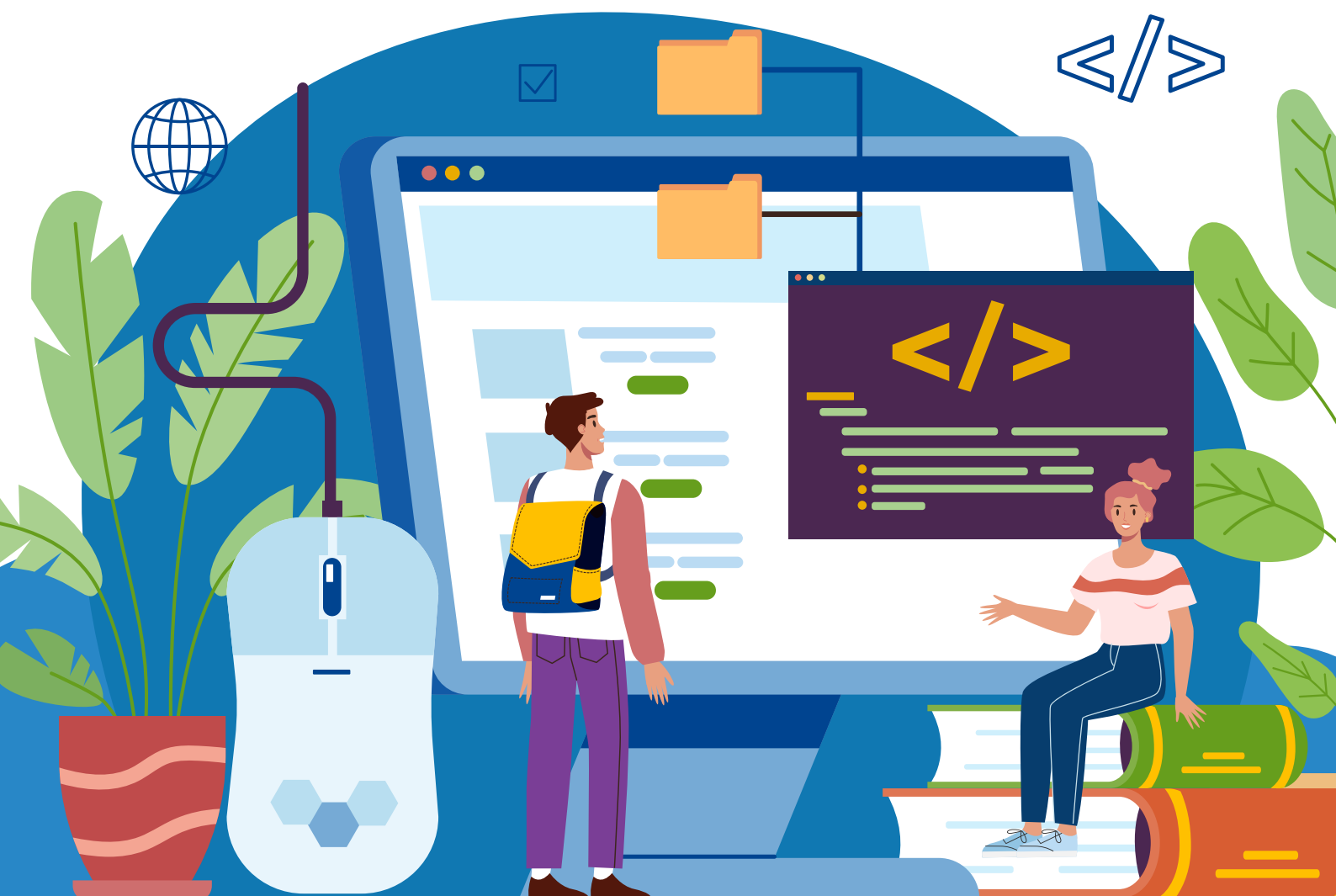




Guidelines for teaching informatics: practical strategies for European classrooms



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Foreword

In a world increasingly shaped by artificial intelligence, data, and algorithms, informatics education is the best means we have to ensure that all learners, starting from early education, are able to not only use digital technology, but to also *understand* and *shape* it.



The *Union of Skills* presents our plan for high quality education, training, and lifelong learning, with digital education as a great way to help Europe's students develop. We are committed to ensuring that European

citizens are well-equipped to navigate an increasingly digital society and economy, and to helping them contribute to a competitive and resilient Union.

The Council Recommendation on improving the provision of digital skills (2023) reflects this urgency, calling on Member States to foster high-quality informatics education from the start of compulsory schooling.

That is why these *Guidelines for Teaching Informatics* have been developed. And it is why they focus on real-world application and use terms such as making students '*data detectives*', and how they can join '*makerspaces*'. You will see how using gaming tools, storytelling or helping students explore the social impact of informatics, can all help develop life skills, and break down stereotypes – so that everyone can learn how informatics can be useful in everyday life.

The guidelines cover digital foundations, helping each learner at their level, and advising how best to assess progress. We want to support teachers across Europe and to help avoid a digital divide, because informatics is taught in uneven ways, and students' access, experiences, and opportunities vary widely depending on national curricula, teacher training, and local support. And this support feeds into our upcoming agenda.

Our Education package which we will propose later this year (2026), will step up the action. In particular, the 2030 Roadmap on Digital Education and Skills will support education systems in equipping Europeans with digital

competences – from basic skills to advanced expertise. And we are working with European EdTech partners to support teachers and education systems in teaching informatics.

The need to help informatics teachers and trainers will also be reflected in the upcoming EU Teachers and Trainers agenda, and the European Schools Alliances. Here the aim will be to help teachers boost their skills abroad, and help schools build connections so that digital education leaders can pass on expertise in a structured way.

These guidelines have been developed by the *Expert Group on High-Quality Informatics Education*. They are designed to be a practical companion for teachers, turning big ideas into clear, usable strategies that can make a real difference in the classroom. They offer evidence-based, practical strategies to help teachers bring informatics to life in their classrooms.

Whether you are an experienced informatics teacher, a schoolteacher integrating digital competence into your subject, or a school leader, I invite you to explore these guidelines and adapt them to your own context. By using them in the classroom, you will help students grow into not just digital users, but also active and capable contributors to our digital society.

Let's ensure that every learner is empowered with strong foundations in informatics, starting now.

Pia Ahrenkilde Hansen

Director-General for Education,
Cultural, Sport and Youth

Introduction

Informatics is taught differently across Europe, shaped by local traditions, school systems and changing societal needs. This variety brings many great ideas, even if it sometimes presents challenges in defining a shared vision of ‘high-quality’ informatics teaching.

To improve informatics education for *all*, we need to understand what works best in various classrooms. While good progress has been made, important questions remain – such as how and when core concepts should be introduced, and how to teach in ways that include and engage every student.

These guidelines aim to help teachers develop practical strategies for making informatics learning fair, engaging and meaningful for *all* students, so that everyone has the chance to enjoy, explore and succeed in our digital world.

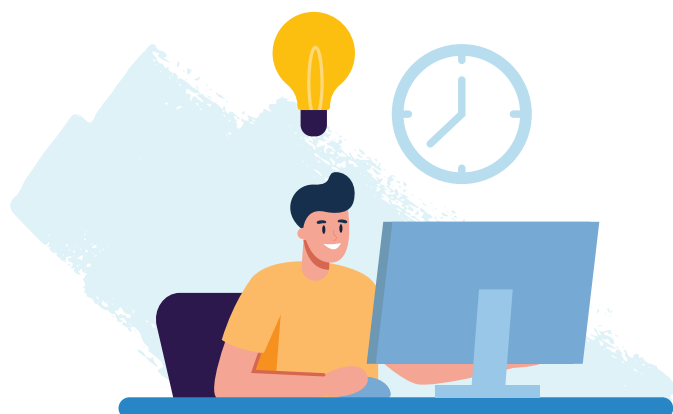
What do we mean by informatics?

You might hear the terms *informatics*, *computer science (CS)*, and *computing* used in similar ways. This is because they often overlap. Still, each has its specific focus:

- **Informatics** looks at how information is created, structured, processed and used in systems;
- **Computer science** is more about theory, such as algorithms, data structures and how computers work;
- **Computing** is a broader term that includes how we use computers and digital tools in everyday life.

This approach **recognises the multifaceted nature and importance of the discipline of informatics**, its interactions with other fields – including science, engineering, math, arts, social sciences and humanities – and its ethical and social implications.

In these guidelines, **we use “informatics” as an umbrella term** that encompasses key ideas and skills from all three areas. We understand **high-quality informatics education in school** to mean the teaching and learning of the scientific principles of the discipline, which constitutes the basis for the development of digital competence, which are research-informed, authentic, practical, forward-looking, evidence-based, inclusive, collective and contextualised.



Why is high-quality informatics education important?

The main goal of high-quality informatics education is to empower all students to:

- **UNDERSTAND** fundamental informatics concepts and methods;
- **DEVELOP** their computational thinking skills, which involve “formulating a problem and expressing its solution(s) in such a way that a computer – human or machine – can effectively carry it out” (Wing, 2014) ;
- **ENGAGE** creatively, critically and ethically with digital technologies, including emerging ones such as artificial intelligence (AI);
- **APPLY** informatics to address meaningful and real-world problems in a holistic, interdisciplinary way, while promoting digital equity and inclusion by ensuring that all students have access to the skills needed to navigate the digital world with confidence and autonomy.

High-quality informatics education in schools goes beyond just learning to code or use digital tools. It enables students to understand how technologies such as mobile apps, websites and AI systems actually work, why they function the way they do, and how they impact our daily lives – from social media and online shopping to smart devices. **Encouraging students to think critically and solve problems creatively prepares them to use technology responsibly and even create their own digital solutions.** This approach aligns with DigComp, the European digital competence framework for citizens, as well as with the [AllLit Framework](#) proposed by the European Commission and the Organisation for Economic Cooperation and Development (OECD). The latest update, [DigComp 3.0](#), which was published in December 2025, places greater emphasis on computational thinking competences and their application in problem-solving. It also includes a stronger focus on critically analysing how data and digital content are created, as well as understanding the ethical and societal impacts of technology and the rights and responsibilities of digital citizens.

