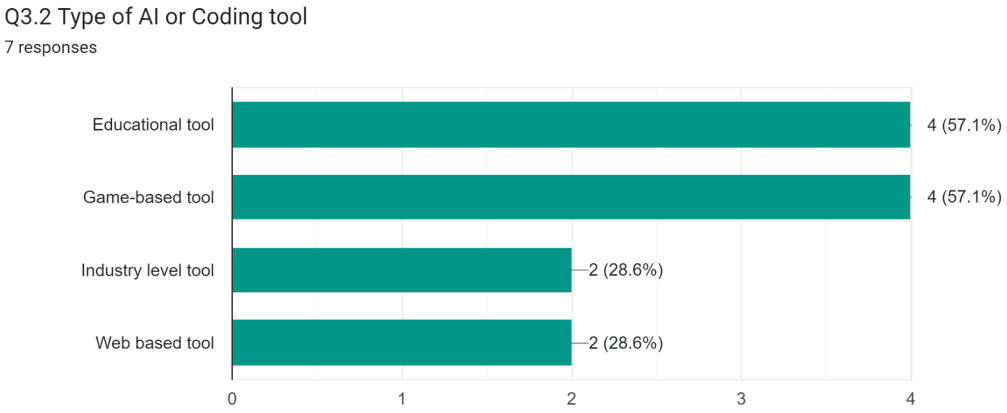
❖ PERCEPTION



In the Italian education sector, the use of digital tools is considered as essential in the teaching and learning process, as the chart shows. Similarly, the data collected confirms that the majority of respondents have elected coding skills and understanding of AI concepts as essential for the population, even for kids, and believe that AI and coding tools can be used to develop different types

of skills while learning and teaching. However, the interest and knowledge about digital game-based tools from the educators is quite mixed and the survey in Italy therefore indicates that the perception of educators is generally positive despite a lack of resources to put the teaching aspects into practice. Additionally, the interest on AI and Coding from students can be discussed as the survey shows mixed results, but educators still believe in a high rate of engagement from their students in a game-based learning environment. According to the Italian educators involved, this high engagement rate would mostly correspond if the appropriate age group receives introduction to elements of Coding and AI, which means mostly 14 years old and older students.

❖ TOOLS AND PRACTICES



Regarding the data collected from the Italian educators, AI and Coding tools, in particular game-based and educational tools, are mostly used in secondary school, followed by high school and higher education institutions. These practices include the use of the 4 following tools: Scratch, used for students to code their own interactive stories, animations and games; code.org, used for students to have the opportunity to learn computer science at their own path; python, used as a an interpreted, object-oriented, high-level programming language with dynamic semantics; or even Roblox, that is

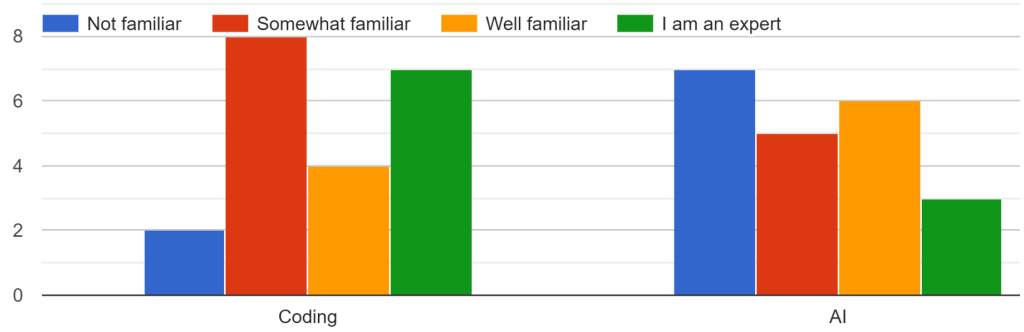
used for students to imagine, create, and share experiences with each other in immersive, user-generated 3D worlds. These mentioned tools are more likely to be suggested to students from the age group 9 to 12 years old, closely followed by the 13 to 17 years old group. They are mostly game-based or code learning based, and are in general free to access, at least for educational institutions.

