Digital education economy

Empowering the Next Generations with Smart Labs and a New Curriculum for the Digital Education Economy

2023

FUNCTIONAL AREAS IN THE EU

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Intro

The fast pace of economic growth is introducing new technologies into the working ecosystem will soon lead to a new digital revolution through AI, machine-learning and robot process automation tools. This digital revolution will have a large impact and will most likely transform the way we live, work, and learn. In today's digital age, technology is rapidly changing, and it has become an essential part of our lives. The digital economy is growing at an unprecedented rate, and it is projected to create over 149 million new jobs globally by 2025[1]. The future belongs to those who can embrace digital technology and adapt to its changing trends.

At the same time, it is worth noting that significant changes in the global workplace will also lead to shifting market dynamics that seem hard to comprehend.

Given that previous Industrial Revolutions were not incredibly steep, they allowed people to quickly reorient their professional activities into other domains. The higher overall productivity stemmed from technological advancements of past Industrial Revolutions led to the need of reskilling large amounts of people in order to occupy vacant jobs. And this not only led to economic growth for the private sector, but also to higher salaries and an overall increase in the quality of life.

What seemed to be a global economic workforce mainly focused on agriculture just 30 years ago, quickly shifted to industrial and service workforce in just one generation. According to World Bank Data[2] (modelled on the International Labour Organization estimates), the world employment in agriculture as a percentage of total employment dropped from 44% in 1991 to just shy of 27% in 2019 - while most advanced EU and worldwide economies only have 1-3% of people employed in agriculture. At the same time, we can see that the global employment in services skyrocketed from 34% up to 51% of the total employment – with most advanced economies in the high 80-90 percentile.

The AI Revolution will most likely not create the same outcome for jobs across industries. The advancements in AI will not only be software-based, but will also lead to improvements in robotics and robot process automation. This means that the changes that we have seen in the past decades in agriculture will be relevant to marketplace shifts in the industrial and services sectors as well.

Just two months after its beta version was officially launched, Chat GPT – a chatbot by OpenAI that uses generative artificial intelligence to create its own content – passed a series of exams that show how it could be replacing entire cohorts of students. It successfully passed a series of Wharton MBA exams, the US medical licensing exam, four law school exams at the University of Minnesota, and the Stanford Medical School clinical reasoning final[3].

These advancements provide a clear understanding that in less than a generation, AI and machine-learning progress can and will easily replace white-collar jobs, as opposed to just blue-collar jobs of previous Industrial Revolutions.

Under these premises, if no advancements are made, it becomes clear that the current

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[1] According to the World Economic Forum, based on a study made by Microsoft, 2022 (link)

[2] Employment in Agriculture (link), Employment in Services (link)

educational framework is set to become obsolete in just a few decades and will not be able to support a growing workforce of future students.

The EU Digital Education Action Plan

To support these market dynamics, the European Commission issued the Digital Education Action Plan 2021-2027 (the second iteration) as a renewed policy initiative to promote high-quality, inclusive, and accessible digital education in Europe. The initiative aims to support the education and training systems of EU Member States in adapting to the digital age, while addressing the challenges and opportunities posed by the COVID-19 pandemic.

The Action Plan, adopted on 30 September 2020, seeks to foster greater cooperation at the European level in digital education among teachers, students, policy makers, academia, and researchers. It contributes to the Commission's priority of creating a Europe fit for the Digital Age, as well as Next Generation EU and the Recovery and Resilience Facility, which aims to make the EU more digital, green, and resilient.

The Digital Education Action Plan is a vital tool in achieving the vision of a European Education Area by 2025. It aligns with the goals of the European Skills Agenda, the European Social Pillar Action Plan, and the 2030 Digital Compass: The European way for the Digital Decade.

The important takeaway from this Action Plan is that the European Union is dedicated to advancing the current educational framework into a new digital education economy model, which will put digital skills as the central pillar of the new ways of learning. This means that besides the large Recovery and Resilience Facility financing available to invest in the current education system, new reforms and tools will subsequently become available to support the advancement to a digital education economy.

The Digital Education Economy

This document does not aim to provide comprehensive data explaining the benefits of transitioning to the digital education economy, but instead starts from the premise that the major shifts in the technological sphere are poised to influence the entire education system.

As we have seen in the past decades that Silicon Valley companies have influenced the university landscape in the United States by heavily investing in research labs and advancing the academic curriculum in computer science, the next years will focus on providing the same advancements into the K-12 education cycles.

To this end, this document aims to provide lists for both hardware and software tools that may be equipped in school smart labs, as well as an alternative education curriculum that can be corroborated with the current school subjects to empower digital economy entrepreneurship and innovation.

[3] ChatGPT could be a Stanford medical student, a lawyer, or a financial analyst, Business Insider, 11.02 2023, (link)

School Smart Labs

Photo by Giu Vicente on Unsplash

The education sector has a significant role to play in preparing students for this digital future. Schools and high schools need to equip students with the necessary digital skills to succeed in the 21st century. One way to achieve this is by creating smart labs in K-12 schools.

Smart Labs are next generation STEM and digital media arts programs for elementary, middle, and high schools. Smart labs are a perfect combination of real-world problem solving and creativity, and currently have the role to engage kids like no other place in school.

Smart labs are technology-enabled learning spaces designed to provide students with hands-on experience in science, technology, engineering, and mathematics (STEM) education. They are equipped with state-of-the-art technology, such as 3D printers, robotics kits, coding platforms, virtual reality (VR), augmented reality (AR), and simulation software.

Smart labs help students develop critical thinking, problem-solving, collaboration, and communication skills. These skills are essential for students to succeed in the digital economy. Furthermore, smart labs promote creativity, innovation, and entrepreneurship, enabling students to become the next generation of digital leaders.

The importance of smart labs in K-12 schools cannot be overstated. They provide a learning environment that is fun, engaging, and challenging, which motivates students to learn and excel. Smart labs help bridge the digital divide by providing access to technology for students who may not have access to it outside of school.

Smart labs can help achieve two major goals:

1) Prepare children for the world of tomorrow, by exposing them to the latest technologies, and ensuring that they incorporate these technologies in their day-to-day work;
2) Create the proper conditions for "black swan" events – i.e., the emergence of geniuses in individual fields, who manage to realize their potential by having access early to tools that promote their innate skills. For example, Bill Gates and Paul Allen had access to one of the first computers in the world, at their high school, and it is that computer that they used to develop the first version of the Microsoft Operating System.

