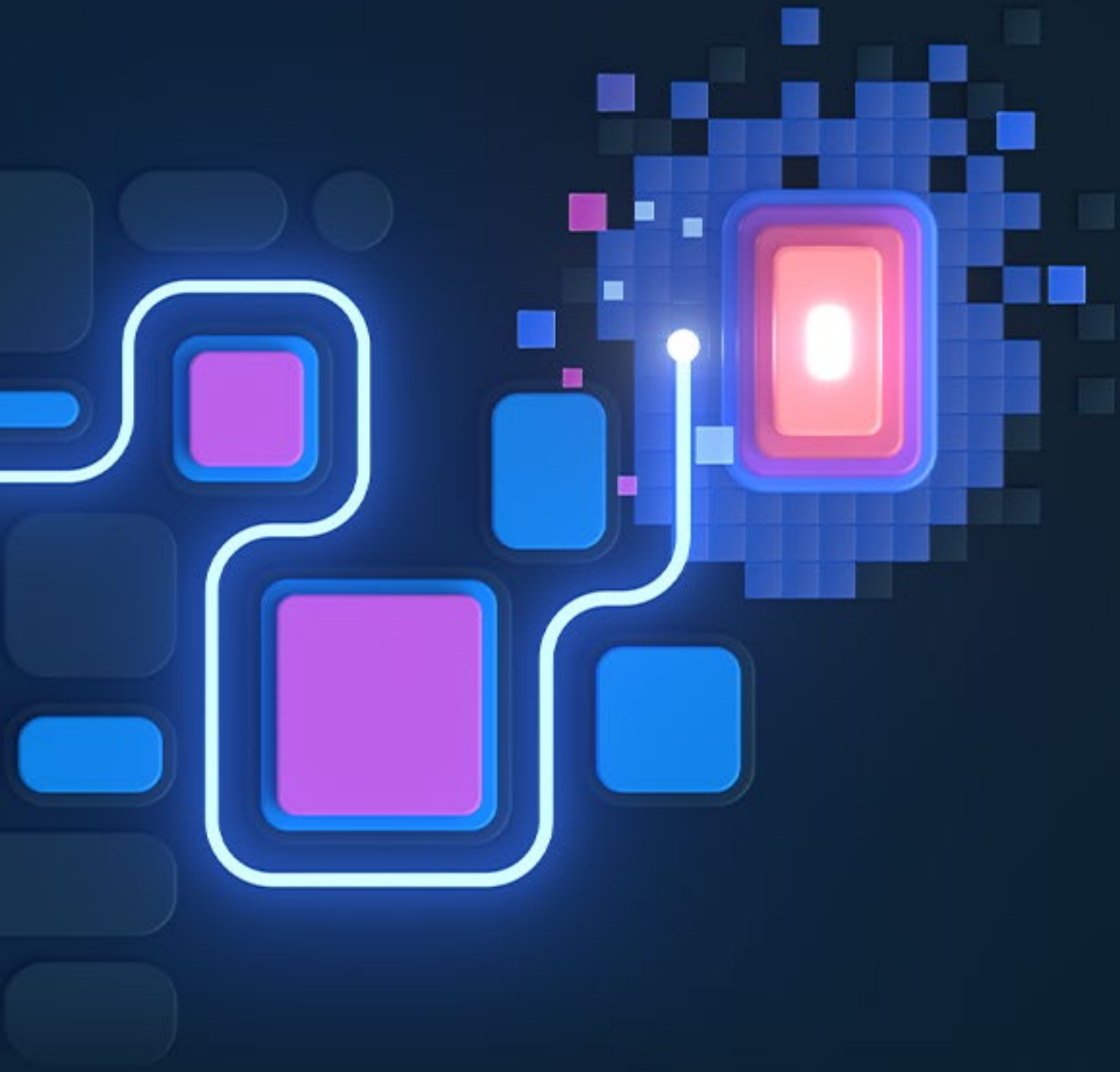
Microsoft



Microsoft Computer Science Curriculum Whitepaper

Table of Contents

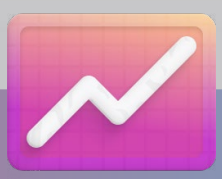
Why is CS crucial in schools?

As computing is incorporated into most forms of work and increasingly affects everyone's lives, it is now crucial for everybody to understand the principles of computing. In particular, today's students will need to draw upon computing skills throughout their lives, making it essential for them to study Computer Science (CS) at school.

This paper explores the case for CS in the curriculum, the reason why a new type of CS framework and guide is needed, how Microsoft is addressing the demand for CS skills, and how Microsoft's CS Guide (MCSG) addresses the needs of the education community.

Computer Science (CS) is the study of computers and computing, including their theoretical and algorithmic foundations, hardware and software, and their uses for processing information. A high-quality CS education equips pupils to use computational thinking and creativity to build computing solutions. CS differs from Information and Communication Technology (ICT) which is about using computers.

Every subject on the curriculum from Fine Art to Physics has advocates who believe that schooling systems can be improved by dedicating more time to its study. However, CS has sufficient strategic significance to cause an increasing number of countries to implement CS to drive economic growth, mitigate against inequality, and digitally empower their citizens. In its October 2021 study of the state of CS globally, The Brookings Institute[i] pinpointed three rationales that frame an increased focus on CS in schools:



Economic Development

Addressing Inclusion

Digital Empowerment

Let's now explore each of these rationales in more depth.

The Economic Case for CS in the Curriculum

CS is fundamental to technology skills, and countries with more workers with these skills will have higher economic growth through better productivity[ii] [iii]. Currently, education generally cannot meet the growing demand for people with tech skills, and this shortage can stifle growth.

Productivity and Growth

Productivity is a key factor in economic growth and there is a commonly held view that countries with more workers with technology skills will attain higher economic growth through better productivity[iv] [v]. Research by Brookings using Organization for Economic Cooperation and Development (OECD) data supports the view that countries with a higher share of graduates from an ICT field tend to have higher rates of per capita GDPi.