The educators from Italy are attracted to the simplicity, support, creative aspects and friendliness to the target groups, without facing any particular challenge experiencing the tools. According to the answers received, educators are aiming to use coding tools more than any other type of tools. The experience of teaching and learning is partially made possible by the use of these mentioned tools as it emphasises the development of skills such as problem-solving and creativity, as well as critical thinking and resilience. According to the survey, it is challenging to estimate the number of users of these tools, but it is more likely to concern less than a 100 users per institution. Indeed, even if the institution itself provides access to various tools, the use of digital tools with AI or Coding elements is made possible by the initiative of the educator itself, who would generally agree on suggesting the use of the tools mentioned to other educators.

d. Greece

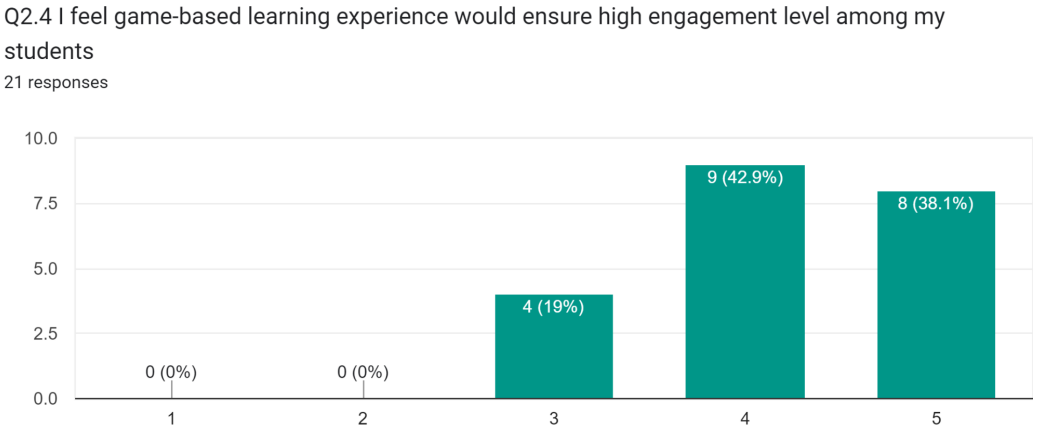
❖ GENERAL INFORMATION

Q1.3 How familiar are you with Coding and/or AI concepts?



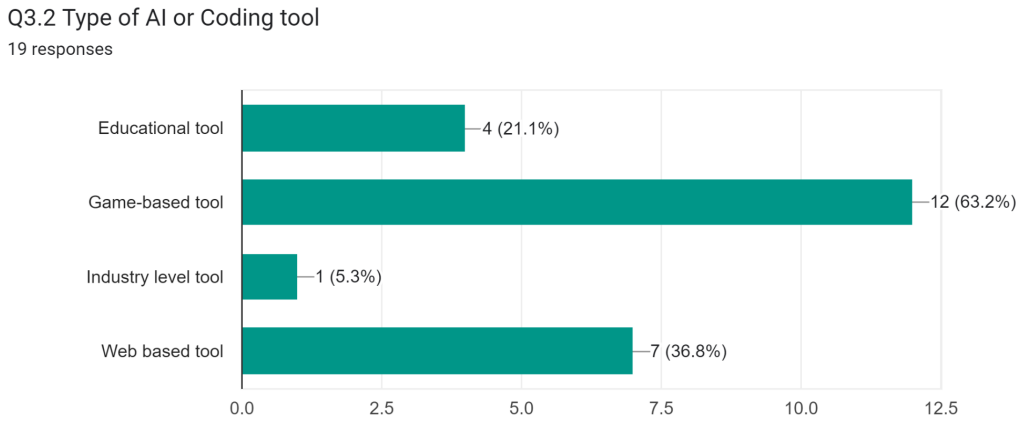
The research conducted in Greece has gathered 21 educators mostly from primary and middle schools, and also from children vocational programs, 2/3 of them coming from the private sector. As it can be seen on the chart, 1/3 of the respondents consider themselves as experts in coding, when only a few are experts in AI. When another 1/3 of them are somewhat familiar with coding, only a few of them are not familiar at all. Indeed, digital game tools are used by a bit more than half of the respondents, even if the data collected shows mixed feelings regarding the familiarity of the respondents with the learning and teaching purposes of AI and coding elements. Game-based, programming language and block-based coding types of tools are most likely to be used. When around 60% of the educators declare using these tools for coding and AI related subjects, and half of the respondents would use it for other subjects, especially Maths and Technology. In their opinion, skills such as logic and problem-solving are more likely to be developed through the development of these practices.