This section outlines the importance of smart labs in K-12 schools and their impact on student learning outcomes. It provides recommendations for the implementation and funding of smart labs in schools and high schools. The document discusses existing programs, and proposed additional interventions. This is a draft, as it is difficult to have a comprehensive overview of the latest technologies and innovations.

A few principles are important to keep in mind when designing Smart Labs:

- While having the right infrastructure in place is a big plus, it is important to also have teachers that know how to use the infrastructure, to provide guidance to children;
- Whenever possible, children should have unfettered access to the infrastructure, including the option of using the infrastructure without supervision;
- The proper infrastructure needs to be doubled by soft measures. Of particular importance are:

  - Courses on inter-personal relationships;
  - Courses on active listening;
  - Courses on entrepreneurship;
  - Financial education;
  - International relations.
- Applying the principle of the "power of twos", by coupling children, and encouraging them to work in teams. Ideas can be improved much more efficiently, if children have a partner, they can discuss their ideas with. Many of the largest companies today have been started and matured by partnerships of two people, such as: Bill Gates and Paul Allen (Microsoft), Sergey Brin and Larry Page (Google), Warren Buffet and Charlie Munger (Berkshire Hathaway), Mark Zuckerberg and Dustin Moskovitz (Facebook), Jeff Bezos and MacKenzie Scott (Amazon), Elon Musk and Peter Thiel (PayPal).

The pages below provide lists of smart labs equipment[4] that can be proactively acquired by educational institutions to invest in the digital education economy and better respond to the market changes of the future. The lists are divided into two specific applications:

- General smart lab school components: which is the starting point for smart lab investments; and
- Specific smart lab school components: equipment that may be acquired by educational institutions to accommodate the educational needs of students in specific areas of learning. Without being exhaustive, the section will provide a few examples of dedicated smart labs that can be used in educational systems.

[4] The list is mainly focused on hardware technology, as software applications can be adjusted as per use cases

General Smart Lab school components

Type	Equipment	Description
Basic equipment	Server	A powerful computer that can be used to host digital content and applications, manage data, and provide network services.
Basic equipment	Network Devices	Routers, switches, and other networking equipment that enable internet connectivity, file sharing, and communication.
Basic equipment	Laptop computers and tablets	Portable computers and handheld devices that can be used for a variety of tasks including research, programming, and multimedia creation.
Basic equipment	Document Camera	A device that captures images of documents and objects in real-time, allowing for easy sharing and collaboration.
Basic equipment	Projector	A device that displays visual content from a computer or other device onto a large screen or wall.
Basic equipment	Portable PA Systems	Audio equipment used to amplify sound and make announcements in large classrooms or auditoriums.
Basic equipment	Video Conferencing Equipment	Cameras, microphones, and speakers used to conduct remote meetings, online classes, and virtual field trips.
Basic equipment	Smart Lockers	Electronic lockers with biometric authentication and charging ports used for secure storage and charging of electronic devices.
Basic equipment	Integrated Practical Training Systems with Virtual Instrumentation and Multimedia Software	Systems that combine virtual instrumentation and multimedia software to create hands-on learning experiences.
Basic equipment	Charging Carts	Storage and charging stations that allow for the safe and convenient storage of electronic devices such as tablets, laptops, and smartphones.
Drawing boards	Interactive Whiteboard	A touch-sensitive board that displays images and information from a computer, allowing students and teachers to interact with

Type	Equipment	Description
		content.
Drawing boards	Smart Board	An interactive board that combines a whiteboard with a computer, allowing for interactive presentations, video conferencing, and digital collaboration.
Drawing boards	Electronic Whiteboards	Similar to interactive whiteboards, but can be used without a computer and can save and share notes and drawings.
Drawing boards	Digital Drawing Tablets	Devices used by students to create digital art and designs with a stylus and a pressure-sensitive drawing surface.
Drawing boards	Smart Pens	Pens with built-in cameras that can capture and digitize handwritten notes and drawings.
Drawing boards	3D Pencil	This is a tool that allows students to create 3D drawings and models. It can be used to teach spatial reasoning and design skills.
Printing	Color / monochrome 3D Printer	A machine that can create three-dimensional objects from digital designs.
Printing	Laser Cutter	A machine that uses a laser to cut and engrave materials such as wood, plastic, and metal.
AR / VR	Virtual Reality Headset	A device that creates a simulated environment that can be used to explore different topics in an immersive way.
AR / VR	Augmented Reality Devices	Devices that blend digital content with the real world to create interactive and immersive experiences for students.
AR / VR	AR/VR Simulators	Simulators that use augmented reality (AR) or virtual reality (VR) to create immersive learning experiences.
Software	Rendering Software	Software used to create 3D models and visualizations.
Software	E-Learning Platforms	Online platforms used for delivering educational content and facilitating online learning.
Robots	Robotics Kit	A set of components that can be assembled to create robots for programming and experimentation.

Type	Equipment	Description
Robots	Multifunctional Robot Arm	A robotic arm that can perform a range of tasks, such as welding, painting, and assembly.
Robots	Multifunctional Educational Robots	Robots designed specifically for educational purposes, such as teaching programming and robotics to students. They come with a range of features and functionalities that allow for hands-on learning and experimentation.
Robots	Robotic Learning Modules	Modules that can be used to teach robotics and programming. They often come with a set of components and software that allow students to build and program robots.
Sensors	Sensor Kit	A collection of sensors that can be used to collect data and perform experiments.
Sensors	Environmental Sensors	Devices used to monitor and measure environmental factors such as temperature, humidity, and air quality.