Introducing informatics concepts and methods in primary education and following coherent and age-appropriate teaching in secondary and vocational education can enhance general thinking abilities, such as abstraction, algorithmic thinking, automation, decomposition and generalisation. While the integration of informatics into compulsory education varies between countries, it is increasingly recognised as a key component of modern education. As such, informatics education in schools must continually evolve to keep pace with rapid technological change.

When taught appropriately – with sufficient space in the curriculum, well-prepared teachers, engaging learning activities, and effective assessment strategies – **informatics education cultivates essential 21st-century skills including computational thinking, problem-solving, creativity, critical thinking and**

collaboration. To remain relevant in a rapidly evolving digital world, informatics teaching must continuously adapt to emerging technologies, societal changes and evolving educational needs.

As teachers, you play a pivotal role in ensuring that students not only learn how to use technology but also understand its impact and potential. Beyond technical skills, you empower learners to critically evaluate and actively shape digital technologies, becoming creators rather than passive consumers. This involves encouraging enquiry, supporting problem-solving, and providing space for experimentation and iteration.

High-quality informatics education supports students not only in navigating a tech-driven society but also in becoming thoughtful and ethical participants in it. By integrating informatics meaningfully, you help students to connect digital skills with real-world contexts and challenges. Ultimately, this kind of education **fosters individual agency and contributes to building a more inclusive, equitable and just society.** Your work in this area is essential to preparing future generations to engage confidently and responsibly with the digital world.

High-quality informatics education equips students with the knowledge, skills and mindsets needed to understand, critically engage with and shape digital technologies in a rapidly evolving world. It prepares learners not only for future careers, but also for active and responsible participation in a tech-driven society, by fostering computational thinking, creativity and ethical dispositions.

What do these guidelines cover?

The guidelines offer insights and actionable ideas for delivering **high-quality informatics education in primary and secondary schools** across Europe.

They respond to key challenges identified in a [literature review](#) regarding the implementation of high-quality informatics education in schools, and propose practical solutions organised around five topics:

Building strong foundations

Ensuring every student's success

Applying effective teaching practices

Assessing effectively the acquired knowledge, skills and attitudes

Promoting teachers' professional learning and development.

The content of each topic builds on research insights and practical examples from policy and grassroots initiatives, helping teachers to take ideas and adapt them for their specific setting and context.

These guidelines have been developed to:

- To offer broad, evidence-based guidance that can be adapted to various educational settings and systems;
- To be practical and to provide ideas that teachers can readily adopt and adapt to their context, resources and needs;
- To focus on equity, inclusion and quality;
- To encourage enquiry and the exploration of new ideas and tested practices;
- To be technology-neutral and remain relevant as technologies and curricula change and evolve;
- To align with EU, national and other relevant educational frameworks and standards.



Who are the guidelines for?

These guidelines are intended for *all teachers involved in teaching informatics in primary and secondary schools, as well as in vocational education and training (VET) in Europe*. This target group of professionals includes specialist computer science/informatics teachers and trainers, schoolteachers engaged in informatics teaching activities (e.g. programming) as part of a broad curriculum, and teachers of other subjects who integrate digital competences or core informatics concepts, methods and practices into their lessons.

We use the term “teacher” broadly to include anyone who helps students to learn about informatics, whether or not this is their official role. **The guidelines are relevant to all teachers** seeking to enhance or expand their practice.

They may also be useful to **other education stakeholders**, such as policymakers, school leaders, teacher educators, EdTech providers and curriculum developers, who are interested in improving informatics education.

No matter how Informatics is taught in your school – whether through a dedicated subject, integrated across the curriculum, embedded in other subjects, or offered as extracurricular activities like lunchtime clubs – these guidelines are designed for educators and trainers at any level or from any background who are looking to enhance their Informatics teaching practice.

How to use the guidelines?

The main body of the guidelines is organised into **five key topics**. These have been identified through a [literature review](#) and consultations with teachers and experts from all over Europe.

Each topic section is designed to stand alone. To ensure clarity and accessibility, we aim to provide full context within each section, which may occasionally result in deliberate repetition across topics. Each topic follows a consistent structure:

- **In a nutshell** – a brief key message that summarises the main guidance;
- **Insights from research** – a short overview of relevant research, explaining why the proposed ideas can be considered for the promotion of high-quality informatics teaching and learning;
- **Insights from practice** – real-life examples and case studies from classrooms, policies or educational initiatives, from which you can draw inspiration to adapt strategies suitable for your context;
- **Ideas for informatics teaching** – practical tips and actionable ideas to enhance your teaching practices;
- **Further reading** – a list of recommended, open-access resources for those who wish to explore the topic more deeply;
- **References** – a list of the key publications referred to in each section.

These guidelines are non-binding and are intended to support teachers, school leaders and education authorities in promoting safe, inclusive and trustworthy digital education environments, in line with European values and applicable EU legislation.

This text includes examples of digital tools, resources and initiatives, along with the names of the companies or organisations that provide them. These references are for illustrative purposes only, and do not imply endorsement by the European Commission. Wherever possible, the authors have aimed to include freely accessible, widely used and diverse examples, especially those from Europe.

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The guidelines at a glance

The table below summarises the key principles of the five topics that make up the guidelines. Although each topic is presented separately, they are interrelated and interconnected.

1. How can you help students to build strong foundations in informatics?

Assisting students in building strong foundations in informatics means introducing key concepts – such as algorithms, data and digital systems – early, and revisiting them in more profound ways as students grow. This approach helps students to become confident, critical and creative users of technology and participants in shaping the digital world as competent citizens, rather than just passive consumers.

2. How can you help all students to succeed in informatics?

Helping all students to succeed in informatics means celebrating diversity, ensuring equitable access to tools and content, and adapting your teaching to meet the diverse backgrounds, needs, interests and abilities of your students. With the proper support and encouragement, every student can succeed in gaining informatics competences in their own way and at their own pace.

3. What does high-quality informatics teaching look like?

High-quality informatics lessons are student-centred, meaningful and interactive. Instead of conventional lectures, great informatics teachers design and facilitate multimodal learning experiences, enabling students to learn by doing, collaborate, debate, solve real problems, experiment and reflect.

4. How can you best assess students' learning in informatics?

Quality assessment should encompass all core areas of informatics, involve every student, and allow them to have a say in their learning. It is not just about the final results; it is about understanding how students learn and helping you to adjust your teaching to meet their needs.

5. How can you further develop your informatics teaching expertise?

Investing in your professional learning and development is one of the most effective ways to boost student learning and inspire more young people to engage with Informatics.

1. How can you help students to build strong foundations in informatics?

In a nutshell

Building strong foundations in informatics begins early, with key concepts such as algorithms, data and digital systems being introduced from the start and deepened as students progress. This empowers students to be creators, not just passive users of technology. Informatics lessons should be age-appropriate, engaging, hands-on and relevant to students' everyday lives, interests and backgrounds. As a teacher, you can play a crucial role in raising the status of informatics skills alongside literacy, numeracy and science among your students and school community.

Key insights from research

Research supports EU policies that recognise **informatics as a core scientific discipline in primary and secondary schools**. The three studies presented below are very useful for **identifying the key areas of informatics**.

The 2022 Eurydice Report [Informatics Education at School in Europe](#) analysed primary and secondary school curricula and identified 10 common areas. These include:

Operational

Programming, algorithms, data and information; modelling and simulation, design and development.

Ethical

Safety and Security, Awareness and Empowerment.

Systemic

Computing systems, people-system interface, networks.

The 2022 [Informatics Reference Framework for School](#), proposed by the Informatics for All Coalition, emphasises the practical skills and ethical dimensions of informatics, adding **digital creativity as another core area**. The framework outlines five main goals that students must achieve by the end of upper-secondary education, helping you to focus on what really matters in their informatics learning.

The [K-12 Computer Science Framework](#), which was initially developed to support informatics education in the USA and is widely used in Europe, focuses on **five core concepts** (computing systems, networks and the internet, data and analysis, algorithms and programming, impacts of computing) and **seven core practices** that emphasise practical applications and informatics skills-building (fostering an inclusive computing culture, collaborating

around computing, recognising and defining computational problems, developing and using abstractions, creating computational artifacts, testing and refining computational artifacts, and communicating about computing).

Together, these frameworks provide the **core elements of informatics, including operational skills, systemic knowledge and ethical considerations**, which are essential for students to thrive in an increasingly digital world. Research reveals that there is often a gap between what the curriculum says should be taught (the intended curriculum) and what actually happens in the classroom (the enacted curriculum). For instance, “unplugged” approaches (i.e. teaching computational thinking and computer science concepts without the use of computers or electronic devices) are sometimes used in ways for which they were not initially designed, and the choices of programming languages taught are often influenced by student- and teacher-driven factors rather than by the curriculum. This highlights the importance of comprehensive and up-to-date curricula that still provide teachers with the flexibility to adapt their methods to diverse teaching and learning needs and contexts.

Research indicates that **starting informatics early** and building on it year by year leads to better learning outcomes. A spiral informatics curriculum, in which core

concepts are revisited with increasing complexity each year, is already in place in various European countries including Croatia, Ireland, Lithuania, Poland and Portugal. This **age-appropriate progression** enables students to deepen their understanding as they mature and gain more experience in engaging with informatics concepts, tools and procedures. Studies also consistently indicate that students of all age groups learn informatics concepts best through hands-on activities, collaborative projects and game-based learning, which make learning more engaging and effective.

A strong foundation in **informatics also supports cross-curricular skills and aims**. For example, computational thinking activities help to develop problem-solving and logical reasoning skills, which are beneficial in disciplines such as mathematics and science. A [2025 literature review](#) on informatics education in Europe notes that it “not only reinforces the foundational aspects of digital competence but also expands their impact by fostering an active, creative, and critical approach to the digital world”. However, a 2022 study by the [German Education Network Stifterverband](#) found that students who studied a dedicated informatics subject had significantly stronger digital skills than those in cross-curricular programmes, and showed no gender differences in performance.