Conversely, lack of tech skills can restrain growth. For example, in 2021, Japan, which has a significant technology skills gap, ranked 27th in the IMD World Competitiveness Ranking[vi]. In response, The Bank of Japan states that to attain sustainable economic growth more use needs to be made of IT, and that productivity needs to improve[vii]. According to the OECD, investing in education and training to broaden and accelerate Japan's digital transformation would help to spur productivity growth[viii]. To this end, Japanese Government is shifting the focus of its public vocational training programs to the digital realm[ix].

By 2030, Japan is expected to have a shortage of 6.4 million workers and 450,000 IT professionals so Microsoft is helping Japanese employees adapt to a changing workplace. Microsoft has been helping people in Japan acquire digital skills in several ways, including as part of Microsoft's Global Skills Initiative[x]. This free training program[xi] has helped 30 million people worldwide acquire job-specific digital skills using content on LinkedIn, Microsoft Learn and the GitHub Learning Lab.

Demand for CS Skills from Employers

According to analysis by LinkedIn and Microsoft, 149 million more digital jobs will be created by 2025, in fields such as privacy, data analysis, cyber security and AI. All these jobs require significant knowledge of CS. By 2030, the global shortage of tech workers will represent $8.5 trillion in lost annual revenue, according to management consulting firm Korn Ferry, cited by the International Monetary Fund[xii].

Since the COVID-19 pandemic all business sectors have shifted to more digital delivery, and this has had a huge consequence on required job skills. As technology increasingly drives the world's economy, governments see economic opportunities associated with creating stronger local CS-based industries[xiii] which in turn drives demand for people with CS skills. The demand for CS skills doesn't just apply to technology jobs, but to the increasing number of occupations that require computing skills in addition to the skills they traditionally demanded. CS education provides the skills that are badly needed by employers generally and ensures that students are competitive and adaptable in rapidly changing labor markets.

Currently, however, education generally cannot meet the growing demand for people with CS skills[xiv]. In October 2022, only 33% of technology jobs worldwide were filled by the necessary skilled. A global survey conducted by Capgemini and LinkedIn found that half of the organizations surveyed say that the digital divide is widening and that they have lost competitive advantage due to talent shortages[xv].

Technology Skills are Valuable to Individuals

With these shortages of talent, it's not surprising that there is above-average wages and faster wage growth in CS relative to the other fields.

For individuals it pays to acquire technology skills. The US Bureau of Labor Statistics (BLS) cited by Coursera, reports the median annual salary of computer scientists as $131,490 with a range of $74,210 for the lowest 10 percent of wage earners and $208,000 for the highest 10 percent. According to Glassdoor, the average base salary for a computer scientist in the US is $107,396, with a range of $88,000 to $192,000[xvi]. This is significantly above the national average salary of $54,132 per year[xvii].

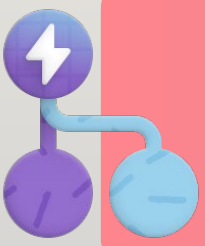
"It's pure supply and demand," says Alan Guarino, a vice chairman at Korn Ferry. *"Companies are paying more, they're hiring more, but there is still a shortage of high-skilled tech workers. Technology is the thread that runs across every aspect of business[xviii]."*

The Equality Case for CS in the Curriculum

Empirical studies have shown that technological skills have reduced inequalities between groups[xix], and universal access to CS education can achieve this in several ways. For example, CS education has been shown to increase college enrolment rates[xx]. This is because CS skills, such as problem-solving[xxi] and planning[xxii] are broadly transferable, making CS a subject that drives success in other subjects. Other benefits include enabling those with lower access to technological resources the opportunity to catch up and adapt.

Cross-Curricular Value

Like languages, math, music, and chess, learning CS can help students learn other subjects. This is because the CS skills, such as problem-solving[xxiii] and planning[xxiv] are broadly transferable. Computer programming – a key part of CS – has been shown to improve students' creativity, problem solving, math and reasoning skills[xxv]. In other words, CS helps students level-up across other subjects because it teaches them how to think.



"Thinking like a Computer Scientist means more than being able to program a computer. It requires with ideas multiple levels, or abstraction. Computational Thinking – which is core to CS - represents a universally applicable attitude and skill set everyone, not just Computer Scientists, would be eager to learn and use."

Jeannette M. Wing, Head of the Computer Science, Carnegie Mellon University

Increased College Enrolment Rates

A 2020 study examined the effects CS courses on students' academic careers in the United States and found that they had a positive and significant effect on increasing the likelihood of enrolling in college. Two districts on opposite sides of the country were involved in the study successfully increased college enrollment by 24% to 34%[xxvi].

CS is also valued by universities across a wide range of disciplines. CS can be useful for many degree courses including biology, chemistry, economics, engineering, geology, mathematics, materials science, medicine, physics, psychology, and sociology[xxvii]. At the University of California, CS is considered foundational background for degrees from Physics to Cognitive Science to Business Information Management[xxviii].

Learners looking to enter the jobs market will find that Microsoft certifications are often listed as a job requirement[xxix]. Microsoft' fundamental certifications validate skills and abilities and are available free to eligible students[xxx].

Digital Inclusion

Other benefits include enabling those with lower access to technological resources the opportunity to catch up with those who have higher levels of access. In other words, those with limited access to technology by any other means, should be able to access technology at school as part of the school's CS provision.

The Empowerment Case for CS in the Curriculum

Our lives now depend on computers in many ways, but most people are merely passive consumers of computing, rather than active creators who understand how computing works.

The ubiquity of computing is a 'double-edged sword'. It delivers significant benefits and can drive inclusion, but it also has negative consequences ranging from polarization to widespread distrust to the erosion of democracy[xxxi]. So, there's a real need for everyone to understand how the computing they use works not just for them but how it can work against them too.

Digital Literacy

As students enter adult life and access online services and participate in the digital world, those without digital skills will be disadvantaged against those who possess them. CS education is therefore a driver of equal opportunities in life as a well as work. All students need the skills, knowledge and understanding of computing that will help them to take a full and active part in social, cultural, economic, civic and intellectual life now and in the future.

At the very least, all students need to be able to stay safe online; secure their devices from cybercrime; understand their rights to privacy; make and share meaning in different modes and formats; create, collaborate, and communicate effectively; and select the right technology tools for what they need to do[xxxii].