Specialized Smart Lab components:

Robotics and Automation

Equipment	Description
Robotics Kits	Robotics kits are essential components for a robotics lab. They include all the necessary mechanical and electrical parts for building and programming robots. Examples of popular robotics kits include Lego Mindstorms, Vex Robotics, and Arduino Robotics kits.
3D Printers	3D printers allow students to design and create their own custom robot parts. This can include mechanical parts, electronic enclosures, and other components. Popular 3D printers for educational settings include the Ultimaker and MakerBot.
Programmable Logic Controllers (PLCs)	PLCs are specialized computers that are used to control automation systems. They can be programmed to control motors, sensors, and other components of a robot. Examples of popular PLCs include Siemens and Allen-Bradley.
Sensors	Sensors are essential components of robots, as they allow the robot to sense its environment and make decisions based on that information. Examples of popular sensors include ultrasonic sensors, infrared sensors, and touch sensors.
Motors	Motors are used to power the movement of robots. They can be servo motors, DC motors, or stepper motors. Examples of popular motor brands include Maxon, Faulhaber, and Nidec.
Microcontrollers	Microcontrollers are small computers that are used to control the behavior of a robot. Examples of popular microcontrollers include the Arduino and Raspberry Pi.
Robot Operating System (ROS)	ROS is an open-source robotics middleware that provides a framework for building robot software. It is widely used in research and education settings.
Simulation Software	Simulation software allows students to test and debug their robot programs before deploying them on real hardware. Examples of popular simulation software include Gazebo and Webots.
Virtual Reality (VR) Systems	VR systems can be used to simulate the behavior of robots in a virtual environment. This can be useful for training purposes or for testing algorithms before deploying them on real hardware.
Augmented Reality (AR) Systems	AR systems can be used to overlay information onto the real

Equipment	Description
	world. This can be useful for displaying sensor data or providing instructions to the user. Examples of popular AR systems include the Microsoft HoloLens and Google Glass.
Wireless Communication Modules	Wireless communication modules like Wi-Fi, Bluetooth, and Zigbee are important components in modern robotic systems. They enable robots to communicate with other devices or systems, and to be remotely controlled.
Computer-Aided Design (CAD) Software	CAD software allows students to design and create 3D models of robot components before printing them on a 3D printer. Examples of popular CAD software include Autodesk Fusion 360 and SolidWorks.
Computer Vision Systems	Computer vision systems enable robots to perceive and understand their environment through cameras and image processing algorithms. Examples of popular computer vision systems include OpenCV and TensorFlow.
Machine Learning and Artificial Intelligence (AI) Libraries	Machine learning and AI libraries like TensorFlow, Keras, and PyTorch enable students to develop advanced robotics applications like autonomous navigation and object recognition.
Control Systems	Control systems are used to regulate the behavior of a robot. They can include software or hardware-based systems like PID controllers, state machines, or fuzzy logic controllers.
Human-Machine Interfaces	Human-machine interfaces like touchscreens, buttons, or voice recognition systems enable users to interact with robots and control their behavior.
Data Acquisition Systems	Data acquisition systems enable students to collect and analyze data from sensors and other components in real-time.
Safety Systems	Safety systems like emergency stop buttons and motion sensors are essential components of any robotics lab. They help to prevent accidents and ensure that students can work with robots safely.
Documentation and Training Materials	Comprehensive documentation and training materials necessary for any robotics lab. This includes user manuals, tutorials, and technical specifications for all the components.

Specialized Smart Lab components:

Computer Science and Coding

Equipment	Description
Raspberry Pi	A Raspberry Pi is a small, low-cost computer that can be used to teach coding and programming. It can be used to build a variety of projects, such as a media center, a home automation system, or a game console.
Microcontrollers	Microcontrollers are small computers that can be used to control electronic devices. They can be programmed to interact with sensors, motors, and other components. Popular microcontrollers for educational use include Arduino and Micro:bit.
3D Printers	3D printers can be used to create physical objects from digital designs. They can be used to teach students about design, prototyping, and manufacturing.
Virtual Reality Headsets	Virtual reality headsets can be used to teach students about immersive computing and virtual reality development. They can be used to create and experience virtual environments.
Robotics Kits	Robotics kits can be used to teach students about robotics and automation. They typically come with motors, sensors, and controllers that can be programmed to perform a variety of tasks.
Coding Software	Coding software, such as Scratch, Python, and Java, can be used to teach students about programming and software development. They can be used to create games, animations, and interactive applications.
Interactive Whiteboards	Interactive whiteboards can be used to teach students about computer science concepts and programming languages. They can be used to display code, diagrams, and interactive simulations.
Augmented Reality Tools	Augmented reality tools can be used to teach students about augmented reality development and applications. They can be used to create and experience augmented reality environments.
Cloud Computing Services	Cloud computing services, such as Amazon Web Services and Microsoft Azure, can be used to teach students about cloud computing and web development. They can be used to create and deploy web applications and services.

Equipment	Description
Internet of Things (IoT) Kits	IoT kits can be used to teach students about IoT development and applications. They typically come with sensors, controllers, and communication devices that can be used to create IoT devices and services.
Video Editing and Production Tools	Video editing and production tools, such as Adobe Premiere and Final Cut Pro, can be used to teach students about video production and digital media. They can be used to create and edit videos for a variety of purposes.
Game Development Tools	Game development tools, such as Unity and GameMaker Studio, can be used to teach students about game development and programming. They can be used to create and publish games for a variety of platforms.
Cybersecurity Tools	Cybersecurity tools, such as antivirus software and firewalls, can be used to teach students about cybersecurity and network security. They can be used to protect computers and networks from cyber threats
Data Analysis Tools	Data analysis tools, such as Excel or other software, can be used to teach students about data analysis and statistics. They can be used to analyze and visualize data for a variety of applications.
Mobile App Development Tools	Mobile app development tools, such as Android Studio and Xcode, can be used to teach students about mobile app development and programming. They can be used to create and publish mobile apps for a variety of platforms.
AI and Machine Learning Tools	AI and machine learning tools, such as TensorFlow and PyTorch, can be used to teach students about AI and machine learning. They can be used to create and train machine learning models for a variety of applications
Cloud-based Collaboration Tools	Cloud-based collaboration tools, such as Google Docs and Microsoft Office 365, can be used to teach students about collaboration and teamwork. They can be used to work on group projects and assignments in real-time.
Digital Arts and Design Tools	Digital arts and design tools, such as Photoshop and Illustrator, can be used to teach students about graphic design and digital media. They can be used to create and edit images, graphics, and other digital media.
Web Development Tools	Web development tools, such as HTML, CSS, and JavaScript editors, can be used to teach students about web development and programming. They can be used to create and publish websites and web applications.