Key insights from practice

- Italy's [2025 curriculum](#) marks a significant shift in informatics education, placing it at the core of the curriculum and recognising its value as both an autonomous discipline and a cross-disciplinary tool. The curriculum emphasises the importance of introducing informatics early. Coding, visual programming and problem-solving have been integrated into the primary school curriculum, striking a balance between digital tools and unplugged activities. The curriculum also promotes hands-on, age-appropriate learning that connects theory to real-world applications. Key content areas include programming, informatics systems and understanding how digital technologies work. Informatics is also considered a core element of STEM education, encouraging interdisciplinary activities that involve data modelling, robotics and AI. In addition, a strong emphasis is placed on cybersecurity and responsible digital citizenship, covering data protection, privacy and media literacy.
- The [Dutch Digital Literacy Curriculum](#) includes nine informatics-related objectives that are organised across practical skills, the creative use of technology and societal impact. It is left up to Dutch schools to decide how they will implement this curriculum. However, it is suggested that should be implemented within the context of other subjects in order to provide meaningful contexts. Although not labelled as Informatics, this curriculum integrates core computing concepts including digital systems, creating with digital technology, programming, security and privacy. Thus, it is essential to consider that the core topic areas of informatics can be cultivated within the context of other school subjects.
- In Ireland, a “[concept and processes](#)” model is used to guide the development of competency-based primary curricula within the curriculum area of Science and Technology. This supports a cross-curricular approach that strengthens the foundations of informatics education from the early years onwards. Early outreach activities (e.g. coding camps) and targeted professional development opportunities for teachers influence student interest and teacher readiness, as is later demonstrated in the subject of Computing in the Irish [Senior Cycle](#). Its broad curriculum is designed to connect smoothly with the junior cycle, helping students to develop their informatics skills and knowledge progressively.

Looking for fresh ideas on teaching informatics?

INTRODUCE CORE INFORMATICS CONCEPTS GRADUALLY, one by one and step by step, so that all students grasp them before you move on to more complex ones. **Use both unplugged activities and digital tools**, avoiding over-reliance on digital tools. **Focus on problem-solving and learning-by-doing skills** in preference to memorisation. Encourage students to think aloud, presenting the strategies they have used, their process of trial and error and their findings, explaining what they have learned to their peers throughout the entire process.

HELP STUDENTS TO EXPLORE THE SOCIAL IMPACT OF INFORMATICS. Present real challenges for the community, such as reducing school energy use, and guide students in designing and implementing informatics-based solutions to them. For example, students can become [Data Detectives](#) – collecting, organising and presenting data that relate to their interests. You can also encourage students to discuss and debate topics such as the environmental impact of digital technologies, digital accessibility, online safety and privacy. For instance, [CodeCarbon](#), a lightweight software package that seamlessly integrates into a Python codebase, can help secondary students to track and reduce the CO2 emissions that arise from their computing activities.

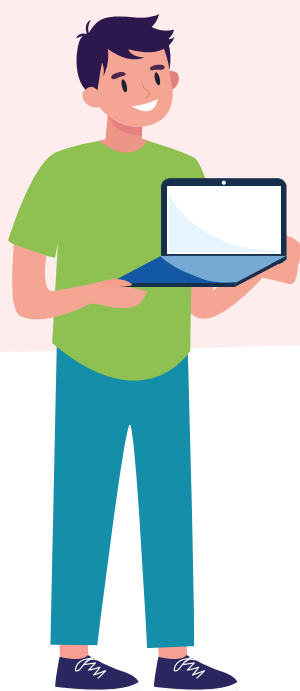
ENGAGE FAMILIES AND THE WIDER COMMUNITY TO BOOST THE VISIBILITY OF INFORMATICS. Many adults may not realise that informatics skills are as fundamental as reading, writing and maths, so schools should bridge this gap by involving families and local community members. This can be done through “family coding evenings”, lunchtime coding clubs and inviting IT professionals to mentor students. Organising activities such as a “school informatics day”, inter-school hackathons and take-home puzzles helps to demystify informatics and spark shared interest. Bringing in experts to deliver presentations on hot topics such as privacy, digital plagiarism or cyberbullying further highlights the subject’s relevance. Such connections with families and the local community can transform informatics from a solitary classroom subject for a few into an essential collective effort, increasing its status and strengthening every student’s sense of support and belonging.

USE A VARIETY OF ACTIVITIES TO HELP STUDENTS UNDERSTAND CORE INFORMATICS CONCEPTS:

- **Transform classroom or other routines into algorithms.** Ask students to prepare step-by-step instructions for tying their shoelaces, finding a book in the school library or organising their backpacks. Younger students might draw each step, while older students can write them down or use flowcharts of pseudocode. Activities like these, along with logic and board games, such as the [Cody and Roby](#) game from the EU Code Week resources, make the concept of algorithms concrete and tangible, showing that any problem or project, from an artwork to a science experiment, can be broken down into smaller steps.
- **Challenge your students to become data detectives.** Encourage students to collect and analyse data from their school, home or community. For example, they might track energy or water usage, local weather conditions or the growth of plants in a school garden. Depending on their age and prior knowledge, students can organise these data into simple charts using paper, spreadsheets or basic code to identify patterns and draw conclusions. These hands-on data projects help students to grasp key informatics concepts, think critically and develop evidence-based reasoning. Resources such as [Inside AI: An Algorithmic Adventure](#), a comic by UNESCO, may help to promote discussions, especially in primary schools, on the impact of informatics on humanity and its social and ethical implications.
- **Help students to understand digital systems and networks.** Complex yet essential informatics concepts, such as computing systems and networks, can be better understood through role-play or physical models. For instance, students can pretend to be “data packets” moving information through a human network to see how information flows (see how this works in the description of the [No Guts, No Glory](#) workshop). Even paper models representing the binary system, circuits or a data centre can teach how hardware, software and humans interact without the need for high-tech resources, and can engage all students through playful activities.
- **Have students solve real-world problems in small teams.** Challenge students to apply informatics skills to solve a problem in the school or local community, such as scheduling and designing a school event or mapping a safe route to the town hall. They might design a data collection activity (such as a simple survey or poll), outline the steps to a solution as an algorithm, or prepare a spreadsheet showing the step-by-step execution of a school event with detailed timings and role assignments. These collaborative and project-based challenges let students see how informatics skills apply in everyday life and how they are relevant to all.
- **Combine programming with storytelling.** Challenge students to create a game or program based on a story, poem or local hero in the context of an interdisciplinary project. Younger students can use picture cards or drama to sequence the narrative, while older or more experienced students can use visual coding tools to animate a scene or dialogue. These activities link abstraction, algorithms and programming with storytelling, showing that Informatics can help them to express their imaginations and be creators rather than consumers of technological artefacts.

Interested in exploring more?

- The numerous [national websites](#) of the countries that organise an annual Bebras Challenge on Informatics and Computational Thinking include valuable materials such as trial competitions, which students can use to test and improve their core informatics skills.
- Two Eurydice reports – [Informatics Education at School in Europe](#) (2022) and [Digital Competence at School](#) (2023) – as well as the European Commission report, [Reviewing computational thinking in compulsory education](#) (2022), provide comparative overviews of national curricula and policies on informatics, digital competences and computational thinking across Europe. These reports will help you understand how other education systems structure and promote core informatics topics.
- The report [Capacity for, access to, and participation in computer science education in Ireland](#) unbundles the country's national landscape in computer science, and positions informatics at the forefront of Ireland's digital agenda.
- IC3 Mattarella Middle School, a lower-secondary school in Modena, Italy, has developed the [Lucy Syllabus](#), which represents a pioneering approach to teaching AI as a field closely linked to informatics. This three-year modular curriculum enables students to progressively build their cognitive, technical and critical thinking competences with regard to AI systems, and aligns with national guidelines and European competence frameworks (e.g. [DigCompEdu](#), [DigComp 2.2](#), [LifeComp](#)). [Recognised by UNESCO](#) as a proven practice, the Lucy Syllabus shows that AI can be taught meaningfully in lower-secondary schools, with a clear structure and long-term skills development.
- The AI Literacy Framework for Primary and Secondary Education ([AILit Framework](#)) is a joint initiative of the European Commission and the OECD, with the support of Code.org. The AILit Framework aims to contribute to the global dialogue on what AI literacy means and how teaching and learning must evolve in the age of AI. It also contributes to the PISA 2029 Media & Artificial Intelligence Literacy assessment.
- The European-level [HERMMES approach](#) to teaching informatics and digital competences for 0 to 18-year-olds includes guidelines, curriculum and age-appropriate practices for developing problem-solving and computational thinking skills in unplugged ways.



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2. How can you help all students succeed in informatics?

In a nutshell

Every student can succeed in informatics when the subject is taught from the start in a way that is inclusive, accessible and engaging. High-quality informatics education means designing lessons that spark curiosity, celebrate diversity and remove barriers. It means ensuring equitable access to tools and content, adapting teaching to diverse backgrounds, needs, interests and abilities, and providing adequate support and encouragement so that each student can thrive in their unique way and at their own pace.

Key insights from research

Research indicates a global push to make informatics mandatory in primary and secondary schools in order to enhance access and participation, particularly among girls and underrepresented groups. However, making the subject compulsory, while recommended, is not enough. To ensure that all students truly benefit, schools must offer **flexible learning pathways and provide support that is tailored to individual needs**. Studies show that girls tend to lose interest in informatics when courses focus solely on programming. To keep all students engaged, the curriculum must go beyond programming to include creative media, design, sports, music, crafts, storytelling and social-impact projects. Schools should also acknowledge and leverage students' cultural backgrounds to create a more inclusive learning environment. A whole-school approach is key. This means involving all staff, reviewing school policies and embedding equity and diversity throughout the informatics curriculum, sending a clear message that informatics is for everyone.

Research also shows that in order **to engage all students, it is crucial to give them greater agency and ownership over their learning**. Students are more engaged and motivated when they can choose their own projects and track their progress through self-assessment and peer-assessment. Collaborative learning also plays a significant role. Working in teams helps students to appreciate diverse perspectives and develop practical communication skills. Student-centred **active learning**, such as project-based learning, group work, educational games and simulations, can make informatics more inclusive. These methods are particularly beneficial for students who struggle in traditional educational settings.

In primary and secondary education, **collective workspaces (so-called 'Makerspaces') can make informatics learning more inclusive and hands-on**. They enable students to experiment and solve problems together, turning abstract concepts into real-world projects. These collaborative settings encourage peer learning and intercultural exchange, helping to dispel stereotypes about who can succeed in informatics. Informal learning opportunities such as **outreach programmes can also improve students' perceptions of informatics and spark interest** among those who might not enrol in related classes. For example, a nationwide outreach programme in Ireland offered short coding workshops in schools, significantly improving secondary students' attitudes towards informatics. Meanwhile, the [German Hackerschool](#) is conducting workshops in schools nationwide, reaching 26,651 students in 2024 and demonstrating that coding can be a fun and engaging activity. Programmes such as this can spark interest in students who might not have otherwise pursued informatics learning.