A foundational part of the MCSG is Microsoft's Digital Literacy course. This course is designed for students to learn how to use devices, software, and the Internet to collaborate with others and discover, use, and create information.

Active Participation vs Passive Consumption

Students need to be able to critically engage with technology, rather than just passively use what is given to them. For example, a practical understanding of computation can explain why crypto currencies contribute to global warming[xxxiii]. Practical learning activities focused on Cloud Computing enables students to realize where their data comes from and goes to. A practical understanding of how robots work leads to an understanding of how the goods and services they use are built and delivered. The goal of active participation is both to make learning productive and relevant, but also to enable students to make informed sustainable decisions rather than just have technology 'done to them' by others.

Humanising Technology

Both humanity and the world of technology stands at an inflection point. A global pandemic, war in Europe, and climate change are creating increasingly complex problems. Even when created with positive intentions, technological advancement can amplify existing problems. Technology that takes advantage of human vulnerabilities — like confirmation bias, cognitive limits, how our dopamine systems work, or our need for social validation — undermines citizenship and drives social polarization[xxxiv].

Creating the conditions to tackle our increasingly complex problems means replacing many old technology paradigms with new humane and sustainable ones. At the very least, all students should be empowered to critically judge the validity, accuracy, and appropriateness of information. They should also build the skills needed to identify and recreate the dysfunctional aspects of the digital world, so it better serves humanity.

Technology Education and Learning Support (TEALS) is a Microsoft Philanthropies program that builds sustainable CS programs in high schools. The program focusses on serving students excluded from learning CS because of race, gender, geography, accessibility, and/or political or social challenges. TEALS helps teachers learn to teach CS by pairing them with industry volunteers and proven curricula. Since its inception in 2009, over 95,000 students have received CS education through the TEALS program.

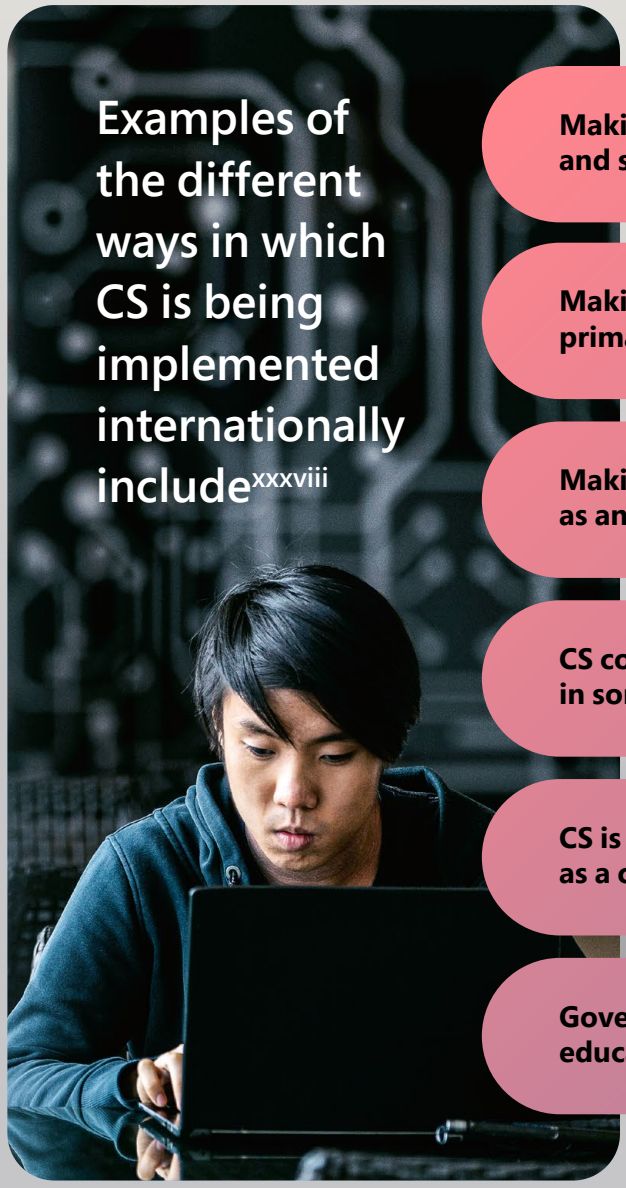
Having established why CS is an essential subject in the curriculum for economic equality and empowerment reasons, lets now turn to practical considerations for implementing CS education.

International Progress Towards CS in Schools

Approximately 70 countries have developed curricula, frameworks, or standards for CS, providing clear evidence of how important this subject is. Each country approaches CS education in a different way. For some, it's about including computational thinking aspects of CS into 21st Century Skills. For others it's about offering CS as a standalone subject or integrated across the curriculum.

A key consideration is that it's necessary for CS concepts to be introduced as early as possible so that they can be embedded and built upon progressively[xxxv], so what happens at primary level matters a lot. At primary level, CS is often integrated as computational thinking as a transversal topic, bringing together the arts and STEM in new ways to make learning more engaging[xxxvi].

In secondary schools, where subjects are typically more siloed, CS is also integrated into other subjects such as mathematics. Only a few countries, Finland for example, formally present CS in a cross-curricular way[xxxvii]. However, there is a significant grass roots effort by teachers at both primary and secondary level to bring in CS informally across the curriculum through campaigns like CS Edu Week and EU Code Week, as well as through after-school programs such as Code Club and CoderDojo.