Specialized Smart Lab components:

Space Travel and Exploration

Equipment	Description
Learning and Training Modules on Physics	Educational materials designed to teach students about the principles and applications of physics. They may include textbooks, videos, interactive simulations, and hands-on experiments to help students learn and apply physics concepts.
Space Exploration Learning Modules	Educational materials designed to teach students about the science, technology, and history of space exploration. They may include videos, interactive simulations, and hands-on experiments to help students learn about space missions, space vehicles, and the challenges of space exploration.
Rocket Science Learning Modules	These modules may cover topics such as rocket propulsion, aerodynamics, rocket design and construction, rocket launch procedures, space mission planning, and more. They may include simulations and models of rocket launches and space missions to help students understand the complexities and challenges of space exploration.
Simulation Software	Simulation software is useful in a space travel and exploration Smart Lab to model and simulate spacecraft trajectories, planetary orbits, and other aspects of space exploration. Students could learn about physics and engineering, and how to design and optimize space missions.
Robotic Learning Modules	Modules that can be used to teach robotics and programming for space travel and exploration. They often come with a set of components and software that allow students to build and program robots, such as lunar rovers or Martian habitats.
Spacecraft Models	Spacecraft models would be useful in a space travel and exploration Smart Lab to help students understand the design and engineering principles of spacecraft. Students could learn about the different types of spacecrafts, such as rockets, satellites, and probes, and how they are built and operated.
Solar System Models	Solar system models would be useful in a space travel and exploration Smart Lab to help students understand the structure and dynamics of our solar system. Students could learn about the planets, moons, asteroids, and comets that make up our solar system, and how they interact with each other.
Data Analysis Software	Data analysis software would be useful in a space travel and exploration Smart Lab to process and analyze data collected by

Equipment	Description
	sensors and other instruments. Students could learn about data visualization and statistical analysis, and how to interpret and draw conclusions from scientific data.
Virtual Reality Headsets	Virtual reality (VR) technology can provide an immersive learning experience for students in a space travel and exploration Smart Lab. VR headsets can simulate space environments, such as the surface of Mars, or the interior of a spacecraft, allowing students to explore and interact with virtual objects and landscapes.
Multifunctional Educational Robots	Robots designed specifically for educational purposes related to space travel and exploration, such as teaching programming and robotics for building and controlling rovers, drones, or other space vehicles. These robots would come with a range of features and functionalities that allow for hands-on learning and experimentation, such as sensors and cameras to simulate space environments.
Robotics Arm	A robotics arm would be useful in a space travel and exploration Smart Lab to simulate the use of robotic arms in space missions. Students could learn about the design and operation of robotic arms, and how they are used to perform tasks such as spacecraft maintenance and scientific experiments.
3D Printers	3D printers would be useful in a space travel and exploration Smart Lab to create and test prototypes of spacecraft parts, tools, and equipment. Students could design and print their own models of Mars rovers, satellites, or space habitats, and learn about the design process and material properties required for space exploration.
Sensor Kit	A collection of sensors that can be used to collect data and perform experiments related to space travel and exploration. These sensors might include accelerometers, gyroscopes, magnetic field sensors, and radiation detectors, among others.
Environmental Sensors	Devices used to monitor and measure environmental factors such as temperature, humidity, and air quality. In the context of space travel and exploration, these sensors might be used to simulate the conditions of other planets or spacecraft habitats. They could also be used to monitor the conditions of the lab itself to ensure that experiments are conducted safely and accurately.
Telescopes	Telescopes are essential tools for observing and studying the universe. Students in a space travel and exploration Smart Lab could use telescopes to study planets, stars, and galaxies, and

Equipment	Description
	learn about astronomy and astrophysics.
Radio Telescopes	Radio telescopes would be useful in a space travel and exploration Smart Lab to study the radio emissions from planets, stars, and galaxies. Students could learn about radio astronomy and how it is used to explore the universe.
Laser Rangefinders	Laser rangefinders would be useful in a space travel and exploration Smart Lab to measure distances between objects. Students could learn about the principles of laser ranging and how it is used in space exploration to determine the distance between spacecraft and planets, moons, and asteroids.
Microscopes	Microscopes would be useful in a space travel and exploration Smart Lab to study the properties of minerals, rocks, and other materials that might be encountered during space exploration. Students could learn about geology and mineralogy, and how to identify and classify different types of rocks and minerals.
Spectrometers	Spectrometers would be useful in a space travel and exploration Smart Lab to analyze the composition of planetary surfaces, atmospheres, and other materials. Students could learn about spectroscopy and how it is used to identify different chemical elements and compounds.
Satellite Imagery	Satellite imagery would be useful in a space travel and exploration Smart Lab to study the surface features of planets and moons. Students could learn how to interpret satellite images to identify geological features such as craters, mountains, and valleys.
Navigation Systems	Navigation systems would be useful in a space travel and exploration Smart Lab to simulate the navigation systems used in spacecraft. Students could learn about the different types of navigation systems, such as GPS and inertial navigation, and how they are used to determine the position and velocity of spacecraft.
Communication Systems	Communication systems would be useful in a space travel and exploration Smart Lab to simulate the communication networks used in space exploration missions. Students could learn about the different types of communication systems, such as radio and optical communication, and how they are used to transmit data and commands between spacecraft and ground stations.
Rocket Engines	Rocket engines would be useful in a space travel and exploration Smart Lab to teach students about propulsion systems used in space exploration. Students could learn about the principles of rocket engines and how they are used to launch

Equipment	Description
	spacecraft into orbit and travel to other planets.
Gravity Simulators	Gravity simulators would be useful in a space travel and exploration Smart Lab to simulate the effects of gravity on spacecraft and other objects in space. Students could learn about the principles of gravitational attraction and how it affects the motion of planets, moons, and other celestial objects.
Astronaut Training Equipment	Astronaut training equipment would be useful in a space travel and exploration Smart Lab to simulate the physical and mental challenges of spaceflight. Students could learn about the effects of microgravity on the human body, and how astronauts train for space missions.
Power Systems	Power systems would be useful in a space travel and exploration Smart Lab to teach students about the different types of power systems used in spacecraft, such as solar panels and fuel cells. Students could learn about the principles of energy conversion and how they are used to generate electricity in space.
360-degree Cameras	360-degree cameras would be useful in a space travel and exploration Smart Lab to capture immersive footage of space environments and simulations. Students could learn about videography and how it is used to document space missions and share the experience of space exploration with the public.
Magnetic Levitation Track	A magnetic levitation track would be useful in a space travel and exploration Smart Lab to simulate the effects of zero gravity on objects in motion. Students could learn about the principles of magnetic levitation and how it is used to transport objects in space.