Research also indicates that **supportive teacher-student relationships have a significant impact on students' engagement in informatics**. As a teacher, the way in which you connect with your students can directly influence their confidence, motivation and sense of belonging. Teachers must receive adequate training in inclusive teaching strategies, such as the use of inclusive language, differentiated instruction and connecting informatics to real-life problems, to help all students build interest and confidence in the subject.

Key insights from practice

- Cases from Spain show how inclusive and engaging informatics education can yield impressive results. At Colegio Juan de Lanuza in Zaragoza, computational thinking is introduced from early childhood and extended to AI in secondary education. A school-wide [makerspace](#) enables students to choose informatics projects that reflect their personal interests, from robotics to digital art, fostering creativity, problem-solving, teamwork and self-directed learning. Equity is at the core of the school's approach, ensuring that all students have access to personalised support and opportunities, regardless of their background, ability or interests. The school actively promotes the participation of underrepresented groups such as girls, through tailored activities and mentorship programmes. The impact of these practices is clear: in a recent regional informatics Olympiad, 9 out of 11 winners were female students from the school, demonstrating real progress in closing the gender gap.
- In another example, again from Spain, girls have consistently outperformed boys in programming contests organised by Universidad Rey Juan Carlos and the non-profit [Programamos](#).
- At the Italian Technical, Economic and [Technological Institute “Luigi Einaudi”](#), teachers use **hands-on, problem-solving approaches such as real-world programming challenges, cybersecurity case studies and AI-driven simulations to engage students**. Equal access to technology is key: students with limited home technology can borrow devices, and students with disabilities can use assistive software. Adaptive learning platforms help to personalise instruction and track student progress, while collaborative programming projects and cross-disciplinary links with economics or STEM disciplines demonstrate the practical applications of informatics. Teachers regularly update their skills through continuous professional development in inclusive pedagogy, AI, cybersecurity and emerging digital tools. The results are clear: more students engage in informatics projects, and overall performance in technology-related subjects has improved. Despite ongoing challenges such as funding and balancing the use of tech with traditional learning, the institution's whole-school commitment, which spans infrastructure, curriculum and teacher training, shows that inclusive informatics education is achievable.
- In Italy, the national [Programma il Futuro](#) project, launched in 2014 by the Italian Ministry of Education, introduces informatics to school students at all levels, involving around 3 million students annually. The project helps students to become familiar with the discipline by means of attractive and easy to use activities and materials.
- Initiatives such as the [Bebras Computing Challenge](#), the [International Olympiad in Informatics](#) and similar extracurricular programmes help to **bridge the digital talent gap by making informatics fun and accessible, as well as nurturing early talent**. National initiatives, such as Poland's [Information Technology Talent Development Programme](#) (2019–2029), aim to identify and support gifted secondary students in areas such as algorithms, programming and game design, building advanced digital skills that are sought after in the labour market.
- These indicative examples from Spain, Italy and Poland underline that **inclusive informatics thrives when there is a whole-school commitment and a comprehensive approach** that removes barriers to access, engaging students with diverse backgrounds, interests, abilities and learning needs. The schools mentioned above have found solutions that benefitted all of their students by viewing the challenges they faced through a constructive lens (“How can we engage everyone in Informatics?”).

Looking for fresh ideas on teaching informatics?

MAKE EVERY EFFORT TO ENSURE ALL OF YOUR STUDENTS HAVE ACCESS TO DEVICES OR CONNECTIVITY.

Check with the school leadership and IT coordinator to set up loan schemes if possible. Use pair programming or rotate stations so that everyone gets hands-on time. In addition, ensure lesson materials are available offline (e.g. on USB memory drive or a local server) for classes with poor internet connections or students without internet access at home, and prioritise tools that can also be used offline, such as [Scratch](#) or [LearningML](#). Prepare non-digital or paper-based alternatives for informatics activities.

PRIORITISE ACCESSIBLE AND OPEN-SOURCE TECHNOLOGY.

Remove any barriers that prevent students from fully participating in informatics activities. Use assistive technologies such as screen readers and speech-to-text tools to support students with special needs. Provide notes or tutorials using accessible formats such as read-aloud text, high-contrast slides and video subtitles. Students who can comfortably access tools and content are more likely to succeed. Furthermore, prioritise free or open-source tools wherever possible, to minimise cost barriers in relation to software and resources.

COMBAT STEREOTYPES BY SHOWING THAT INFORMATICS IS FOR EVERYONE.

Use diverse role models whose age, gender, orientation, ethnicity, achievements and abilities reflect a broad range of relatable experiences. For instance, you can get inspiration from the [Ada Lovelace Day Education Pack](#) – a series of resources for teachers and parents that focuses on students aged 11–14 and addresses gender stereotypes that hold students back. Emphasise examples of informatics skills and knowledge being used to create social value, e.g. in caregiving or environmental protection. For example, you can invite professionals from the local community, such as an educational app developer or an activist who uses data for social change, to showcase tangible and accessible applications of informatics. Deliver the message that not every student needs to become an informatics expert, but every student should have the opportunity to understand and use informatics in their lives. Focus on how informatics skills help students to make a difference in what matters to them. Ensure you understand what topics and issues matter to your students; knowing their interests will help you to relate your informatics lessons to their areas of concern.

ENCOURAGE COLLABORATION, TEAMWORK AND PEER LEARNING TO MAKE ALL OF YOUR STUDENTS FEEL INCLUDED AND VALUED.

Organise mixed teams that include students from diverse backgrounds and abilities, assigning clear roles so that students learn to collaborate towards a shared goal, such as developing a digital solution to a local problem. Rotate the roles in future projects so that all students experience each role and learn to collaborate across gender, ability, culture and background. Peer support is crucial in enabling all students to engage in informatics – students feel more confident in their ability to learn informatics if most of their friends have done so.

USE INCLUSIVE AND GENDER-NEUTRAL LANGUAGE.

When designing a learning activity, ensure it resonates with all students (e.g. so that girls will receive it with the same enthusiasm as boys) and that everyone understands what to do, regardless of language or other barriers. For instance, the [AccessCSforAll](#) project provides resources for the inclusion of all students in informatics education. One such resource is the [Quorum](#) programming language, which is designed to be intuitive for students with disabilities and offers a novel way for individuals who are blind to develop projects. The ACM [Word Matters](#) initiative provides a list of informatics terms to be avoided, since they can be considered offensive or exclusionary, and offers alternative language.

INCLUDE ALL STUDENTS IN YOUR TEACHING.

Offer multiple engagement routes, including low-barrier entry points, tiered tasks, optional enrichment and extension challenges for fast finishers. Remember, there is no such thing as an “average student”: your goal is to reach everyone, from those with low interest or ability to tech-savvy and gifted students. Each student should find something that fits their abilities, interests, needs and talents, enabling them to feel challenged but not lost.

PERSONALISE THE LEARNING EXPERIENCE.

Wherever meaningful, use adaptive platforms or tools that adjust tasks to each student's real-time performance. Personalised learning helps both students who need more time, as well as those who are advanced, to stay engaged. Remember: students can achieve the same outcomes through diverse tools, at varying paces, or along personalised learning pathways.

HELP STUDENTS TO SEE THE VALUE OF INFORMATICS THROUGH CROSS-CURRICULAR LEARNING.

You can engage more students in informatics when it is integrated with other subjects or cross-curricular themes. Try to co-design activities with teachers of different subjects. For instance, simulate epidemics in biology, analyse election data in civics, or generate patterns for textile design in arts and crafts. [Code.org CS Connections](#) offers lesson plans and ideas to easily integrate informatics into other subjects such as maths, language arts, science and social studies, through fun and engaging projects.

USE MULTIMODAL TEACHING METHODS.

Not all students learn in the same way, so the use of multiple modes of instruction can help you reach everyone. This might include combining short lectures or explanations with visual aids (diagrams, videos), interactive demonstrations and hands-on practice, both digital (e.g. coding) and unplugged activities (e.g. understanding sorting algorithms by students holding number cards). For example, you could explain a concept such as encryption using a quick video clip or a story, follow this up with a physical lock-and-key analogy, and lastly, a coding exercise. Let students show what they have learned in different ways through code, flowcharts, screencasts, summaries, scenarios, comics or presentations. By varying your teaching modes, you ensure that no student is consistently left out by a one-track teaching style.

KEEP LEARNING AND SHARING INCLUSIVE TEACHING PRACTICES.

Participate in professional development workshops or courses that focus on inclusive teaching strategies in informatics. Join teacher communities or forums (locally or online) to get new ideas for inclusive lessons, and share what works in your attempts to engage marginalised or underrepresented student groups. Remember, you do not have to be the lone expert – high-quality informatics is a team effort.

Interested in exploring more?

- [Issue 11 of Hello World](#), the Raspberry Pi Foundation's magazine, is devoted to inclusion and diversity in informatics. It features stories from teachers who have created inclusive environments for their learners, as well as lesson plans and activities that you can adapt and try with your students. Also, in Issue 17 of the magazine, you can read an [article](#) on approaches and techniques to increase confidence and self-esteem in informatics for students with special needs and disabilities.
- Drawing on interviews and questionnaires completed by more than 3,000 European students and education leaders, [a Google report](#) pinpoints six significant barriers (perceiving informatics as an isolated subject, a lack of relatable role models, lack of support for teachers, not connecting informatics with real life, parents' disconnection from Informatics learning, and limited peer networks) that limit the involvement of girls in informatics education.
- Greek-language [board games](#) (soon to be available in English and other languages under Creative Commons) highlight the vital role of women in advancing science, with an emphasis on informatics.
- The article [Rethinking Informatics Education](#), written in the context of the DIGITAL FIRST project, presents the theory and practice of teaching informatics in primary and secondary schools across 10 EU countries. It seeks to answer the following questions: what do we learn/teach, how do we learn/teach it, and are we happy about it?
- The [STEAM Alliance for Female Talent](#) – Girls on the Rise in Science – is an initiative of the Spanish Ministry of Education and Vocational Training, created to promote STEAM vocations among girls and young women and to reduce the gender gap. More than 150 companies and organisations have joined the Alliance, and many of its initiatives focus on informatics.
- [Opportunities, Issues, and Challenges for Generative AI in Fostering Equitable Pathways in Computing Education](#) explores how AI can expand access to informatics education, particularly for underrepresented students who attend minority-serving institutions and community colleges. The authors highlight challenges such as limited resources and disparities in educational opportunities. AI-driven tools, such as large language models, could personalise learning and bridge gaps in informatics education. However, concerns persist with regard to biases in AI and in relation to its ethical implications. The authors emphasise co-designing AI solutions with educators and students as a way to ensure that AI fosters inclusion, supports computational thinking and enhances learning in informatics disciplines.