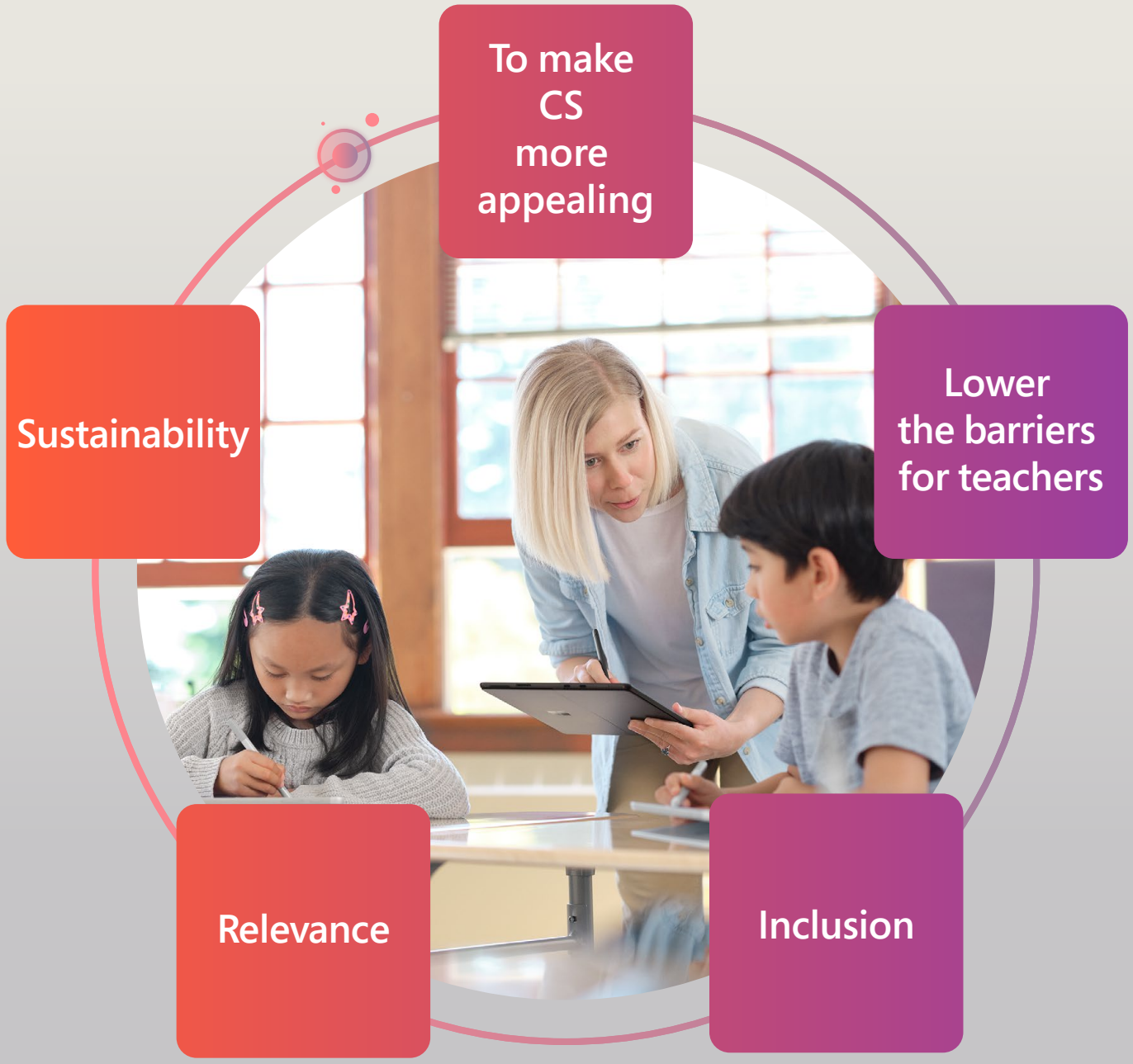


Examples of the different ways in which CS is being implemented internationally include[xxxviii]

Making CS mandatory in primary and secondary school	Israel England South Korea
Making CS mandatory in either primary or secondary schools	Portugal Morocco Japan
Making CS available everywhere as an optional or elective course	Chile Nigeria Nevada
CS courses are made available in some schools or districts	Argentina India South Africa
CS is taught as a cross-curricular subject	Mexico Spain Norway
Government has CS education plan or pilot	Brazil Finland France

Why a New CS Curriculum Guide for Schools?

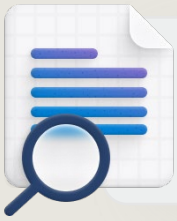
With 70 countries building or using CS curricular, why create a new CS curriculum guide now? There are several reasons for this.



Let's now look at each of these in turn.

Make CS More Appealing

Regardless of how CS is implemented, many implementations of national or state-wide CS curricula fail to engage students in the subject.



In California, regarded by many as the epicenter of the technology industry, more students take ceramics than take CS despite significantly better job prospects in the tech world[xxxix].

Too few young people are choosing to study CS in school, while at the same time the popularity of CS as course choice for university undergraduates grows.

Surveys from various countries suggest that despite a clear economic incentive, relatively few primary and secondary education students express interest in pursuing advanced CS education. For example, three out of four U.S. students in a recent survey declared no interest in pursuing a career in CS[xl]. And the differences by gender are notable: nearly three times as many male students (33%) compared to female students (12%) expressed interest in pursuing a CS career in the future[xli].

National level CS curricula can be academic and dry and is often criticized by students for being delivered through teacher-centered pedagogies. The curricula seldom link to real-world societal problems and miss the opportunity to inspire young people to apply their learnings to develop solutions that might impact the world around them. So, the MCSG was conceived as a student-centric curriculum using constructivism, hands-on activities, problem-solving, and inquiry-based approaches which are more appealing to diverse groups of students[xlii].

Microsoft MakeCode is a free online learn-to-code platform where students can build games, code devices, and modify Minecraft. Students can use it to write programs for the micro:bit - the credit card-sized computer that you could embed into any project, and can progress from basic 'block-based' programming to general purpose coding languages.

To foster motivation, CS learning activities need to be directly relevant to students lives rather than abstract. Students also need to feel that their work is addressing their concerns, particularly regarding sustainability. In recent years, media attention has focused on the increasingly vocal demand from the world's youth to address climate change through education, exemplified by the millions of students behind the Fridays for Future movement. So, by mapping the UN's Sustainable Development Goals to each learning activity, the MCSF makes meaningful links between CS and sustainability.

Imagine Cup Junior is the version of Imagine Cup which is applicable to students between the ages of 13-18. It is a global technology challenge where educators lead secondary students to develop solutions that can be used to positively make a difference in the world. Over the past 20 years, more than two million student competitors have signed up Microsoft's Imagine Cup to build and learn together, make a difference in their communities, and innovate for impact.

