

STEM & ESD: Innovative Teaching and Learning through IoT, Big Data & AI



A Handbook for Teachers

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Innovative Teaching and Learning
through IoT, Big Data & AI**

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Note

This Handbook is a collaboration by teachers and educators who wish to promote innovative STEM teaching & learning in secondary schools. The thematic chapters and teaching modules aim to provide recommendations and stimulate new ideas for STEM lessons that combine the concepts of Education for Sustainable Development and 21st Century Skills with the integration of IoT tools in the classroom. The views and opinions expressed in this report are the sole responsibility by the respective contributors and do not necessarily reflect the views of the Visegrad Fund, the Asia-Europe Foundation (ASEF) or any of the partner organisations involved.

Forewords



Forewords from

Czech Republic

Hungary

Poland

Slovakia

Czech Republic

Foreword

We are delighted that we could, as the Czech Republic, participate together with other V4 countries in this project, which will be completed this year. The issue of sustainable development and the role of innovative teaching and learning STEM (Science, Technology, Engineering and Mathematics) in schools when addressing local and global challenges is an important topic for the Czech Republic in the context of Environmental Education and Training (EVVO), on which the Ministry of Education, Youth and Sports (MEYS) cooperates with other ministries, especially the Ministry of the Environment. The topic is anchored into the conceptual materials of the MEYS. It is also accomplished by fulfilling tasks included in strategic and action documents in the field of sustainable development in cooperation of other ministries with the MEYS. Furthermore, it is emphasized in the Policy Statement of the Government of the Czech Republic 2022.

Primary and secondary schools in our country have long been involved in various activities and projects to support environmental education. For this purpose, they create school networks and partnerships with companies with regard to new technologies and materials. The projects are thematically focused on, for example, renewable energy sources, reducing emissions in transport, climate change associated with water scarcity, water saving and management, recycling, waste economy, waste management, for example, in practical training, etc.

The EVVO is an integral part of initial education at primary and secondary schools, including vocational schools. It is thematically included in the framework educational programmes for individual fields of education.

The goal of the EVVO and education for sustainable development is to guide students to behaviour that respects the principles of sustainable development. This means to meet the needs of current generation without compromising the needs of future generation, creating respect for living and non-living nature, protecting and improving of a natural and cultural heritage, environment and understanding of global issues. It guides students to understand the connection between various natural phenomena and human activities, between local, regional and global environmental issues; to understand the connection between environmental, economic and social aspects within the principles of sustainable development, to master the basic principles of environmentally friendly and responsible approach in personal and professional actions. The teaching aims to connect a theoretical knowledge to the practical

use and development of skills in a broader context and depending on the pursued field of education.

The EVVO, as well as education for sustainable development in a broader sense with its interdisciplinary character, create preconditions for the use of a number of tools of the teaching process management, whether of a traditional type (lesson, excursion, practical training) or an innovative type (for example project teaching, school conferences, cooperation with centres of ecological education, mutual exchange of experience between schools or other educational institutions).

Within the STEM concept, the topic of the EVVO and education for sustainable development is perceived as an integration process in relation to subjects that accomplish this concept (especially physics, natural history, chemistry, mathematics, ICT). For the Czech educational environment, this concept represents a change in the interpretation of education, which should guide to a more comprehensive approach, interconnection of individual topics and thus better preparation of pupils.

This project, called V4IoT, enabled the involved partners to participate in solving tasks focused on sustainable development – to identify, research, analyse and discuss the assignments; evaluate data and compare it with data from different parts of the world. The project also contributed to the development of pupils' digital competences and innovative teaching methods based on the exchange of experience. It may serve as an inspiration for other schools and contribute to the use of new forms and methods of teaching from a broader point of view. The created handbook is a useful document of a factual and mainly methodological nature.

The Ministry of Education, Youth and Sports would like to convey a thank you to all the involved institutions and partners of the project, including the primary school in the Czech Republic (Seč), which received an above-standard technological equipment and contributed to solving issues related to sunlight, solar energy, UV radiation, temperature changes gained over a certain period of time. The school thus gained valuable international experience during the implementation of these topics in education that can be further disseminated.

Ministry of Education, Youth and Sports
Czech Republic

Today's local and global challenges are not individual problems of particular states, and although local initiatives do count, the solution lies in shared efforts and collaborative actions.

Transdisciplinarity is used as a keyword regarding sustainability. It means that we all need to share our knowledge, exchange views and work together to shift from mere growth to a fair and viable development. Regional collaboration gives purpose to local actions, and networks provide knowledge building to support meaningful actions.

We need to educate young people to become citizens who have a comprehensive and scientific knowledge so that they are able to find their ways in the world and understand its changes when they leave school. It is important to make them aware of their own role and importance in using natural resources and transforming the environment.

In order to promote economic development and competitiveness of countries, it is essential to attract the attention of as many young people as possible to scientific and engineering professions.

The pedagogy and practice of education for sustainable development has developed organically from and in close connection with environmental education.

We consider it very important to introduce education for sustainable development at the earliest possible age and ensure continuity between different school levels, with an emphasis on the whole school approach. Throughout the whole phase of public education there is special emphasis on the topics of STEM fields and sustainability adjusted to the age and previous knowledge of the target group.