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3. What does high-quality informatics teaching look like?

In a nutshell

High-quality informatics teaching puts students at the centre. The most successful teaching practices move away from lectures to create interactive experiences in which students learn by doing, collaborate, debate, solve real-world problems, experiment, and reflect. Theory can be combined with practice through the use of both plugged-in and unplugged activities, as well as specialised and cross-curricular projects. These help to make abstract informatics concepts concrete and meaningful for every student, at their own pace.

Key insights from research

While research does not point to a specific **“right” way to teach informatics, specific teaching strategies tailored to informatics** and informed by research can enhance learning. For instance, an [international working group](#) identified four central traditions in informatics education: algorithmic, design-making, scientific and societal. Combining these approaches can help you to **reach students from different backgrounds and with varying abilities and interests**. High-quality **informatics teaching** often employs strategies that are effective in any subject, such as providing students with multiple ways to learn and to demonstrate their knowledge – the concept behind [Universal Design for Learning](#) (UDL). Research indicates that making use of multiple modalities enhances students’ learning of informatics. High-quality informatics teaching often combines digital activities (such as block-based visual coding) with unplugged ones that do not require specific infrastructure or resources (e.g. card games, role-plays or puzzles). These hands-on activities help to make abstract informatics concepts more concrete and engaging, especially for younger students. Similarly, physical computing using robots, sensors or microcontroller kits, adds a kinaesthetic element that is excellent to building confidence and interest.

Studies emphasise that pedagogical goals should come first, followed by the selection of the tools and activities (digital, unplugged or physical) that best align with the learning objectives. It is also essential to **match tools with age-appropriate activities, ensuring a smooth progression from one level to the next**. For instance, you can start with simple unplugged activities or physical computing tasks and then gradually move to more complex and abstract work, such as block-based (e.g. [ScratchJr](#)) and text-based programming (e.g. [Python](#)). Similarly, learners can begin exploring digital systems through graphical user interfaces, such as using drag-and-drop tools to organise files or manage settings, before progressing to using terminal commands and editing configuration files.

Research strongly supports the use of active, constructivist approaches in informatics. In other words, students learn informatics best by doing (even in simple ways) rather than just listening or reading. **Collaborative and peer-based learning is another teaching approach that is effective in informatics.** For instance, pair programming in primary education builds students’ confidence and communication skills. It also helps them to collectively identify and fix mistakes and bugs.

Language matters in informatics. Research based on real-world classroom observations highlights that the clear and intentional use of technical vocabulary (e.g. when it is presented with everyday analogies) and well-structured instructions and discussions, significantly enhances students' understanding of abstract concepts and learning. Techniques such as think-aloud, peer explanation or the creation of glossaries help students to develop accurate mental models and to better conceptualise key informatics terms, thereby addressing conceptual challenges and supporting deeper understanding. In addition, studies show the effectiveness of structured classroom dialogue, especially in collaborative activities or pair programming, along with peer instruction and classroom presentations

by students. These are powerful ways to enhance active learning (real-life projects, experiments, peer-teaching/learning/assessment, communication and collaboration skills). In summary, when teachers employ active, student-centred methods, students not only master key concepts in informatics but also build the confidence and skills needed to adapt and thrive in today's digital world.

Lastly, research underlines that informatics helps students to build 21st-century skills such as problem-solving; analytical, critical and creative thinking; as well as digital competences – skills they will need in school and in their future endeavours.

Key insights from practice

- Numerous European programmes and networks actively support teachers in applying research-informed teaching methods. For instance, the German [IT2School](#) initiative provides **freely licensed and age-appropriate teaching** resources to introduce students to the basics of informatics, digital literacy and AI. Its resources also cater for less experienced informatics teachers and are already used in more than 1,000 schools. Teachers report that the resources are accessible and motivating for students of various ages and backgrounds. These have helped schools to introduce informatics successfully into their curricula, and have helped local administrations to support less experienced teachers and to overcome the shortage of informatics teachers (as in Schleswig-Holstein, the northernmost federal state of Germany). The key lesson from cases such as IT2school is that having readily available, high-quality, inclusive and interactive resources can make a big difference in teaching informatics successfully.
- **Game-based platforms provide another example of an innovative approach to teaching and learning informatics.** These platforms employ scenario-based approaches to help teachers and students develop a deep understanding of informatics concepts. Many of these platforms also offer lesson plans (although these do not always align with various national curricula), which provide teachers with inspiration and resources to create meaningful and effective game-based learning experiences.
- **A shift towards active learning is increasingly visible** in schools across Europe. In many classrooms, rather than sitting passively in rows, students regularly work in pairs or small groups on real-life projects. Case studies present examples of teachers setting up makerspaces or using off-the-shelf kits for resources such as robots, microcontrollers and sensors, so that students can build, test and iterate informatics artefacts. Cross-curricular projects are also quite common. For example, geography courses might include data-logging lessons. In several studies, teachers have reported that allowing students to choose their projects and linking informatics to other subjects or to real-life challenges significantly boosts motivation, engagement and, consequently, learning.

- Grassroots projects and other after-school initiatives, such as EU [Code Week](#) events, bring informatics into real-life contexts. Students learn through challenges and contests, interacting with peers, community mentors, industry partners and other stakeholders. Technology also allows teachers to create **collaborative projects between schools**, even in different countries. Examples of this type of collaboration include **eTwinning projects**, such as [Code Race @SDGs](#), which involves schools from Tunisia, Greece, Lithuania and Serbia, as well as **Erasmus+ projects** such as [HERMMES](#), which unites 15 partners including international associations, national school associations, universities and schools. Teachers also benefit from such collaborations, through mentoring, planning lessons together and co-teaching, which helps to build confidence and foster innovation.
- Lastly, several European initiatives and projects are helping to shift informatics teaching towards focusing more on students and their future – emphasising that digital fluency is as fundamental as literacy. For example, the [Digital First Project](#), a consortium of 15 partners from 10 European countries, runs a series of Dialogue Clubs (DCs), in which stakeholders with diverse perspectives come together to share ideas and enhance teaching methods across Europe. Instead of focusing on the structural, syntax-heavy teaching of informatics, the project emphasises functional language and computational thinking. This helps to empower learners to interact with technology more intuitively and creatively.

Looking for fresh ideas on teaching informatics?

PROMOTE STUDENT AGENCY.

Let your students choose and adapt their learning paths. This could be as simple as offering two options for a project (“Build a website about X or a game about Y”) or asking students to select from a range of project topics such as sport, music, fashion, climate, etc. Everyone should still meet the same learning goals. This helps students to take ownership of their learning, which in turn builds their confidence and interest in informatics.

CREATE A CLASSROOM CULTURE THAT CELEBRATES EXPERIMENTATION AND VIEWS MISTAKES AS ESSENTIAL STEPS IN LEARNING, AND NOT AS FAILURES.

Mistakes are like “bugs” that students need to fix; not failures or reasons for blaming themselves or others. Encourage students to reflect on such “failures” and to try alternative strategies for achieving their learning goals. Organise sessions in which you, the teacher, deliberately make mistakes, and ask students to “debug” them – or even celebrate your “favourite mistake of the day” together as a class, as was proposed in a panel on debugging at the [SIGCSE conference](#).

USE A PLAYFUL APPROACH MORE OFTEN.

Game-based learning engages students to explore informatics concepts in a playful, low-pressure setting. You could begin units with a game before moving to abstract concepts or complex tasks. For instance, try using puzzles, card or board games, escape rooms (such as the one on [cyber technology and safety](#) for students in grades 6–8) or team challenges that mimic tasks in informatics, such as fixing “broken” instruction sets or creating simple rule-based games. These learning activities help students to overcome challenges and motivate everyone to participate and succeed.

MAKE IT HANDS-ON, WITH A FOCUS ON CREATING AND TINKERING.

Embrace the “makerspace ethos” in your informatics teaching – even without a dedicated lab. Small maker activities such as paper prototyping, or crafting algorithms with physical objects or simple robotics kits, can make a difference. For instance, one open educational resource (OER) from Spain guides primary students in creating their own [pet-robot](#) using micro:bit. Hands-on projects (e.g. designing [plant-watering sensors for the schoolyard](#)) allow students to engage physically with informatics concepts. This can help to demystify abstract ideas and excite those learners who prefer tactile activities, promoting a sense of accomplishment and inclusivity in the learning process. You could also set up a small corner of the classroom for informal exploration, with books, robot kits, old electronics to disassemble, or a computer station with engaging challenges. Students could use this space to work at their own pace or in small teams during breaks or after they have finished their work.

HELP STUDENTS TO REFLECT ON THEIR LEARNING.

Run periodical “share and reflect” sessions in class, during which students can explain their projects or designs to classmates or review each other’s work. This practice develops their ability to talk about informatics concepts, tools and procedures, as helping them to reflect on their learning (what worked well and what did not, who supported them, what they would do differently, etc.) and improving their communication and critical thinking skills. Remember that success in informatics looks different for every student – what matters is that they experience it, use it and feel empowered by it.

GIVE STUDENTS REGULAR FEEDBACK AND CHANCES TO IMPROVE THEIR WORK.

This helps to build confidence and a growth mindset. Use various assessment techniques (see Topic 4), such as a mix of traditional quizzes with project portfolios, peer reviews and self-reflection logs. This will enable all students to assess the full cycle of learning progress (planning, testing, collaboration and final product) meaningfully and transparently.

PROMOTE “ETHICS BY DESIGN” IN YOUR CLASSROOM, EVEN IF IT IS NOT EXPLICITLY MENTIONED IN THE INFORMATICS CURRICULUM.