Lower the Barriers for Teachers

Teachers across the world feel that they are not able to teach CS. For example, 44% of teachers in England only felt comfortable teaching the lowest levels of the curriculum as they did not believe they had adequate skills in CS to teach the more advanced topicsx[liii]. So, what do teachers require, and how does the MCSG address these requirements?

A key component in the Microsoft CS Curriculum Guide (MCSG) is Microsoft Minecraft CS Kit. The goal of this kit is to develop a coding mindset and computational thinking skills through meaningful and relevant learning experiences, in the context of a wider learning community. The kit is specially designed to address relevant academic standards in a logical, sequential progression and aims to provide teachers with the content and tools needed to implement CS in the classroom.

Teacher training should clearly be a top priority, but a well-designed curriculum guide can lower the barriers for teachers by addressing the following requirements:

Content

Finding engaging content and activities is crucial to being able to teach CS successfully. But content also must be framed in terms of logical and stage-appropriate sequence and engaging contexts.

Sequencing

Teachers also need to know what concepts students need to grasp at which stage, and how to progressively increase their mastery of CS content, skills, and mindset through their school careers.

Context

Students ought to be able to see an end goal to their studies, so a key opportunity is to build motivation by taking students through a journey towards CS-enabled employability and even entrepreneurship – regardless of their main career choices.

Organization

Teachers self-report that they need more support in evolving their pedagogy to be more effective in CS education and to find the right balance between teacher-centric and student-centric methods[xliv]. As students progress, learning activities need to be increasingly about collaboration and teamwork, so a CS curriculum Guide should specify how learning activities are organised.

The MCSG provides links to over 300 learning resources connected directly to specified learning outcomes, carefully organized in sequences and contexts designed to engage students. It frames the contexts for not only what students should learn but how they should learn. It builds knowledge of fundamental concepts, revisiting and refining them throughout the school career according to student developmental stages.

Trained and motivated teachers are essential to the implementation of CS, and Microsoft has a wide range of support available to teachers including training and professional development, certification, educator programs, showcase schools, instruction materials, product guides, and a global mentorship program.

Inclusion

CS across the world has a well-documented gender skew. For example, in 2020 in the number of girls choosing to study CS at GCSE (public examination level) was just over 21.4% of total entrants[xlv]. To address the growing CS skills gap, this bias needs to be tackled and CS curriculum design can help. A good place to start is to engage both boys and girls early in primary schools by making the subject relevant and meaningful rather than abstract and dry. Team-based learning activities can do much to dispel the social stigma based on the idea that CS is just about coding as a solitary activity by providing an outlet for creativity, problem-solving and solution-building. The MCSG also offers opportunities to showcase women role models by shining a spotlight on the many great women pioneers of computing.

Equity is also about making sure all students, regardless of socio-economic status, race, ethnicity, or special learning needs, can take computing courses that are appropriate for their needs and abilities. Again, applying the principles of gaining interest at an early age, relevance and meaning, and collaborative learning can help.

Relevance

In recent times, computing has evolved at a breathtaking pace, and change will continue to accelerate into the foreseeable future. Near-constant changes in technology can quickly render a CS curriculum irrelevant very quickly. A lot of curricula used in schools now predates the rapid rise in significance of key areas such as Artificial Intelligence (AI) - which is rapidly changing the world of intelligence itself. Current priority computing areas such as Humanising Technology, Technology Ethics, Metaverse, AI Foundation Models, Quantum, Cyber Security, Low Energy Solutions, Drones and Autonomous Vehicles have appeared relatively recently. CS curriculum needs to be as future proof as practical and regularly updated. A student following a curriculum that lasts 13 years will live through changes in technology that are hard to imagine, so the curriculum needs to be designed in a way in which learning activities can be constantly updated. Therefore, a key goal of the MCSG is to be future proof by incorporating subjects that are likely to be highly relevant into the longer term.

Sustainability

Sustainability is no longer optional – it's an imperative[xlvi]. Consumers are demanding it, investors are investing in it, government are legislating for it. Sustainability offers exciting learning opportunities in the CS curriculum. By connecting CS learning objectives to real-world sustainability problems, the MCSF is designed to inspire learners to develop solutions to real-world problems rather than simply completing abstract tasks.

For example, climate change is a key sustainability challenge, and computing – particularly AI and Blockchain - contributes to global warming. But at the same time, computing offers solutions to the problem as well. This provides interesting challenges and problems for CS students to work on. It provides motivation and real-world context for learning about cutting-edge technology and for developing superior problem-solving and analytical skills.

Computing can help accelerate progress towards each of the 17 United Nations Sustainable Development Goals (SDGs)[xlvii] which is why every learning activity from level 10 upwards in the MCSF is linked directly to SDGs.

Microsoft is taking a global leadership position on climate change with a commitment to be carbon negative by 2030. Reflecting this in CS education, Microsoft's Imagine Cup Junior AI For Good Challenge enables students to learn how AI can be applied to solving sustainability problems and develop their creative problem solving skills.

Microsoft's Approach to Computer Science Education

Microsoft's long experience as a leader in the computing industry, combined with unrivalled global partnerships gives it the capacity to support the development and implementation of CS Education. Microsoft's approach to CS is predicated on the principle of 'CS For All' delivered through a range of offerings and partnerships.

Reach

Children and young people (primary, secondary and further education students), including groups historically excluded from CS education because of race, gender, geography, and/or political or social crisis.

By offering

Teacher Training
- Training sessions, online and live
- Global community of trained educators
- Mentor program

Curricula and Content
- Microsoft CS Guide
- Minecraft and MakeCode CS curricular, content, and certification
- Imagine Cup & Imagine Cup Junior

Implementation services
- Consulting services and training for system-wide change
- Teals - direct classroom support for teachers

So that

- More students have equitable access to inclusive CS education and are exposed to pathways to future economic opportunity.
- More education institutions have the teacher capacity to offer CS courses and pathways independently.
- More students from groups historically excluded from learning CS take CS courses and demonstrate interest and excitement in CS opportunities

Let's now look more closely at Microsoft's offerings for Computer Science.