❖ PERCEPTION



The research made through the survey in Greece indicates that the use of digital tools in the learning and teaching environment is seen as essential, especially when it involves the basic coding and understanding of AI skills. However, it is noticeable that 23% of the respondents do not share this opinion when it comes to kid's education. In the same way, the majority of educators believe that it might raise the interest of their students, and are even more confident to agree on the fact that their engagement would be high, and that it would enhance the development of various skills by tackling different subjects. When the age group is concerned, 2/3 of the Greek educators would choose to introduce AI and coding basic elements to students from 9 to 13 years old, while the other 1/3 would choose 14 years old and older students. In the end, around 3/4 of the respondents are interested and/or familiar with the use of digital game-based tools in the teaching of AI and Coding.

❖ TOOLS AND PRACTICES



When it comes to tools and practices in the Greek educational environment, mostly game-based tools and web-based tools are usually used at primary schools closely followed by secondary schools. Selected by a majority of the respondents, the tools used mostly tackle code structure learning, statistical and programming software, block programming, quiz and game creation for students from 9 to 12 years old.

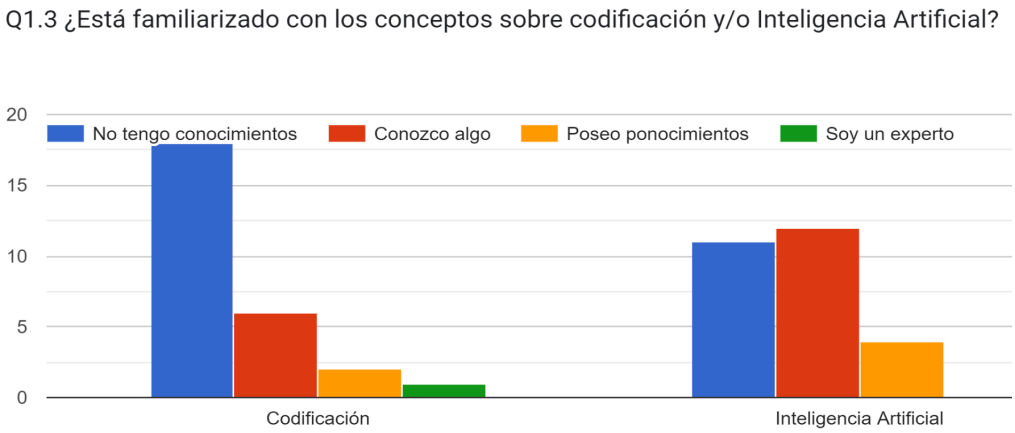
A wide range of tools are mentioned by the Greek educators, such as Bamboozled, a platform enabling educators to create their own games for teaching purposes; Blooket, a gamified learning platform where teachers host games through question sets; Lightbot, a puzzle game based on coding, enhancing programming logic; R, a statistical and data analytics software using programming language; CodeCombat, an educational video game for learning software programming concepts and languages. Other tools were mentioned, like Kahoot, Minecraft, Nea Paideia or Scratch. All of these tools are either free to access, or at least have a free licence for educational institutions.