Specialized Smart Lab components: Industrial Design and Engineering

Equipment	Description
CAD Software	Computer-aided design (CAD) software, such as AutoCAD and SolidWorks, can be used to create 2D and 3D designs of products and engineering components.
3D Printers	3D printers can be used to create physical prototypes of product designs. They can be used to teach students about prototyping, design iterations, and manufacturing.
Laser Cutters	Laser cutters can be used to cut and engrave materials, such as wood, acrylic, and metal. They can be used to create precise and intricate designs for product prototypes and components.
CNC Machines	Computer numerical control (CNC) machines can be used to automate the manufacturing process of product components. They can be used to teach students about computer-controlled manufacturing and precision engineering.
Arduino Boards	Arduino boards can be used to control electronic components and sensors for product design and engineering applications. They can be used to teach students about electronics and automation.
Sensors and Actuators	Sensors and actuators can be used to measure and control physical parameters of products and engineering systems. They can be used to teach students about feedback control and automation.
Simulation Software	Simulation software, such as ANSYS and COMSOL Multiphysics, can be used to simulate and analyze the behavior of engineering systems and components. They can be used to teach students about engineering analysis and design optimization.
Product Development Kits	Product development kits, such as LittleBits and Makeblock, can be used to teach students about product design and engineering. They typically come with sensors, actuators, and controllers that can be used to create a variety of product prototypes.
Virtual Reality and Augmented Reality Tools	Virtual reality and augmented reality tools can be used to create and experience product designs and engineering systems in virtual environments. They can be used to teach students about immersive design and engineering.
Cloud-based Collaboration Tools	Cloud-based collaboration tools, such as Google Docs and

Equipment	Description
	Microsoft Office 365, can be used to teach students about collaboration and teamwork in product design and engineering.
Materials Testing Equipment	Materials testing equipment, such as tensile testing machines and hardness testers, can be used to measure the mechanical properties of materials used in product design and engineering.
Rapid Prototyping Tools	Rapid prototyping tools, such as mold-making machines and casting equipment, can be used to create product prototypes and small-scale production runs. They can be used to teach students about manufacturing and production processes.
Project Management Software	Project management software, such as Trello and Asana, can be used to manage product design and engineering projects.
Collaborative Design Software	Collaborative design software, such as SketchUp and Fusion 360, can be used to facilitate collaborative product design and engineering. They can be used to teach students about design collaboration and communication.
Computer Vision and Image Processing Tools	Computer vision and image processing tools, such as OpenCV and MATLAB, can be used to analyze and process images and video for product design and engineering applications.
IoT Platforms and Tools	Internet of Things (IoT) platforms and tools, such as Raspberry Pi and Arduino, can be used to connect and control smart devices for product design and engineering applications.
Design Thinking Tools	Design thinking tools, such as DesignKit and IDEO, can be used to facilitate creative problem-solving and user-centered design in product design and engineering.
Sustainability Assessment Tools	Sustainability assessment tools, such as the Life Cycle Assessment (LCA) software, can be used to assess the environmental impact of product designs and engineering systems.
Patent and Intellectual Property Tools	Patent and intellectual property tools, such as the United States Patent and Trademark Office (USPTO) website and PatentWizard software, can be used to teach students about patent law and intellectual property protection in product design and engineering.
Industry-standard Design and Engineering Software	Industry-standard design and engineering software, such as CATIA and NX, can be used to teach students about advanced design and engineering techniques and practices used in professional settings.

Specialized Smart Lab components:

Applied Mathematics

Equipment	Description
Interactive whiteboards and projectors	These can be used to display mathematical concepts in a visual and interactive way, making it easier for students to grasp difficult concepts.
Graphing calculators	These can be used to graph functions, analyze data, and solve equations, helping students to better understand mathematical concepts.
Computer algebra systems (CAS)	These software programs, such as Mathematica and MATLAB, can be used to perform complex calculations and solve mathematical problems.
Geometry software	These software programs, such as GeoGebra and Cabri Geometry, can be used to explore and visualize geometric concepts.
Data collection tools	These include tools such as sensors, probes, and data loggers, which can be used to collect and analyze data in real time.
Statistical analysis software	These software programs, such as SPSS and Minitab, can be used to analyze data and draw conclusions from it.
Computer programming software	These software programs, such as Python and R, can be used to develop and implement mathematical algorithms and models.
Electronic textbooks and e-books	These can provide interactive features such as animations, videos, and simulations to help students understand mathematical concepts.
Online resources	These include websites and online courses that provide additional information and practice problems for students to reinforce their understanding of mathematical concepts.
3D printing technology	This technology can be used to create physical models of mathematical concepts, making it easier for students to understand abstract concepts in a tangible way.
Virtual reality technology	This technology can be used to create immersive experiences that help students visualize and understand complex mathematical concepts.
Augmented reality technology	This technology can be used to overlay digital information onto real-world objects, providing interactive and engaging learning experiences.

Equipment	Description
Robotics and automation tools	These tools can be used to teach mathematical concepts related to motion, kinematics, and control theory.
Cryptography and cybersecurity software	These software programs can be used to teach mathematical concepts related to encryption, decryption, and digital security.
Applied mathematics simulation software	These software programs, such as COMSOL Multiphysics and ANSYS, can be used to simulate real-world phenomena and apply mathematical concepts to solve practical problems.