Microsoft's Offerings for Computer Science

Training and Support for Teachers	• Online and live training • Microsoft Learn for Educators
Global Community of Trained Educators	• Microsoft Educator global program
Curricula and Content	• Minecraft CS Curriculum • MakeCode CS Curriculum • Hacking STEM • Imagine Cup Junior
Mentor Program	• Certified Minecraft-based educators
Implementation Services	• Microsoft Professional Services • Change Management program design and implementation • Training for System-Wide Change • Global Education Training Partner Program
Direct Classroom Support for Teachers	• Microsoft TEALS
Microsoft Computer Science Guide (MCSG)	• CS Curriculum Framework • Standard mapping • Classroom-ready content mapping • Lesson and project suggestions for coding • Implementation Guide

Certification

Exam AZ-900: Microsoft Azure Fundamentals

Exam AI-900: Microsoft Azure AI Fundamentals

Exam DP-900: Microsoft Azure Data Fundamentals

Exam SC-900: Microsoft Security, Compliance and Identity Fundamentals

Teacher Training and Support

Training Sessions

Online and live training is available across a range of subject areas and learning pathways including coding.

Microsoft Learn for Educators

Microsoft Learn online learning paths and helps teachers to bring relevant and effective learning materials into the classroom.

Global Community of Trained Educators

Teachers can join and learn from a global network of educators trained on using Microsoft tools in the classroom.

Mentor Program

Teachers can also become certified in Minecraft-based education through a global community of educators who are passionate about Minecraft in the classroom.

Implementation Services

Professional Services

To help drive system-wide change Microsoft Education Industry Services can help deliver consulting services for Change Management, program design and implementation, and content creation, curation, delivery, and analytics solutions.

Training for System-Wide Change

Members of Microsoft's Global Education Training Partner Program can provide training for system-wide change. Members undergo official Microsoft training that enable them to deliver system-wide programs such as Microsoft's Education Transformation Framework; Future-Ready Skills and Industry Certifications; and Minecraft Education.

Direct Classroom Support for Teachers

The Microsoft TEALS (Technology Education and Learning Support) program partners directly with individual schools to bring teachers and volunteers together to help students learn how to code using proven curricula.

Curricula and Content

Minecraft CS Curriculum

Minecraft Education CS offers 150 hours of CS content for beginner to advanced levels supported by a range of training material for educators. It also offers comprehensive resources and training for teachers through the Minecraft Education Teacher Academy and Webinar Series.

MakeCode CS Curriculum, and 'Hacking STEM'

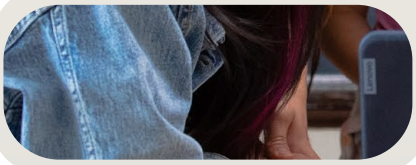
Microsoft MakeCode is a free platform for creating engaging CS learning experience and provide a progression pathway into real-world programming. The program offers several full-length courses, resources, and guidance for teachers. In addition, Microsoft Hacking STEM provides middle school standards-based, project-based lesson plans focusing on visualising data across science, technology, engineering, and math (STEM) curriculum.

Imagine Cup Junior

Imagine Cup Junior is a global technology challenge for students between the ages of 13-18. The goal is to enable and help educators lead students to develop solutions that can be used to positively make a difference in the world.

Certification

Demand for technical industry recognised certification is growing across the world[xlviii], and schools are a great place for learners to start their professional certification journey. Many K-12 aged students have gained Microsoft professional certifications. Students who gain professional level certification gain confidence and a sense of personal accomplishment as well as showing future employers and their educators their perseverance and determination to earn a rigorous globally recognized credential[xlix]. Certification also gives students credibility to enter the increasingly technical, digitally infused jobs market, where there are significant demands for certificated skills. In the United States, certification can also be added to transcripts for institutions to enable learners to obtain college credit or advanced placement in a degree program[l].



A good place to start with certifications is for all students to gain Microsoft Office skills and to get these skills recognised through certification. Using Microsoft Office is the backbone of vast areas of modern work and gaining the foundational skills and confidence in Microsoft Office sets up students for the world of work[li].

For students aged between 11-15 years, Coding in Minecraft provides a pathway of introductory courses and assessments to develop and prove their coding and introductory CS skills using MakeCode and JavaScript or Python[lii].

For students aged between 16-18 years – certification pathways can include the following Microsoft technical "Fundamentals" certifications:

Microsoft CERTIFIED FUNDAMENTALS

- Azure Cloud Fundamentals
- Azure AI Fundamentals
- Azure Data Fundamentals
- Azure Cybersecurity Fundamentals

Learning pathways with Microsoft Official Coursework preparatory for these industry recognized Fundamentals certifications are available on Microsoft Learn. Each certificate learning pathway is also supported by "Pre-Fundamentals" learning content. For educators interested in incorporating official curricula for Fundamentals coursework and industry certification exams into their programs of study in school, the Microsoft Learn for Educators program provides instructor resources, including course data sheets, educator teaching guides, educator certifications, presentation materials, and lab exercises.

Each certificate is supported by "Pre-Fundamentals" learning content. For educators interested in incorporating curricula for Azure Fundamentals coursework and industry certification exams into their programs of study, the Microsoft Learn for Educators Program referenced above provides instructor resources, including course data sheets, educator teaching guides, educator certifications, presentation materials, and lab exercises.

Microsoft Computer Science Guide (MCSG)

Microsoft has developed a curriculum guide that will help you plan and implement CS. It will step you through the each of the key tasks involved and covers resources requirements and the questions that will need to be addressed.

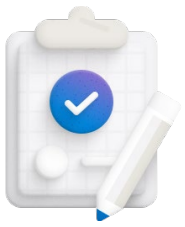
The guide covers the following

- CS and a vision for change
- Options for end-goals
- Curriculum options
- Microsoft CS Curriculum Framework, Structure & Principles
- Organizational options
- Resource requirements
- Teacher training
- Creating demand
- Engaging and exciting students
- Connecting CS to other curriculum areas
- Working in partnership
- Sustainability
- Continuous improvement

MSCG comprises the following assets

Whitepaper

- Provides a rationale for CS implementation



Toolkit

- Curriculum framework
- Learning outcomes
- Mapping to standards
- Implementation planning
- Career guidance
- Lesson and project suggestions for Coding

Map

- Learning pathways
- Module level mapping to content, assets and links

The MSCG Toolkit contains details and links to all the programs referenced in this white paper.