Among these tools, aspects related to the data collecting, coding principles, versatile aspects, possibility to make the tasks more complex, adaptability, graphics are highly appreciated by the educators, even though challenges are quite common with those tools, mainly regarding the guidance or the lack of engagement from the students as it might get slow or not be built in the most efficient way. Those tools are described as usually friendly to their target group, and highly effective for the teaching and learning environment, involving critical thinking and problem-solving skills. Even if more

than half of the time the access to the tool is provided by the institution itself, the number of users does not expand beyond 100 users. As most of the educators would recommend others to use these tools, it might be recommended to use it for higher educational level.

e. Spain

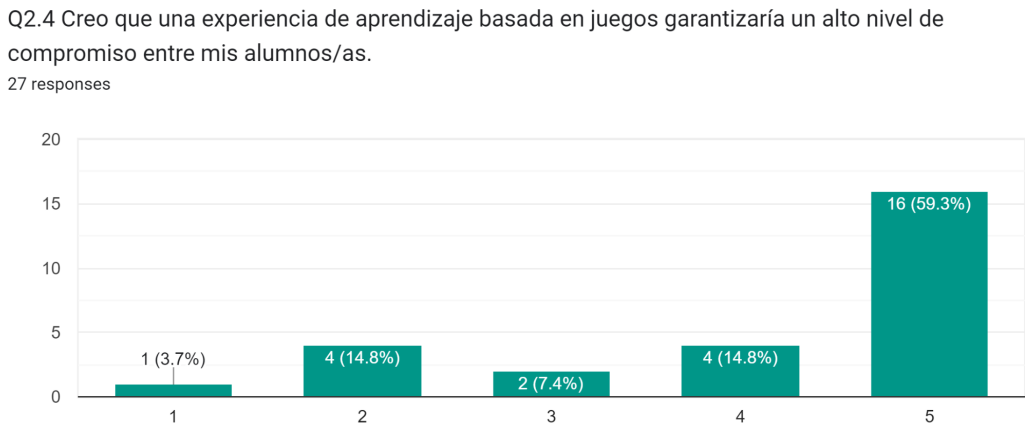
❖ GENERAL INFORMATION



With a total of 27 responses from Spanish educators mostly from public funded primary or secondary schools, this research shows that knowledge about coding concepts is not popular among educators. According to the chart, the concepts related to AI have a tendency to be slightly more popular. Even if the results show that the respondents are mostly not familiar at all, or only a little, with AI digital tools, 3⁄4 of them do use digital tools in their teaching and learning process, particularly game-based ones such as Blooket and Kahoot, but also online learning platforms. For almost 70% of the respondents, these tools are used to teach subjects other than AI and Coding related ones, such as Languages, Natural Sciences, Music and Arts. On the contrary, only 40% of educators would use it for AI and Coding related subjects. By introducing digital tools in their teaching and learning methods,

Spanish educators target the development of various skills such as creativity, critical thinking, problem-solving, logic and collaboration.