Specialized Smart Lab components:

Aerospace Engineering

Equipment	Description
Flight Simulators	Flight simulators, such as X-Plane and Microsoft Flight Simulator, can be used to simulate flying experiences and teach students about the principles of flight.
Wind Tunnels	Wind tunnels, such as the Eiffel Wind Tunnel and the Low-Speed Wind Tunnel at NASA Ames Research Center, can be used to test models of airplanes and rockets and study aerodynamics.
Remote-Controlled Aircraft	Remote-controlled aircraft, such as quadcopters and fixed-wing aircraft, can be used to teach students about flight control and stability.
3D Printing	3D printers can be used to create scale models of aircraft and spacecraft, as well as other components needed for experimentation and testing.
Computer-Aided Design (CAD) Software	CAD software, such as SolidWorks and AutoCAD, can be used to design and model aircraft and spacecraft structures and parts.
Sensors and Data Acquisition Systems	Sensors and data acquisition systems, such as accelerometers, gyroscopes, and pressure sensors, can be used to collect data during flight tests and simulations.
Robotics and Automation Components	Robotics and automation components, such as servomotors and actuators, can be used to control and automate the movement of aircraft and spacecraft parts.
Rocket Propulsion Systems	Rocket propulsion systems, such as solid and liquid rocket engines, can be used to teach students about rocket propulsion and spaceflight.
Telemetry and Communication Systems	Telemetry and communication systems, such as radios and antennas, can be used to transmit data from aircraft and spacecraft to ground stations.
Materials Testing Equipment	Materials testing equipment, such as tensile testers and fatigue testers, can be used to test the strength and durability of materials used in aircraft and spacecraft structures.
Avionics Equipment	Avionics equipment, such as GPS receivers and flight instruments, can be used to teach students about navigation and flight control systems.
Payload Development Tools	Payload development tools, such as data loggers and image sensors, can be used to design and develop payloads for use in

Equipment	Description
	aerial and space missions.
Rocket Launch Systems	Rocket launch systems, such as launch pads and launch vehicles, can be used to launch and test rockets and spacecraft.
Solar Cells and Power Systems	Solar cells and power systems can be used to power aircraft and spacecraft, and to teach students about renewable energy and power management.
Computational Fluid Dynamics (CFD) Software	CFD software, such as ANSYS Fluent and OpenFOAM, can be used to simulate and analyze fluid flow around aircraft and spacecraft structures.

Specialized Smart Lab components:
Digital Arts and Media

Equipment	Description
Graphic Design Software	Graphic design software, such as Adobe Creative Suite and CorelDRAW, can be used to create digital artwork, illustrations, and designs. They can be used to teach students about graphic design principles and techniques.
Video and Audio Editing Software	Video and audio editing software, such as Adobe Premiere and Audacity, can be used to edit and manipulate digital media. They can be used to teach students about video and audio production techniques.
3D Modeling and Animation Software	3D modeling and animation software, such as Blender and Maya, can be used to create 3D models and animations. They can be used to teach students about 3D design and animation techniques.
Virtual and Augmented Reality Tools	Virtual and augmented reality tools, such as Unity and Unreal Engine, can be used to create immersive digital experiences. They can be used to teach students about virtual and augmented reality technologies and applications.
Digital Photography Equipment	Digital photography equipment, such as DSLR cameras and tripods, can be used to capture high-quality digital images. They can be used to teach students about photography techniques and composition.
Green Screens and Chroma Keying Tools	Green screens and chroma keying tools, such as ChromaCam and OBS Studio, can be used to create special effects and composites in digital media. They can be used to teach students about digital compositing techniques.
Motion Capture Systems	Motion capture systems, such as OptiTrack and Xsens, can be used to capture human movements and transfer them to digital characters. They can be used to teach students about motion capture techniques and applications.
Digital Drawing Tablets	Digital drawing tablets, such as Wacom and Huion, can be used to create digital artwork with a pen-like stylus. They can be used to teach students about digital drawing and painting techniques.
Sound Booths and Microphones	Sound booths and microphones, such as the Blue Yeti and Audio-Technica AT2020, can be used to record high-quality audio for digital media. They can be used to teach students about audio recording techniques and voice acting.

Equipment	Description
Game Design Software	Game design software, such as GameMaker and Construct, can be used to create 2D and 3D games. They can be used to teach students about game design principles and mechanics.
Digital Storytelling Software	Digital storytelling software, such as StoryMap and Twine, can be used to create interactive narratives and multimedia stories. They can be used to teach students about storytelling techniques and digital media integration.
Digital Humanities Software	Digital humanities software, such as Omeka and Scalar, can be used to create digital exhibitions and archives. They can be used to teach students about digital humanities research and presentation.
Social Media Analytics Tools	Social media analytics tools, such as Hootsuite and Sprout Social, can be used to analyze social media trends and engagement. They can be used to teach students about social media marketing and analytics.
Website and App Development Tools	Website and app development tools, such as WordPress and Appy Pie, can be used to create websites and mobile apps. They can be used to teach students about web and app development principles and techniques.
Digital Marketing and Advertising Tools	Digital marketing and advertising tools, such as Google AdWords and Facebook Ads, can be used to create and manage online advertising campaigns. They can be used to teach students about digital marketing and advertising strategies.

Specialized Smart Lab components:

Sustainable Energy

Equipment	Description
Solar Panel Kits	Solar panel kits are a great way to teach students about renewable energy sources. They typically come with solar panels, batteries, and a charge controller, and can be used to power small devices like LED lights or small motors.
Wind Turbine Kits	Wind turbine kits are another great way to teach students about renewable energy sources. They typically come with a small wind turbine, generator, and batteries, and can be used to power small devices like LED lights or small motors.
Energy Monitoring Systems	Energy monitoring systems are used to measure energy consumption and production in a building or a specific device. They can be used to teach students about energy efficiency and how to reduce energy consumption.
Smart Thermostats	Smart thermostats are used to control the temperature in a building or a specific room. They can be programmed to turn off when no one is in the room or adjust the temperature based on occupancy or outdoor temperature. They can be used to teach students about energy efficiency and how to reduce energy consumption.
Energy-efficient Appliances	Energy-efficient appliances like refrigerators, air conditioners, and light bulbs can be used to teach students about energy efficiency and how to reduce energy consumption.
Fuel Cell Kits	Fuel cell kits are used to teach students about hydrogen fuel cells and how they can be used to generate electricity. They typically come with a small fuel cell, hydrogen storage tank, and batteries.
Microbial Fuel Cell Kits	Microbial fuel cell kits are used to teach students about microbial fuel cells and how they can be used to generate electricity from organic matter. They typically come with a small microbial fuel cell, electrodes, and a battery.
Geothermal Heating and Cooling Systems	Geothermal heating and cooling systems use the natural heat of the earth to heat and cool a building. They can be used to teach students about renewable energy sources and how they can be used to reduce energy consumption.
Hydroelectric Power Kits	Hydroelectric power kits are used to teach students about hydroelectric power and how it can be used to generate electricity from water. They typically come with a small water

Equipment	Description
	turbine, generator, and batteries.
Solar Water Heating Systems	Solar water heating systems use the heat of the sun to heat water. They can be used to teach students about renewable energy sources and how they can be used to reduce energy consumption.
Energy Storage Systems	Energy storage systems are used to store energy for later use. They can be used to teach students about renewable energy sources and how energy storage can be used to balance energy production and consumption.
Energy Efficiency Software	Energy efficiency software is used to analyze and optimize energy consumption in a building or a specific device. It can be used to teach students about energy efficiency and how to reduce energy consumption.