Include simple open-ended questions in lessons, such as “Is this application good for people?”, “Could it harm anyone?” or “How might it impact the environment?”. These questions fit naturally into design and problem-solving tasks. Even young students can reflect on the impact of the technology they use or create. Helping them to think about ethics early on enables them to question assumptions, understand different viewpoints and grasp the complexities of moral issues – as proposed, for example, in the lesson plans (available in English, Spanish, Portuguese and Dutch) on algorithmic bias from the [FAIAS Erasmus+](#) project.

CELEBRATE STUDENTS' SUCCESS AND SHARE THEIR PROJECTS TO RAISE THE VISIBILITY OF INFORMATICS.

Organise an end-of-unit “tech fair” at which students demonstrate their projects to their classmates, parents or the school community. This boosts confidence and inspires new ideas and synergies. You can also promote students’ work at events to raise the visibility of informatics beyond the school community. For instance, you can co-organise “micro-hackathons” with other teachers –half-day events during which students of different ages and backgrounds team up to prototype quick solutions to school community problems. Check out the [EU Code Week guide](#) on how to organise an event for inspiration on how to run various types of events and tech fairs.

Interested in exploring more?

- The School of Computational Thinking and Artificial Intelligence project was created by the Ministry of Education and Vocational Training of Spain. The Ministry published a [report](#) presenting the results of projects that involved a total of more than 7,000 students. The report includes practical tips and proven practices (see a selection of 58 practices [here](#)), as well as lessons learned, shared firsthand by participating teachers. The sections for each practice contain information about their goals, sessions and evaluations, as well as reflections on the difficulties encountered during their implementation.
- The Raspberry PI Foundation’s portal includes a [Teaching Resources](#) section containing classroom resources on informatics (as well as AI and machine learning). These are complemented by courses, events, webinars and reading materials for teachers. It also provides guidance on how to start a code club and offers other valuable resources including research-informed pedagogical principles. The portal includes a similar section containing [resources for students](#).
- [CS Unplugged](#) offers a rich collection of off-screen computer science activities (games, puzzles, stories) that teach computing principles without a computer. This is excellent for primary teachers, or as an introduction to a topic.

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4. How can you best assess students' learning in informatics?

In a nutshell

To properly assess informatics learning, you should combine diverse methods to check what students understand and how they apply skills, solve problems and create ideas. These methods include formative feedback during lessons, summative evaluations of final outcomes, and encouraging students to reflect on their own learning. Assessment should address all core areas of informatics and support inclusivity and student agency. Instead of just looking at results, high-quality assessment in informatics values the learning process, adjusts to different students' needs and helps to improve both teaching and learning.

Key insights from research

Every day, teachers across Europe assess informatics knowledge, skills and understanding in many ways. These include projects and portfolios, in which students submit computer applications or digital artefacts they have created; quizzes, games and programming challenges to test specific knowledge; observations, peer feedback and checklists during practical work; or having students explain their work in presentations. However, using these indirect measures to assess learning can be challenging and imprecise. This is particularly true in informatics. Because the field changes so rapidly, there are few standards by which students' knowledge, skills and attitudes can be evaluated, and it is challenging to assess creative solutions to open-ended, real-world problems. To address this, researchers have collaborated with teachers and the educational community to develop **validated assessment instruments** that provide reliable and fair indicators of students' progress. Many of these tools are free and can help you feel more confident in your assessment while supporting students' growth. **Different assessment instruments serve complementary purposes** in the evaluation process. Some check what students already know before they begin lessons. Others measure what they have learned at the end of a learning period. Other tools help learners along the way by providing feedback or testing whether students can apply their skills in new contexts. Using a combination of these instruments helps to integrate assessment as a fundamental component of informatics teaching, and supports various goals:

- **Assessment for learning** (formative) provides ongoing feedback during lessons, helping both students and teachers to adjust and improve learning in real time;
- **Assessment as learning** (formative) encourages students to reflect on their own progress, fostering a deeper understanding and ownership of their learning journey; and
- **Assessment of learning** (summative) evaluates what students have learned by the end of a learning period, providing a comprehensive measure of their knowledge, skills and attitudes.

Most research and practice publications focus on programming skills and summative evaluations. However, to fully understand students' skills, ideas, creativity and progress, it is essential to use a combination of assessment methods. This will help to cover all aspects of informatics, leading to better teaching and support for students.

Key insights from practice

- Teachers from Europe and beyond use **automatic open-source assessment tools** that analyse students' creations to assess computational thinking skills and provide **formative feedback**. These automatic tools, which include **LitterBox** (a resource created in Germany) and **Dr. Scratch** (Spain), assist teachers by automating repetitive tasks, such as the time-consuming task of manually reviewing student projects to assess the appropriate use of programming constructs such as functions or logical operators. This allows teachers to focus more on supporting students. Dr. Scratch uses a rubric to analyse projects and portfolios in order to assess computational thinking skills such as data representation, abstraction and problem decomposition. Teachers can also create and share their personalised rubrics with other educators. Dr. Scratch's **formative feedback** can be used for self-assessment, as the tool includes an assistant to guide students in improving their projects. The latest version of the tool introduces a tracking mode. This provides a detailed overview of how a student's computational thinking skills develop over time, **shifting the focus from the final product to the process itself**.
- The use of **multiple-choice diagnostic questions** that can be automatically graded is also quite widespread. These provide quick feedback, reveal various conceptions, identify difficulties students face, measure progress and help to plan the next lesson. Tools such as **Project Quantum** save time by offering ready-made questions on multiple areas of informatics knowledge, such as the representation of information, operating systems, network communications, cybersecurity and social implications. Such tools also analyse typical student responses, helping educators to spot common conceptions and plan accordingly in advance.
- Another effective **formative assessment method**, specifically aimed at programming skills, uses **Parsons problems**. These puzzle-like activities give students a programming challenge and all of the necessary code instructions to solve it, but the instructions are out of order. Students' job is to put the code in the correct sequence in order to complete the task. Parsons problems often include distractions – additional statements that are not part of the solution. Teachers report that this approach is more effective at assessing programming knowledge than asking students to write code from scratch.
- In some programming environments, it is also possible to create **microworlds** that are similar to Parsons problems. For instance, in **Snap!**, you can customise the interface, manage the flow of a puzzle, and adjust settings to better suit your assessment goals. By creating different versions of such microworlds, you can support diverse learners and design responsive assessments. **Rubrics** can be helpful because they present clear learning goals and show what success looks like. For instance, a formative assessment rubric has been used to assess computational thinking skills in **physical computing courses**.

✈ In a study that gathered 300 practices for assessing creativity in informatics classrooms, teachers advocated for understanding **creativity** from the **perspective of students**, acknowledging their diverse experiences and goals. The teachers emphasised fostering a classroom culture that values assessment as a constructive process for both students and teachers. To underline the significance of the **student's learning process**, teachers who participated in the study highlighted the following practices:

- Assessing drafts and reflections in **design journals**;
 - Gathering **feedback from multiple sources** (including peers or family members); and
 - Encouraging students to make their own rubrics to **assess their work and reflect on their learning**.
- ✈ This approach places more value on the learning process and helps students to take ownership of their work.
- ✈ Several Erasmus+ projects focus on making **assessments** in informatics more inclusive. Since different forms of assessment work better for different learners, using a **broad range of assessment practices** contributes to equity and inclusion. Aside from tests, other techniques include oral presentations, games, entry and exit tickets, conversations, independent and **group projects** that require collaboration, and compiling projects into **portfolios** to assess progress. They also involve students in setting assessment criteria, and encourage self-assessment and reflective practices.

Looking for fresh ideas on teaching informatics?

MAKE SURE TO OFFER APPROPRIATE ASSESSMENT OPPORTUNITIES FOR ALL ASPECTS OF INFORMATICS.

Choosing the right instrument for each assessment activity will depend on the area of informatics to be evaluated; whether you are assessing knowledge, skills or attitudes; whether the teacher or the students will perform the assessment; and whether the goal is formative, summative or other.

INCORPORATE “CHECKPOINTS” WITHIN LARGER PROJECTS.

You can do this by providing ongoing feedback and support opportunities. This benefits students who work at different paces and emphasises the importance of the entire creation process, not just the final product.

MAKE ASSESSMENTS MORE INCLUSIVE

Using [Universal Design for Learning](#). This means presenting information in various formats and allowing students to demonstrate their learning in different ways, such as through programming creations, oral presentations, interviews or visual representations (e.g. concept maps or diagrams). The [Modeling at School Erasmus+ project](#) offers resources for diagrams in assessment activities (e.g. simple visual representations, such as boxes and arrows, to represent the steps of a process, the logic of a program, or how the elements of a system or network relate to each other).

GET STUDENTS INVOLVED IN DESIGNING AND INTERPRETING ASSESSMENT CRITERIA.

For example, in a team project, students can determine the criteria used to assess collaboration. They can define what good teamwork looks like – such as making active contributions to discussions, using collaborative tools, resolving conflicts or fulfilling a specific role. This helps students better understand what is expected and to take ownership of their learning.

USE VALIDATED INSTRUMENTS.

The non-profit [Institute for Advancing Computing Education](#) offers a collection of validated evaluation instruments. These can be filtered by student age, topic, cost and more. Many are free and are adapted to different grades, allowing you to assess your students' informatics attitudes, knowledge and skills.

USE AUTOMATED FEEDBACK – BUT GUIDE STUDENTS THROUGH IT.

Rule-based, automatic analysis tools are available for various computing environments. The objective nature of the feedback given by these applications, which is based on well-defined criteria, may boost students' confidence – especially for those who do not feel “tech-savvy”. However, your supervision is key to helping students to view this feedback as an opportunity for growth and ensuring that learners do not merely tweak their projects to meet the tool's criteria.

BE AWARE OF THE RISKS AND LIMITATIONS OF AUTOMATIC GRADING TOOLS.

While helpful, these tools – especially AI tools that use large language models – can pose risks in relation to diversity, fairness and preventing discrimination. They may also pose challenges in terms of transparency (how decisions are made) and accountability (who is responsible for errors). In any event, the teacher is always accountable for grading, regardless of the method used.

EVALUATE HOW STUDENTS APPLY INFORMATICS TO ADDRESS REAL-WORLD PROBLEMS.