❖ PERCEPTION

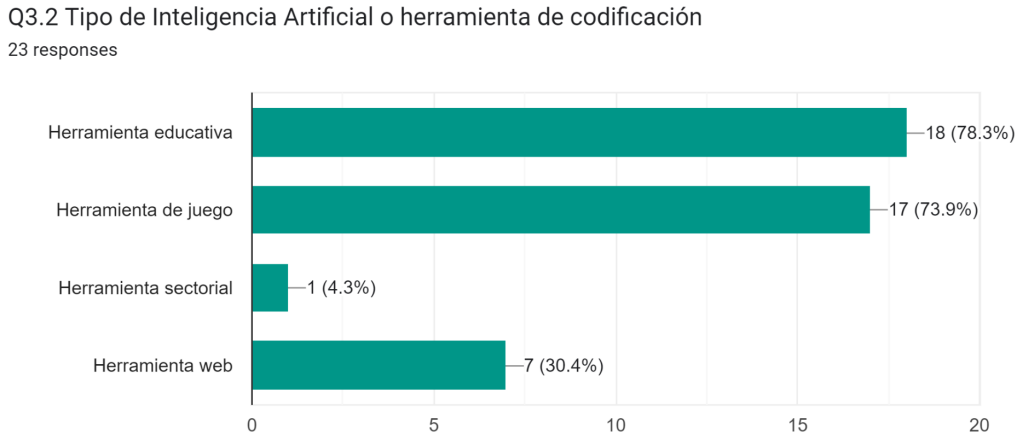


According to the data collected during this research, Spanish educators mostly agree on the fact that digital tools are essential in the learning and teaching process, even if the results are mixed in terms of being essential for kids. However, in the opinion of more than ¾ of the respondents, the interest of the students reaches a high level, and this can be correlated with an even higher level when it comes to their commitment to the use of digital game-based tools. When educators are asked to rate their familiarity and knowledge related to AI and Coding elements, it is highlighted that almost 75% of the respondents are well familiar or expert.

In the same way, the data reveal that educators agree on the fact that using coding elements in the teaching process enables the teaching and development of various skills. However, the results show that these aspects might depend on the level and type of education. This is confirmed by the mixed results when it comes to the age group most appropriate to teach basic AI and coding concepts. Indeed, a bit less than half of the respondents believe that students from 9 to 13 should be

the main target group, when the rest of the respondents would pick a younger or an older age group as the most appropriate one.

❖ TOOLS AND PRACTICES



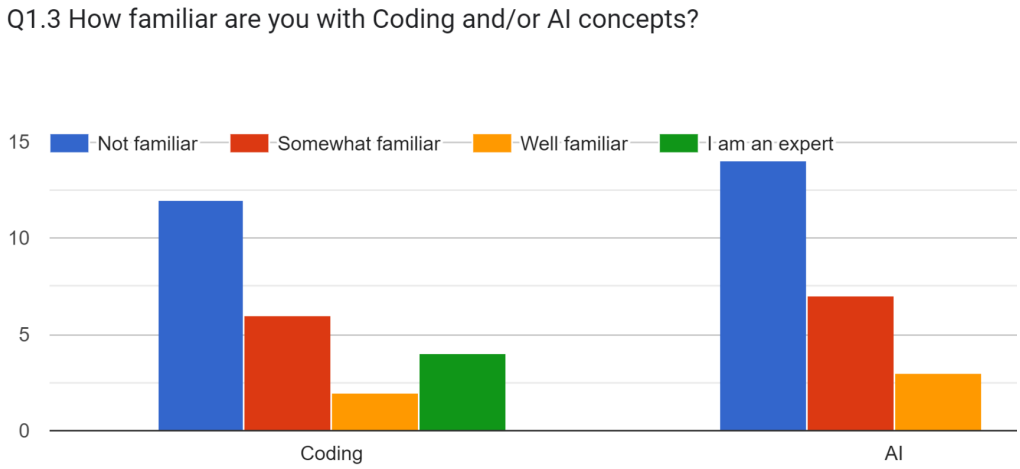
In Spain, AI and coding elements are mostly taught at primary school and secondary school, by the use of educational and game-based tools. These tools are used for a wide range of students, from 9 to 17 years old. In that sense, the Spanish kindergarten sector is not concerned at all by the use of such digital tools. A wide range of tools are used among the Spanish educators, the most popular being Kahoot, Scratch, Minecraft, googlesites. Other tools like Pasapalabra, that enables the understanding of various concepts more efficiently for students and brings social cohesion; CAD (Computer Assisted Design) softwares; LCMS (Learning Content Management System) using moodle platforms; Microbit, that is used to understand how softwares and hardwares work together. Finally, respondents have highlighted other tools that they would like to be using, such as Class Dojo, robotics tools, adult learning tools, Lyricstraining and Classcraft.