Conclusion

The rapid rise in significance of CS in the context of increasingly complex global problems and accelerating technological change makes it urgent to implement a modern approach to CS curricula. Right now, some aspects of computing are significantly changing the world for the better whilst other aspects of computing are amplifying existing problems, and these are aspects of life and work that students must surely at the very least learn to navigate. Not only do they need to navigate technology, they also need to become active builders of CS solutions learn how to adapt to a constantly changing digital landscape.

The Microsoft CS Guide includes a curriculum structure, map and implementation guidance, as well as a program of study objectives and proposed content for CS that spans learners from age 5-18. This curriculum guide is based on our years of expertise as a leader in the computing industry, on academic research around the teaching of CS, and on learnings from countries around the world.

References

[i] https://www.techopedia.com/2/27878/software/what-is-the-difference-between-computer-science-and-information-and-communications-technology-ict

[ii] Maryska, Milos; Doucek, Petr; Kunstova, Renata; The Importance of ICT Sector and ICT University Education for the Economic Development, Procedia - Social and Behavioral Sciences, 2012

[iii] Dale W. Jorgenson, Khuong M. Vu, The ICT revolution, world economic growth, and policy issues, Telecommunications Policy,Volume 40, Issue 5, 2016

[iv] Maryska, Milos; Doucek, Petr; Kunstova, Renata; The Importance of ICT Sector and ICT University Education for the Economic Development, Procedia - Social and Behavioral Sciences, 2012

[v] Dale W. Jorgenson, Khuong M. Vu, The ICT revolution, world economic growth, and policy issues, Telecommunications Policy,Volume 40, Issue 5, 2016

[vi] https://news.microsoft.com/apac/2022/02/18/skilling-for-japans-digital-transformation/

[vii] https://www.boj.or.jp/en/research/wps_rev/wps_2022/data/wp22e10.pdf

[viii] https://www.oecd.org/japan/japan-broaden-the-digital-transition-to-strengthen-economic-recovery-from-covid-19-says-oecd.htm

[ix] https://asia.nikkei.com/Economy/Japan-government-to-shift-vocational-training-focus-to-digital-skills

[x] https://news.microsoft.com/skills/

[xi] https://news.microsoft.com/features/free-online-digital-skills-courses-revive-hope-and-careers-for-millions-amid-the-pandemic/

[xii] https://www.imf.org/en/Publications/fandd/issues/2019/03/global-competition-for-technology-workers-costa

[xiii] Arguing for CS in the School Curriculum, Educational Technology & Society, 2016, Fluck et al

[xiv] https://www2.itif.org/2016-computer-science-education.pdf

[xv] https://www.weforum.org/agenda/2022/10/why-are-young-people-not-preparing-for-the-jobs-of-the-future/

[xvi] https://www.coursera.org/articles/computer-science-salary

[xvii] https://www.thebalancemoney.com/average-salary-information-for-us-workers-2060808

[xviii] https://www.imf.org/en/Publications/fandd/issues/2019/03/global-competition-for-technology-workers-costa

[xix] Building Skills for Life, How to Expand and Improve CS Education Around the World, Emiliana Vegas, Michael Hansen, and Brian Fowler, Brookings Institute, October 2021

[xx] The Effect of Advanced Placement CS Course Taking on College Enrolment, Emily Anne Brown Richard S. Brown, Ph.D, West Coast Analytics Report, 2020

[xxi] Can Majoring in CS Improve General Problem-solving Skills?, ACM, Salehi et al., 2020

[xxii] The effects of coding on children's planning and inhibition skills, Computers & Education, Arfé et al., 2020

[xxiii] Can Majoring in CS Improve General Problem-solving Skills?, ACM, Salehi et al., 2020

[xxiv] The effects of coding on children's planning and inhibition skills, Computers & Education, Arfé et al., 2020

[xxv] https://codeorg.medium.com/cs-helps-students-outperform-in-school-college-and-workplace-66dd64a69536xxvi

[xxvi] http://www.westcoastanalytics.com/uploads/6/9/6/7/69675515/longitudinal_study_-_combined_report_final_3_10_20__jgq_.pdf

[xxvii] https://www.hereford.ac.uk/explore-courses/courses/computer-science/

[xxviii] https://codeorg.medium.com/cs-helps-students-outperform-in-school-college-and-workplace-66dd64a69536

[xxix] https://techcommunity.microsoft.com/t5/microsoft-learn-blog/microsoft-certifications-boost-it-careers-from-the-start/ba-p/2038067