Specialized Smart Lab components:

Biotechnology

Equipment	Description
Polymerase Chain Reaction (PCR) Machines	PCR machines are used to amplify small quantities of DNA or RNA. They are essential components of molecular biology experiments and are widely used in biotechnology labs.
Gel Electrophoresis Systems	Gel electrophoresis systems are used to separate and analyze DNA, RNA, and proteins based on their size and charge. They are commonly used in DNA sequencing and protein analysis experiments.
Spectrophotometers	Spectrophotometers are used to measure the absorbance of light by biological molecules. They are used in a wide range of applications, including quantification of DNA, RNA, and proteins, and enzyme activity assays.
Incubators	Incubators are used to maintain a constant temperature and humidity in the lab. They are commonly used for growing cells and bacteria, as well as for performing biochemical reactions that require specific environmental conditions.
Microscopes	Microscopes are used to observe and analyze biological samples. They are used in a wide range of applications, including cell biology, microbiology, and pathology.
Centrifuges	Centrifuges are used to separate components of a biological sample based on their density. They are commonly used for isolating DNA, RNA, and proteins, as well as for separating cells and bacteria.
Liquid Handling Systems	Liquid handling systems are used to automate the process of pipetting and dispensing liquids in the lab. They are commonly used for high-throughput screening and other applications that require precise and accurate liquid handling.
High-Performance Liquid Chromatography (HPLC) Systems	HPLC systems are used to separate and analyze complex mixtures of biological molecules. They are commonly used for protein purification and analysis, as well as for drug discovery and development.
Mass Spectrometry Systems	Mass spectrometry systems are used to analyze the chemical composition of biological molecules. They are commonly used for protein identification and quantification, as well as for drug metabolism studies.
Next-Generation Sequencing	NGS machines are used to sequence DNA or RNA. They are

Equipment	Description
(NGS) Machines	commonly used for genome sequencing, transcriptome analysis, and metagenomics studies.
Automated Cell Culture Systems	Automated cell culture systems are used to grow and maintain cells in the lab. They are commonly used for drug discovery and development, as well as for producing biologics and vaccines.
Bioinformatics Software	Bioinformatics software is used to analyze and interpret biological data. It includes software for sequence analysis, genome annotation, and data visualization.
Flow Cytometers	Flow cytometers are used to analyze and sort cells based on their size and fluorescence properties. They are commonly used for immunology, cell biology, and cancer research.
Thermal Cyclers	Thermal cyclers are used for PCR and other thermal cycling applications. They are commonly used for DNA amplification, genotyping, and gene expression analysis.
Microarray Scanners	Microarray scanners are used to analyze the hybridization of DNA or RNA to a microarray chip. They are commonly used for gene expression profiling, SNP genotyping, and DNA methylation analysis.
Antibody-Based Assay Systems	Antibody-based assay systems are used to detect and quantify proteins or other biological molecules in a sample. They are commonly used for immunoassays, ELISAs, and western blotting.
Laboratory Information Management Systems (LIMS)	LIMS software is used to manage and track laboratory samples, experiments, and data. It includes software for sample tracking, data management, and reporting.

Digital Entrepreneurship Skills

Photo by Marvin Meyer on Unsplash

In today's rapidly changing digital economy, digital entrepreneurship skills are increasingly becoming a necessity for a promising career choice. Digital entrepreneurship involves creating, developing, and managing a global business or enterprise. The digital economy has transformed the way we conduct business, communicate, and interact with the world. Therefore, it is essential for students to have the necessary digital entrepreneurship skills to succeed in the future economy.

It is important to note that digital entrepreneurship is not only focused on helping students become the next entrepreneurs and business owners of tomorrow, but also to help them achieve early skills that can help them also become intrapreneurs – or the managers and executives of the large corporations of tomorrow.

With the rise of technology and digital communication, the ability to identify and capitalize on opportunities in the digital marketplace has become a crucial aspect of entrepreneurship. In light of this, it is essential to provide students with the necessary skills to navigate the digital world and become successful digital entrepreneurs.

The education curriculum needs to adapt to the challenges of tomorrow's digital economy. While some career paths may become completely replaced by AI and robots in the next decades, intrapreneurship and entrepreneurship will most likely still exist and thrive in the future digital economy.

Students need to learn new skills and knowledge that are required to become successful digital entrepreneurs. By incorporating digital entrepreneurship modules in schools and high-schools, students can acquire the necessary skills and knowledge to pursue a career in the digital economy.

Starting from the importance of digital entrepreneurship skills for students in schools and high-schools, this chapter will provide a list of potential learning modules that students can learn to acquire the skills needed to become successful digital entrepreneurs.

As students' progress through their education, it is crucial to ensure that they receive a curriculum that meets the demands of the modern world. In particular, students need to develop a range of digital entrepreneurship skills to be able to adapt and thrive in the digital economy.

Digital entrepreneurship skills are not the premise to replace the current school curricula, but merely to accompany it while focusing on new school subjects that are better suited for the career paths of the future.

Providing students with digital entrepreneurship skills is essential to prepare them for the challenges of the digital economy. By learning new and adapted skills, students can become successful digital entrepreneurs and contribute to the growth of the future digital economy. The list of potential learning modules provided in this chapter is just the beginning, and it is essential to continually evaluate and update the curriculum to meet the demands of the ever-changing digital landscape.