In their practice, Spanish educators use these tools as it supports the teaching process in a more dynamic, intuitive, visual, motivational and effective way, it creates a social cohesion while creating videogames and enables the students to start a discussion/ask questions while offering a

more personal experience for each student. The educators insisted on the fact that according to their needs, they would use any kind of web tool that would allow us to support their teaching process. Most of the tools are free to access and only 10% of the educators are likely to use tools that require a specific licence. According to the results, practices require flexible, interactive and easy-to-use tools that can be used on different devices, in particular tablets. Those tools are described as 100% useful for teaching and learning, definitely with problem-solving, critical thinking and collaboration facilitation development and would completely be subject to a recommendation. These practices are highly used in Spain, as half of the respondents estimate that there are more than a 100 users in their institutions. In general, the implementation of practices are mostly enhanced by educators themselves and sometimes by the educational institution.

f. Latvia

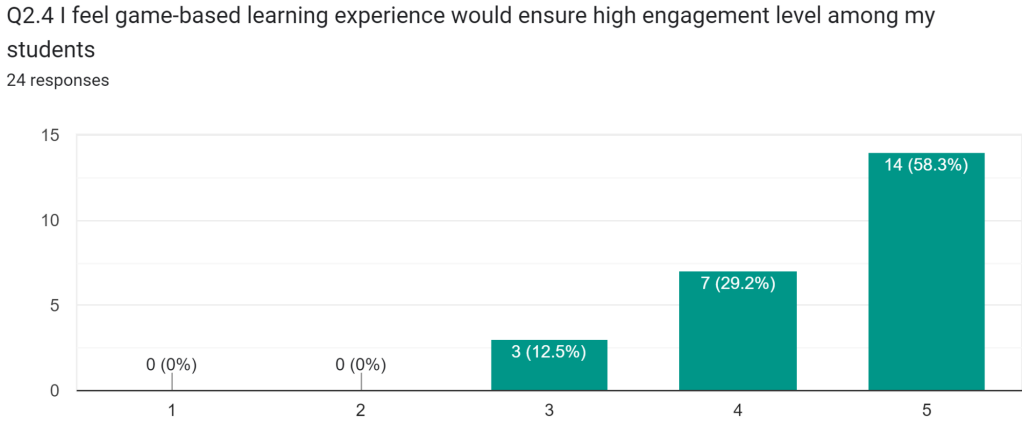
❖ GENERAL INFORMATION



The research led in Latvia has brought 24 educators mostly from public primary and middle school, as well as children vocational program educators. In general, Latvian educators are not familiar at all with AI and coding concepts, as it can be seen on the chart, even though we can notice

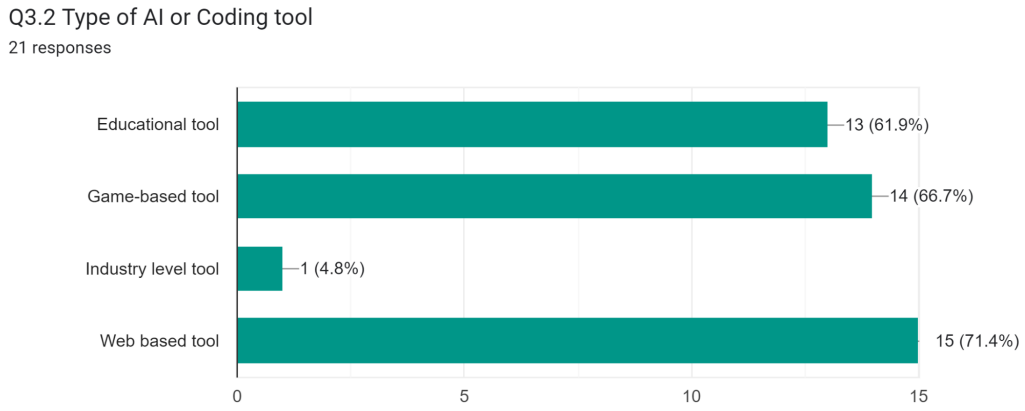
some experts regarding coding. The data collected indicates that almost ¾ of them use digital tools in their teaching experience, mostly game-based tools and web-based learning platforms. However, Latvian educators usually do not use tools with AI and coding concepts to teach about AI and coding. As a consequence, ¾ of the respondents use digital tools to teach other subjects, such as Art and Music, Math or even Languages, as it emphasises the development of logic, problem-solving and critical thinking skills, as well as creativity in some cases.