For example, you can use open datasets with data from real-life events, or simulators and emulators that enable interaction with equipment and infrastructure that may not be available in the classroom. For instance, teachers in secondary or VET use open-source tools such as NetGUI-Kathará and WireXRk, which are based on software developed in Spain and Italy, to create complex scenarios involving multiple computers, routers and networks. These even allow students to visualise network traffic in 3D, delivering an immersive experience with interactive animated scenes using either VR headsets or desktop browsers.

USE RUBRICS TO IDENTIFY AREAS IN WHICH LEARNERS MAY REQUIRE MORE GUIDANCE AND PRACTICE.

For instance, if students use visual programming tools such as [Scratch](#) or [Scratch Jr](#), you can use the [Scratch Jr Project Rubric](#) to evaluate aspects such as syntax complexity, efficiency and program customisation.

GET INSPIRATION FROM INFORMATICS CONTESTS.

While they are not made for assessment, tasks from regional, national and international contests can give you some great ideas. For example, the [Bebras Challenge](#), founded in 2004 in Lithuania, offers computational thinking tasks categorised according to concepts, with explanations of the relevance of each to informatics. These are easy to adapt to various age and experience levels. For older students, such as those in secondary school or VET, regional and national Olympiads in informatics offer advanced challenges that can also be used for assessment or enrichment.

Interested in exploring more?

- [K-12 CS Assessments](#): measure what you treasure. A hub full of resources and a community of educators focused on the formative assessment of informatics.
- [Hello World Magazine, issue 3](#): approaches to assessment, with articles on how to assess different aspects of informatics, the use of Parsons problems and auto-grading tools.
- The [Cyber Chronix](#) online game, story and quiz, created by the EU, can be used as part of an assessment about data protection and privacy risks.
- [OECD. Unlocking High-Quality Teaching](#): includes a chapter on using formative assessment and feedback to guide students' progress by using different practices and attending to individual needs.
- Erasmus+ projects with a focus on informatics assessment, such as:
 - [TINKER](#) – an auThentic learNing and gender-inclusive framework for tEaching infoRmatics in European schools.
 - [DIGITAL FIRST](#) – Digital tech as the first language: informatics for digital natives.

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5. How can you further develop your informatics teaching expertise?

In a nutshell

Well-prepared, knowledgeable and confident teachers are the key to improving informatics education in European schools. To teach effectively, you need both a strong understanding of the subject ("*know what to teach*") and the right tools and methods ("*know how to teach*"). Ongoing school-based support and opportunities to collaborate and learn from fellow teachers are also essential. Investing in your professional learning and development is one of the most effective ways to boost student learning and inspire more young people to engage with informatics.

Key insights from research

With informatics education growing in schools across Europe, the need for qualified teachers specialising in informatics has risen sharply. This calls for coordinated efforts in:

- Pre-service informatics teacher preparation and certification (licence to teach informatics); and
- In-service professional development of informatics schoolteachers at all levels of school education.

Strengthening the pre-service preparation of teachers in informatics by higher education institutions is essential in two ways: (i) to expose pre-service teachers (in all subjects) to *informatics content* and/or *pedagogy* within their general training, and (ii) to establish *preservice informatics education specialisation* programmes. The impact of this approach may only be seen in the longer term, as it takes time for new graduates to enter and integrate into the school system.

In parallel, it is essential to focus on effective ways for in-service teachers to build and enhance their *informatics teaching expertise*. Many professional learning initiatives for informatics teachers have been studied, and research shows that the following key elements are essential for **effective professional learning**:

- **Integrated technological–pedagogical–content knowledge (TPACK)**: this means having a solid understanding of what to teach (current informatics concepts; how to teach it (designing and orchestrating active-learning lessons); and which tools to use (digital and physical-computing tools). This blend helps teachers to adapt as informatics evolves, thereby continuing to craft meaningful, engaging and diverse learning experiences for all students.
- **Collaboration with fellow informatics teachers**: sharing curricular resources, lesson plans and classroom implementation experiences gives you fresh ideas, builds confidence and helps you to solve challenges. It also reduces the isolation often experienced by informatics teachers and promotes the visibility of informatics as a school subject.
- **Coaching and expert support** within your own classrooms and school can also make a difference. When provided over an adequate time period (typically a full school year), this can enable in-classroom observation and reflection.

- Being part of an active **professional learning community** (PLC) allows you to engage in discussion, provide mutual support, practice peer assessment, collaborate in joint action research and reflect on teaching and learning.
- **The recognition of professional learning should NOT reflect just attendance, but real impact** through certification that reflects how you apply new knowledge in the classroom and how this improves student learning outcomes.

In conclusion, research suggests that traditional, standalone professional development courses have only a limited impact. But when they are combined with real classroom support, access to curricular resource hubs, collaboration and participation in professional learning communities, they can empower **teacher agency** and improve **confidence** and **self-efficacy**. This **“ecosystem” approach** – blending formal and informal learning opportunities – is a powerful way to support high-quality informatics teaching.

Key insights from practice

- Professional development for informatics teaching should address the needs of three different groups of teachers:
 - Generalist teachers in primary education who have no specialisation in informatics and need to integrate informatics teaching into the primary school curriculum;
 - Specialist teachers in (primary), lower- and upper-secondary education, as well as in VET, who specialise in other subjects (e.g. maths, science, art, music, etc.) and need to integrate informatics into their subject teaching; and
 - Specialist teachers in primary, lower- and upper-secondary education who specialise in informatics and teach informatics courses (both novice and expert teachers).
- As countries continue to reform their national informatics curricula, a need is emerging for **sustainable, large-scale** professional development to support all teachers who engage in informatics teaching.
- Effective professional development for informatics teachers should lead to positive outcomes in informatics teaching – that is, it should help all students to learn informatics more deeply and **broaden student participation, enrolment and engagement**.
- In this context, we present three notable examples of **professional development in informatics teaching** that follow a **holistic “ecosystemic” approach**. These initiatives aim to build lasting teacher capacity and confidence in teaching informatics at scale. They typically focus on creating a scalable and sustainable model for professional development (PD) and the necessary infrastructure to support teachers.

✈ The UK's **National Centre for K-12 Computing Education (NCCE)** offers a comprehensive professional development programme for teachers at various educational levels – primary, secondary, General Certificate of Secondary Education (GCSE) – and career stages (trainee teacher, early career, senior leader). The NCCE also supports informatics teaching through a wide range of activities and resources, including:

- Traditional training courses and seminars (offered through several geographically dispersed school hubs);
- Editable curriculum resources (including lesson plans, presentations, assessments, classroom projects and homework);
- Physical computing kits for loan;
- Pedagogical content knowledge resources (such as lesson plans, two-page summaries of research findings for “quick reads”, a podcast for teachers and a “Big Book” that expands on pedagogical resources);
- A community of practice ([Computing at School](#)) for sharing experiences and contributing resources; and
- An accreditation scheme for both teachers (certification) and schools (quality mark).

✈ In Spain, two key initiatives provide a comprehensive range of professional development opportunities for teachers, both within the country and internationally. [CodeINTEF](#), run by the Ministry of Education and Vocational Training, supports informatics teachers through various projects including “Code School 4.0”, and provides open educational resources and diverse training opportunities, such as online tutored courses, Massive Open Online Courses (MOOCs), Nano Open Online Courses (NOOCs) and summer schools. In addition, the grassroots non-profit organisation [Programamos](#) delivers cutting-edge PD activities for educators based on their research and practice. These initiatives include providing scholarships for educators to attend informatics conferences, social media challenges for teachers to learn about various topics through daily learning nuggets, and collaborations with filmmakers to produce a movie on the impact of AI in society, accompanied by educational resources suitable for various age groups and learning levels. Together, CodeINTEF and Programamos have collaborated on multiple initiatives that provide extensive professional development opportunities for the entire educational community.

✈ **Code.org's Teachers' Professional Development programme** is a global initiative that has attracted more than one million educators. It follows an “*ecosystem approach*” that is connected to Code.org's computer science and AI curricula. It offers access to a wide range of teaching resources (lesson plans, instructional videos, slide decks, formative and summative assessment resources, sample lab projects), along with self-paced online modules, facilitator-led workshops, and a forum for teachers to ask questions and share best practices, thoughts and ideas.

Looking for fresh ideas on teaching informatics?

Here are some practical and actionable ideas to further develop your informatics teaching skills and practices.

ENGAGE IN SELF-DIRECTED, LIFELONG PROFESSIONAL LEARNING

Focus on enhancing your pedagogical content knowledge (PCK) in informatics as well as your technological pedagogical content knowledge (TPACK) for informatics teaching, with the aim of improving students' learning outcomes and engagement.

- Join relevant **online courses** and **MOOCs** from repositories such as the [Europe Code Week Online Courses](#), the [European School Education Platform](#), the [Europass Teacher Academy](#), the [European Schoolnet Academy](#), the [TeaEdu4CT – Future Teachers Education: Computational Thinking and STEAM MOOC](#), the FutureLearn's [Teaching Computing MOOC](#), the CODE's [AI 101 for Teachers course](#), the [FUN-MOOC courses](#), the UK's [National Centre for Computing Education Online Training Courses](#), the [Raspberry Pi Foundation's MOOCs at edX](#), or the [Scratch Courses](#), [AI Campus](#), [Computer Science Inclusive Learning Environment \(CSLINC\)](#)
- Make use of relevant **video tutorials**, such as EU Code Week's [Coding@Home](#), or **podcasts** such as [EU Code Week Podcast](#). You can also explore repositories and portals that offer **free training materials and resources**, such as EU Code Week's [Learning Bits](#) and [Ibis](#).
- Follow relevant **professional informatics magazines**, such as [Hello World Magazine](#) (which features practical teaching tips, lesson ideas and case studies), [CSTA Voice](#) (which provides analysis and commentary on issues relating to primary and secondary informatics education), [ACM Inroads](#) (on informatics education research and informatics curricula) or the German [Informatische Bildung in Schulen](#).



EXPERT GUIDANCE AND MENTORSHIP

Well-planned and funded follow-up support in schools, provided on demand by expert mentors for an adequate period of time, is essential to making PCK and TPACK relevant in the context of specific classroom and school conditions.

- Access networks of mentors and experts, not only to find knowledge on technical issues but mainly to support your classroom teaching. For example, at the European Commission's [Digital Education Hub](#), you can receive **expert guidance** or **mentorship** on addressing your current challenges through online clinics (one-time meetings that focus on problem-solving) and mentorship programmes (which offer expert guidance to achieve your digital education goals).