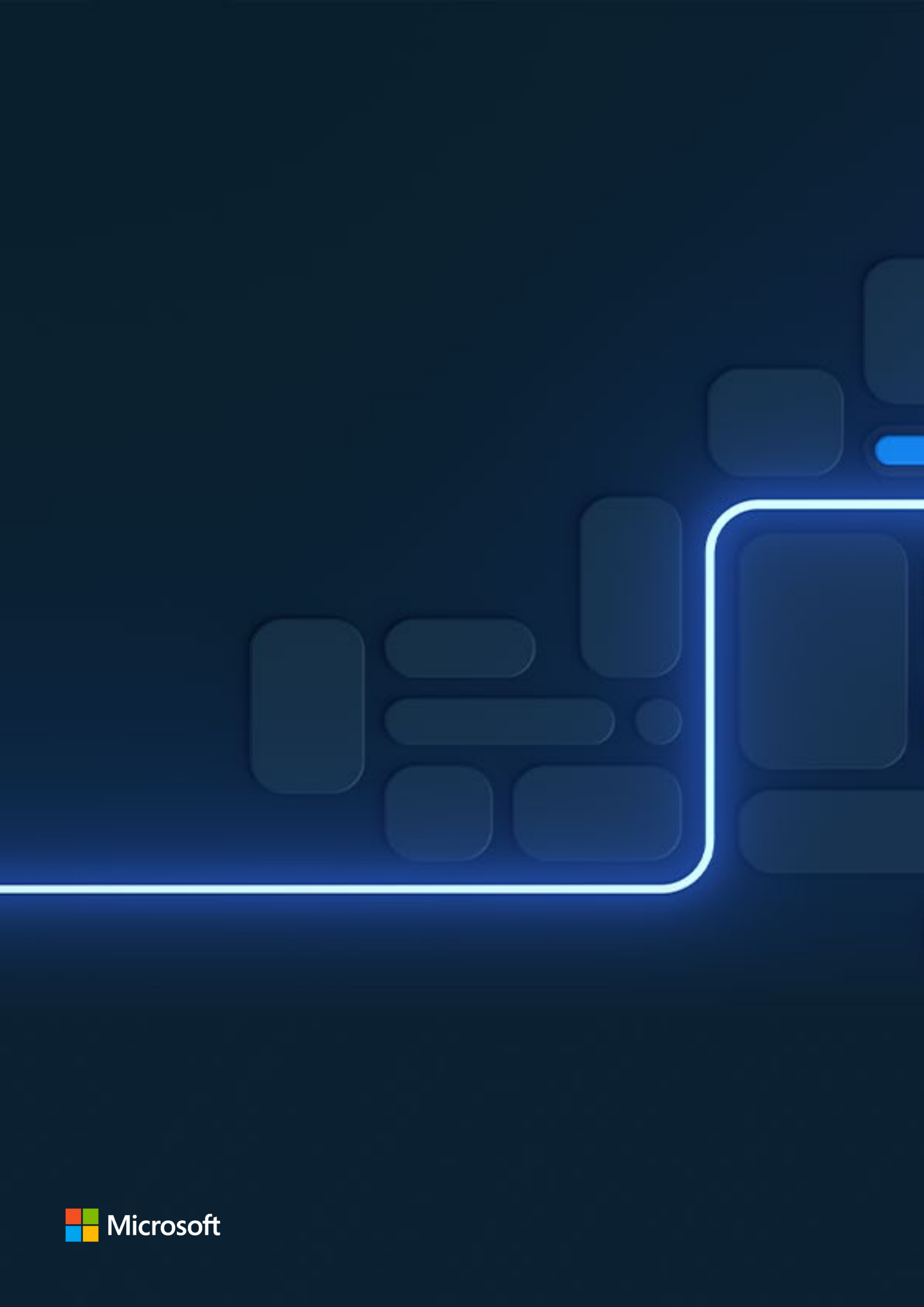
[xxx] https://docs.microsoft.com/en-us/certifications/student-training-and-certification

[xxxi] https://www.humanetech.com/insights/the-drivers-of-extractive-technology

[xxxii] https://www.nfer.ac.uk/publications/futl06/futl06.pdf

[xxxiii] https://science.howstuffworks.com/environmental/conservation/issues/cryptocurrency-climate-change-news.htm

[xxxiv] https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634414/EPRS_STU(2019)634414_EN.pdf
[xxxv] Webb, M., Davis, N., Bell, T., Katz, Y. J., Reynolds, N., Chambers, D. P., & Sysło, M. M. (2017). CS in K-12 school curricula of the 2lst century: Why, what and when?. Education and Information Technologies, 22(2), 445-468
[xxxvi] Henrique de Paula, B., Burn, A., Noss, R., Valente, J.A. (2018) Playing Beowulf: Bridging computational thinking, arts and literature through game-making. International Journal of Child-Computer Interaction, 16 (June), 39-46.
[xxxvii] Balanskat, A. & Engelhardt, K. (2015) Computing our future. Computer programming and coding priorities, school curricula and initiatives across Europe. Brussels: European Schoolnet. Accessed from https://fcl.eun.org/documents/10180/14689/Computing+our+future_final.pdf/746e36b1-e1a6-4bf1-8105-ea27c0d2bbe0
[xxxviii] Building Skills for Life, How to Expand and Improve CS Education Around the World, Emiliana Vegas, Michael Hansen, and Brian Fowler, Brookings Institute, October 2021
[xxxix] https://www2.itif.org/2016-computer-science-education.pdf
[xl] Building Skills for Life, How to Expand and Improve CS Education Around the World, Emiliana Vegas, Michael Hansen, and Brian Fowler, Brookings Institute, October 2021
[xli] https://news.gallup.com/opinion/gallup/320663/girls-interest-computer-science-challenge.aspx
[xlii] Kotsopoulos, D., Floyd, L., Khan, S., Namukasa, I.K., Somanath, S., Weber, J. & Yiu, C. (2017) A Pedagogical Framework for Computational Thinking. Digital Experiences in Mathematics Education vol. 3, pages 154–171(2017)
[xliii] The Royal Society. (2017). After the reboot: Computing education in UK schools. London: The Royal Society. Accessed from https://royalsociety.org/~/media/policy/projects/computing-education/computing-education-report.pdf
[xliv] Bower, M., Wood, L. N., Lai, J. W., Howe, C., Lister, R., Mason, R., Highfield, K., & Veal, J. (2017). Improving the Computational Thinking Pedagogical Capabilities of School Teachers. Australian Journal of Teacher Education, 42(3).
[xlv] https://www.theguardian.com/careers/2021/jun/28/why-arent-more-girls-in-the-uk-choosing-to-study-computing-and-technology
[xlvi] https://www.ft.com/content/d5c571e4-47c3-11e8-8ee8-cae73aab7ccb
[xlvii] https://www.itu.int/en/mediacentre/backgrounders/Pages/icts-to-achieve-the-united-nations-sustainable-development-goals.aspx
[xlviii] https://home.pearsonvue.com/voc/2021-report
[xlix] https://www.pearsonvue.co.uk/Documents/Grow-your-programme/VoC.aspx
[l] https://learn.microsoft.com/en-us/certifications/college-credit
[li] Pearson Vue, Certiport white paper - Ten reasons schools should offer Microsoft certification to students
[lii] https://codingcredentials.com


Microsoft