❖ PERCEPTION



Latvian educators mostly agree on the fact that digital tools are essential in the learning and teaching environment, but the understanding of AI and coding concepts for kids is a bit less important. When students are seen as probably interested in the learning of these concepts, their engagement is seen as high, knowing that the most appropriate age groups would be 9 to 13 years old and 14 years old and older students. When the learning of these concepts are mostly seen as enabling the learning of different skills for various subjects, educators from Latvia are showing mixed results regarding how much they are familiar or interested in teaching AI and coding digital tools, most of them having a medium knowledge and interest.

❖ TOOLS AND PRACTICES



Through this research, we can highlight that AI and coding tools are mostly used at secondary schools in Latvia, using web-based, educational and game-based tools for students aged from 9 to 12 years old. Many of the tools used by the educators are block based, interactive platforms for programming and quizzes, such as Kahoot, Quizlet, Scratch, HTML, quizizz, Minecraft, Roblox and Python. The availability of the tool in Latvian is also an important aspect to take into consideration, which is why educators also use tools such as Digiklase, which offers various digital tools ready to use; startit.lv, which is a platform to learn computing and programming; soma.lv, which shares learning content for many different subjects and a wide range of levels; uzdevumi.lv, which similarly shares content on various subjects with the possibility to provide assessment; fixmix.lv, that mainly focuses on contents regarding Physics; Steamup, which focuses on technical subjects or even maciunmacies, which focuses on learning languages.

Even if most of the tools are free to access, or at least for educational institutions, 20% of the educators declare to use tools requiring a licence. As mentioned, the lack of Latvian resources on some of these platforms is one of the main challenges, as well as old aspects of the tools. Aspects such as transdisciplinarity, interactivity, user friendliness and remote use are appreciated to use

amusing programming tools. Many skills are most likely to be developed, in particular problem-solving, critical thinking and resilience, even if almost 10% of the respondents don't approve of the effectiveness of these tools to teach and learn and would not recommend it. The number of users of these tools, which are mainly provided by platforms or organisations outside of the institution, highly depends and is estimated between 1 to more than a 100 users by the respondents, showing mixed results. Among the tools that educators would like to get familiar with, we can find more common tools such as Minecraft and Roblox.

Conclusion

To conclude, the analysis of each national desk research highlights a disparity among educators in Europe in terms of familiarity with digital tools using AI and Coding concepts. Therefore, it is noticed that there is room for further education and exploration of AI and coding concepts, knowing that every educator would recommend the use of related tools. The active use of digital tools with AI and Coding elements in the teaching environment is a response to the positive views towards these tools, which emphasises the significance of these elements in the educational context, as well as their importance in today's society. In the same way, when most of the educators would recommend teaching AI and coding concepts to students from 9 to 12 years old, the national desk research in Croatia and Italy revealed that these concepts should be taught also in kindergarten. Using digital tools is seen as a motivating teaching method as the level of commitment from the students is expected to be high in most cases. From the comparative analysis, it can be seen that the most popular tools are game-based and web-based ones, and are very convenient to teach subjects other than AI and coding, such as Maths and Technology. Some tools are very popular such as Kahoot, Minecraft, Roblox, Quizziz, Scratch, Java and Python.

As most of the time, the use of digital tools using AI and coding concepts are from the initiative of the educators themselves, educational institutions only show a few efforts to enhance AI literacy among the students. It might explain the low familiarity level of Spanish educators with such tools, which could be resolved if the institutions would provide access to the tools themselves. Indeed,

institutions play an important role when it comes to the widespread use of digital tools as an educational licence is required to access some of them and educators would in general recommend their use to others. As it can be observed that Italian educators tend to only use a few tools while Latvian educators have a wider range of resources, there is a need to create initiatives that would facilitate the understanding of these tools and would train and motivate educators to use it in their teaching. In the same way, not all participants declare facing obstacles but Greek educators mention facing a few challenges regarding accessibility or quality, such as the old aspects of the tools or the lack of performances. The importance of new initiatives is highlighted by the fact that educators agree on a wide range of skills to be developed by the use of tools using AI and coding concepts such as problem-solving, creativity, and critical-thinking.