CONNECT WITH BROADER EUROPEAN COMMUNITIES INVOLVED IN INFORMATICS AND DIGITAL EDUCATION

Build collaborations and communities of practice (CoPs) between teachers (from the same school or different schools); between schools (from the same municipality or region, or at a national or European level); and between schools and universities.

- Engage with [EU Code Week](#) community [ambassadors](#), leading teachers and coding enthusiasts worldwide. The [European Commission](#) and education ministries in the European Union and Western Balkan countries provide support for this.
- Follow the [Informatics for All](#) coalition, created by the [ACM Europe Council](#), the [CEPIS Education Committee](#) and [Informatics Europe](#) to advocate for informatics education as a core discipline in schools across Europe.
- Join the [European Digital Education Hub](#), an online collaborative community for digital education enthusiasts in Europe and beyond, as well as [Bebras national communities](#).
- Participate in the EU's [ALL DIGITAL](#) Communities of **Practice (CoPs)**, **DigComp CoP** and Certification CoP. ALL DIGITAL is a pan-European association representing European member organisations that work with 25,000 digital competence centres.
- Collaborate within the [eTwinning](#) European school community and online space, designed for teachers and staff to collaborate and develop national and international interdisciplinary digital education school projects.
- Explore other teacher networks and CoPs, such as the [Scratch Educator Meetups Network](#), the [Teaching with Scratch Discussion Group](#), the [Artificial Intelligence \(AI\) for K-12 initiative \(AI4K12\)](#) community of practitioners, [Scientix](#) – the core STEM Education Community in Europe, [Hedy.org](#) or [The Beauty and Joy of Computing \(BJC\)](#).

BUILD TIERED (CUSTOMISED) AND CERTIFIED PROFESSIONAL DEVELOPMENT PATHWAYS

Recognition and certification should go beyond merely attending courses, and should encompass classroom application and its impact on students' learning outcomes.

- **Engage in self-reflection on your digital competences** for teaching and learning to identify strengths and gaps, then design your professional learning path to further develop these strengths and close the gaps. Use the European Commission's [SELFIE4TEACHERS](#), based on the [DigCompEdu](#) conceptual framework on teachers' digital competence.
- **Choose the professional learning programme** that best matches your knowledge and experience – beginner, intermediate or advanced. For guidance, see how courses are classified in the [Europass Teacher Academy](#).
- **Obtain national-level certifications** where available, such as the UK's Teach [Primary](#) and [Secondary](#) Computing Certificate or the Spanish [Competencia Digital Docente](#).
- **Consider other specific certifications**, such as [Arduino Certification](#), [Raspberry Pi Foundation Certification](#) through edX, [MIT App Inventor Certification](#) and [Scratch Certifications](#).
- **Seek recognition of your achievements** through **Open Badges** and/or **micro-credentials** wherever they are available, such as [Digital Promise Micro-Credentials](#) (USA).



Interested in exploring more?

- The German Informatics Association study [Werde Informatiklehrer:in](#) (“**Become an Informatics Teacher**”) examines the various routes and requirements to entering the informatics teaching profession in Germany. It describes the current situation of informatics in the German school system, the demand for informatics teachers and the various options for entry into the teaching profession. The study also offers tips and recommendations for those interested in pursuing a career as an informatics teacher.
- The [SFI Discover Weave Project](#) in Ireland focuses on creating research-based teacher workshops, including follow-up visits to schools. The project was designed with an approach of co-creation, putting teachers at the centre of the initiative. Research Ireland and HEA (Higher Education Authority) have also funded a [national outreach project](#). Csinc (a TU Dublin research centre), through its national outreach programme, has helped teachers to build their confidence in teaching computer science, even when they had little previous experience. Many teachers, particularly women, have shown interest in introducing computer science to senior classes in the future. Feedback from those involved has been very positive, with teachers feeling more confident and better supported.
- Several European projects include professional learning opportunities and materials for informatics teachers. See, for example, the following projects: [Computer Science Learning Community](#), [Computational Thinking at School](#), [Artful Educational Robotics to promote Computational Thinking in a Blended Learning context](#), [DIGITAL FIRST – Digital tech as the first language: Informatics for digital natives](#), [D-Paideia – Pedagogical Digital Competences as a key element for the digital transformation](#), and [TINKER – an auThentic learNing and gender-inclusive framework for tEaching infoRmatics in schools across Europe](#)



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From guidelines to action

These guidelines are not step-by-step instructions or ready-made solutions – they are a starting point for collective action. The vision of high-quality informatics education presented here can only become a reality when teachers, school leaders and community partners work together with a shared purpose. This is not a task for individual educators to shoulder alone. Meaningful and lasting change comes from collaboration, shared commitment and mutual support.

Implementing the ideas proposed here may feel challenging at first, **but the journey forward involves taking practical and manageable steps and celebrating progress as you go.**

So, where to begin? **Start by identifying one or two ideas from the guidelines that feel relevant and manageable for your classroom.** You might try an unplugged activity to teach fundamental informatics concepts (Topic 1), adapt a project to make it more inclusive (Topic 2), or support students in reflecting on their learning (Topic 4). Small and achievable goals matter. Quick wins build momentum, and success breeds confidence.

Talk to your school leadership. Share your vision with your school leadership team and reflect together on your school's preparedness for the changes needed, whether this concerns equipment, teacher training or curriculum coverage. Their support is essential in terms of time, resources and training. Even a short meeting can open doors to new opportunities, partnerships or team teaching options.

Collaboration with colleagues is just as powerful. Take advantage of teacher meetings or even informal chats with peers to share ideas for interdisciplinary lesson plans or collaborative projects. Consider forming a small group with peers to explore ways to integrate informatics across the curriculum. Identify where you need support – whether it's inclusion strategies, assessment techniques or professional development – and use Topic 5 to guide your next steps.

Work together to set realistic milestones. Try one idea from the "pedagogy" chapter this month, or pilot an assessment approach from Topic 4 next month. Give yourself and your students time to adapt and grow through experience.

Do not forget parents and carers. Invite them to participate in projects or coding activities to demonstrate how informatics develops essential skills, similar to literacy and numeracy. Simple activities, such as viewing student-made animations or playing a coding game, can help parents to become supporters of your efforts.

Look beyond your school, too. Local libraries, community centres and tech companies may offer makerspaces, hackathons or mentorship. Tap into these opportunities to bring informatics to life for your students. Partner with universities, startups or research centres to expand access and bring in fresh ideas.

Join teacher networks and communities of practice – locally or across Europe. You will find others facing similar challenges and sharing useful strategies, resources and encouragement. You may even find partners for grants, joint projects or training opportunities. If you don't know where to begin, explore the national and EU-level programmes listed throughout these guidelines.

Above all, reflect on and celebrate your progress. What new ideas have worked? How has your teaching changed? Where have students grown – not just in terms of knowledge, but in confidence, creativity and collaboration? Every step forward counts, even when things don't go perfectly. Use setbacks as learning moments to adjust and improve.

In the end, high-quality informatics education is not something you implement alone – it's something we build together. These guidelines only become real when teachers, school leaders and communities come together around a shared goal: to make informatics meaningful, inclusive and empowering for every student.

So start now. Try one new idea. Talk to one colleague. Take one small step – and keep going. You are not alone. Across Europe, thousands of teachers are on this journey with you. Imagine the impact if each of us brings just one more person along. Together, we can transform how informatics is taught and ensure all students are prepared to thrive in a digital world.



Glossary of key terms

Artificial intelligence systems

refers to a machine-based system that is designed to operate with varying levels of autonomy and which may exhibit adaptiveness after deployment. Such a system can, for explicit or implicit objectives, infer from the input it receives, how to generate outputs such as predictions, content, recommendations or decisions that can influence physical or virtual environments.

Source: European Commission, Guidelines on the definition of an artificial intelligence system established by AI Act

Curriculum

this is the term used to describe the official study programmes issued for schools by top-level education authorities. National curricula may include learning content, learning objectives, attainment targets, syllabuses or assessment guidelines, and may be published in any form or in any number of official documents. In some countries, the national curriculum is set out in legal decrees. More than one type of curriculum document may contain provisions relating to informatics/computer science, and these may impose different levels of obligation with which schools must comply. They may, for example, contain advice, recommendations or regulations. Whatever the level of obligation imposed, all curricula establish the basic framework around which schools develop their teaching to meet the needs of their pupils.

Source: Eurydice, Informatics education at school in Europe

Coding

implementing solutions in a particular programming language.

Source: European Commission, Staff Working Document accompanying the Digital Education Action Plan 2021-2027

Computational thinking

the thought processes involved in formulating a problem and expressing its solution(s) in such a way that a computer – human or machine – can effectively carry it out.

Source: Wing, Computational thinking's influence on research and education for all

Computer science

see informatics

Computing

see informatics

Digital citizenship

the capacity to participate actively, continuously and responsibly in communities online and offline, through competent and positive engagement with digital technologies (by creating, working, sharing, socialising, investigating, playing, communicating and learning).

Source: Council of Europe, Digital Citizenship Education

Digital competence

this involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society. It includes information and data literacy, communication and collaboration, media literacy, digital content creation (including programming), safety (including digital well-being and competences related to cybersecurity), intellectual property-related questions, problem-solving and critical thinking.

Source: Council Recommendation, Key Competences for Lifelong Learning

Digital literacy

the ability to access, manage, understand, integrate, communicate, evaluate, create and disseminate information safely and appropriately using digital technologies. This includes competences that are variously referred to as information literacy, media literacy, computer literacy and ICT literacy. Digital literacy involves a dimension of active and civic engagement with the digital world and promotes active citizenship.

Source: European Commission, Guidelines for teachers and educators on tackling disinformation and promoting digital literacy through education and training

Informatics

known in many countries as computer science or computing, is a distinct scientific discipline. It is characterised by its own concepts, methods, body of knowledge and open issues. Informatics covers the foundations of computational structures, processes, artefacts and systems, the design of their software, their applications, and their impact on society.

Source: Eurydice, Informatics education at school in Europe

Programming

the act of analysing a problem, designing a solution and implementing this.

Source: European Commission, Staff Working Document accompanying the Digital Education Action Plan 2021-2027