Digital Marketing[5]

- Fundamentals of digital marketing
- Get a business online
- Make sure customers find you online
- Promote a business with online advertising
- Expand a business to another country
- Connect with customers over mobile
- Promote a business with content
- Understand customer needs and online behaviors
- How to enhance and protect your online campaign
- Customer segmentation and prospecting
- Content, advertising, and social IMC
- Marketing in a digital world
- What is social?
- Marketing analytics
- Understanding the web
- Host a design thinking workshop
- Learn about Agile project management and SCRUM
- Use digital tools for everyday tasks
- Build your online business
- Prepare for your business plan
- Write a business plan
- Connect and collaborate anywhere with digital tools
- Create a presentation about a topic

Career development[6]

- How to design your CV
- Build confidence with self-promotion
- Land your next job
- How to increase productivity at work
- Intro to digital wellbeing
- Effective networking
- Business communication
- Communicate your ideas through storytelling and design
- Speaking in public
- Organizational design: know your organization

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[5] Source: Learn with Google, (link)
[6] Source: Learn with Google, (link)

- Strategic innovation: building and sustaining innovating organization
- Social psychology
- Conflict transformation
- Foundation of everyday leadership
- Inspiring leadership through emotional intelligence
- Preparing to manage human resources
- Model thinking
- Basics of inclusive design for online education
- Improving communication skills
- Design thinking for innovation
- Initiating and planning projects
- Instructional design foundations and applications
- Time management for professional productivity
- Design thinking for greater good: innovation in the social sector

Life skills[7]

- Internet safety
- Financial literacy
    - Budgeting and saving
    - Consumer credit
- Personal finance
    - Interest and debt
    - Investments and retirement
    - Income and benefits
    - Housing
    - Car expenses
    - Taxes
    - Paying for college
    - Keeping your information safe
- College admissions
    - Making high school count
    - Exploring college options
    - Applying to college
    - Life after college
- Careers
    - Navigate your career
    - Serve your community
    - Support health and wellness

[7] Source: Khan Academy, (link)

    - Work in tech
    - Advertise and sell
    - Start a business or go freelance
    - Educate
    - Design, create, perform
    - Conduct research
    - Manage people and processes
- Growth mindset
- Entrepreneurship

Computing[8]

- Hour of Code
- Computer programming
    - Intro to JS: Drawing & Animation: Computer programming
    - Intro to HTML/CSS: Making webpages: Computer programming
    - Intro to SQL: Querying and managing data: Computer programming
    - Advanced JS: Games & Visualizations: Computer programming
    - Advanced JS: Natural Simulations: Computer programming
    - HTML/JS: Making webpages interactive: Computer programming
    - HTML/JS: Making webpages interactive with jQuery: Computer programming
- Computers and the Internet
    - Digital information: Computers and the Internet
    - Computers: Computers and the Internet
    - The Internet: Computers and the Internet
    - Online data security: Computers and the Internet
    - Computing innovations: Computers and the Internet
- AP®/College Computer Science Principles
    - Digital information: AP®/College Computer Science Principles
    - The Internet: AP®/College Computer Science Principles
    - Programming: AP®/College Computer Science Principles
    - Algorithms: AP®/College Computer Science Principles
    - Data analysis: AP®/College Computer Science Principles
    - Simulations: AP®/College Computer Science Principles
    - Online data security: AP®/College Computer Science Principles
    - Computing innovations: AP®/College Computer Science Principles
    - Exam preparation: AP®/College Computer Science Principles
    - AP® CSP standards mappings: AP®/College Computer Science Principles
- Computer science

[8] Source: Khan Academy, (link)

    - Algorithms: Computer science
    - Cryptography: Computer science
    - Information theory: Computer science
- Pixar in a Box
    - Orientation: Pixar in a Box
    - The art of storytelling: Pixar in a Box
    - The art of lighting: Pixar in a Box
    - Simulation: Pixar in a Box
    - Color science: Pixar in a Box
    - Virtual cameras: Pixar in a Box
    - Effects: Pixar in a Box
    - Patterns: Pixar in a Box
    - Rigging: Pixar in a Box
    - Animation: Pixar in a Box
    - Environment modeling: Pixar in a Box
    - Character modeling: Pixar in a Box
    - Crowds: Pixar in a Box
    - Sets & staging: Pixar in a Box
    - Rendering

Interpersonal skills

Communication Skills

- Verbal communication
- Nonverbal communication
- Active listening
- Public speaking
- Conflict resolution
- Negotiation skills

Teamwork and Collaboration

- Group dynamics
- Collaboration strategies
- Leadership and followership
- Effective feedback
- Diversity and inclusion
- Building trust and rapport

Emotional Intelligence

- Self-awareness
- Self-regulation
- Empathy and compassion

- Social skills
- Handling stress and pressure
- Mindfulness and resilience

Problem Solving and Decision Making

- Analytical thinking
- Creative thinking
- Critical thinking
- Decision-making frameworks
- Brainstorming techniques
- Problem-solving strategies

Time Management and Goal Setting

- Prioritization
- Time allocation and scheduling
- Setting goals and objectives
- Tracking progress and milestones
- Dealing with distractions and procrastination
- Work-life balance

Networking and Professionalism

- Building professional relationships
- Business etiquette and manners
- Personal branding and reputation
- Professional communication
- Job search and interviewing skills
- Career development and planning

Popular training modules offered by business accelerators and incubators

Y Combinator

- Startup Fundamentals
- How to Start a Startup
- Growth
- Fundraising
- Legal and Accounting
- Hiring and Culture
- Sales and Marketing
- Product Development

Techstars

- Customer Acquisition
- Market Segmentation
- Financial Modeling
- Pitching and Fundraising
- Scaling
- Product and Customer Development
- Team Dynamics
- Growth Hacking

500 Startups

- Customer Acquisition
- Growth Hacking
- Sales and Marketing
- Fundraising
- Product Development
- Metrics and Analytics
- Leadership and Team Management

Seedcamp

- Product-Market Fit
- Customer Acquisition
- Sales and Marketing
- Fundraising
- Legal and Accounting
- Talent and Culture
- Scaling
- Product Development

StartX

- Product Development
- Customer Acquisition
- Fundraising
- Legal and Accounting
- Marketing and Branding
- Team Building
- Operations and Scaling

Plug and Play

- Market Research and Analysis
- Business Strategy
- Financial Planning and Modeling
- Customer Development
- Pitching and Fundraising
- Sales and Marketing
- Scaling and Operations

MassChallenge

- Customer Discovery
- Market Validation
- Business Planning
- Sales and Marketing
- Fundraising
- Legal and Accounting
- Scaling and Growth