The cooperation between schools and the actors of the economy can contribute to the better utilization of the region's geopolitical and educational potential.

The expansion of the ways and means of cooperation by fostering peer learning through joint projects and campaigns offers further development opportunities for science education. It is a major goal to attract the attention of more and more young people to STEM fields. This kind of professional orientation cannot be maintained without providing pupils and

students with proper digital competences, as the development and use of products aimed at sustainability cannot be achieved without applying robotics, artificial intelligence and other IT solutions.

According to our experience educators are always keen on getting access to relevant information, new ideas and support. That is why we hope that this training and handbook will be well received.

State Secretariat for Public Education

Ministry of Human Capacities

Hungary

To develop meaningful skills among students, which will allow them to actively contribute to the future labour market, is a challenge that all education systems around the globe face. Dynamic changes in the economic, political, legal and international landscape require the most comprehensive education for its beneficiaries.

On the one hand, the education process should provide learners the possibility to flexibly react to ongoing changes; on the other hand, it should equip them with specialist knowledge in selected fields to gain in-depth expertise.

As part of the activities undertaken by the Ministry of Education and Science, we have defined five skills that, we believe, will play a key role in the future. Our attention should be focused on their development, namely: 1) independent thinking, 2) problem solving, 3) leadership, 4) cooperation, and 5) self-management.

This publication, as well as the overall activities of the V4IoT project, is fully aligned with the activities by the Polish Ministry of Education and Science: the connection between the use of the Internet of Things (IoT), Big Data and Artificial Intelligence (AI) and Sustainable Development as well as the need to innovate STEM methodology in classrooms.

Education on sustainable development is a permanent element of education in kindergartens, primary and secondary schools. The topic of climate change and environmental protection is crucial and has been included in the curriculum and activities carried out in Polish schools for over 10 years. The Ministry of Education and Science considers it as a priority and is carefully monitoring the growing role and importance of shaping the right attitudes among children and young people towards climate change and environment.

The "Laboratories of the Future" programme is the largest digitalisation project in the Polish education system. It helps schools and educators by providing and implementing content for STEM subjects, for example by engaging teachers and students in concrete activities and by developing innovative teaching tools and materials. One of the Ministry's priorities is to support teachers in their professional development and to help increase their knowledge on climate phenomena.

In the field of STEM education and education on sustainable development, we cooperate with other public institutions, amongst them the GovTech Poland Centre, the Ministry of Foreign Affairs, and the Ministry of Climate and Environment. At the national and international level, we take part in initiatives promoting the financing of innovative educational activities.

We would like to express our appreciation to the Asia-Europe Foundation (ASEF) for undertaking a very important and necessary initiative. This Handbook for Teachers contains highly relevant and interesting content that can be used as a reference and as useful indicators for teachers. We believe that the activities as outlined in the publication will inspire teachers during their work.

The Digital Transformation Team
Ministry of Education and Science
Poland

One of the most pressing challenges that humanity faces today is ensuring a just and dignified life for all, regenerating nature and enabling biodiversity to prosper. This has never been more important, and therefore requires a shift away from unsustainable practices and an awareness of the value of the environment, which our future as a species and the future of our planet depend on. This systemic change cannot be achieved through political agreements, financial incentives or technological innovations alone. Although they are important and necessary, especially in the long term, a change in education and in lifelong learning is also needed.

Competence-based education that helps students develop sustainability-related skills based on knowledge and attitudes can help promote responsible actions and stimulate a willingness to take or demand action at local, national and global levels. Becoming competent in sustainability issues will allow students not only be aware of the problems, but also to act. The European Commission is committed to the Sustainable Development Goals (SDGs), and Quality Education (SDG 4) is crucial to achieving all the goals. In line with the key role of lifelong learning, the development of sustainability competences through education and training has become a policy goal of the EU and its Member States. Sustainability is one of the European Commission's key education and training priorities for 2019-2024.

There is a broad consensus that sustainability issues need to be integrated into lifelong learning. However, sustainability is a complex concept that needs to be defined and it is very ambiguous. Sustainability means different things to different groups of people at different times. Sustainability and sustainable development are often used interchangeably, despite their conceptual differences. According to UNESCO, sustainability is best described as a long-term goal, such as achieving a more sustainable world, while sustainable development, as the word suggests, involves many processes and pathways used to stimulate development or make progress in a sustainable way. For example, the SDGs are global goals that encourage all countries and sectors to work together to ultimately achieve sustainability by addressing the challenges of sustainable development.

Being competent in the area of sustainability enables students to embody the values of sustainability and use complex systems in order to adopt or demand measures that restore and maintain the health of ecosystems and strengthen justice, thus generating visions for a sustainable future.

Sustainability education focuses on developing students' knowledge, skills and attitudes towards sustainability so that they can think, plan and act with sustainability in mind, in order to live in harmony with the planet. All types of learning – formal, non-formal and informal – are considered to be important to develop this during early childhood, through to adolescence, and subsequently adults. Sustainability as a competence applies to all spheres of life, both personal and collective.

Department of Secondary School Education
Ministry of Education, Science, Research and Sports
Slovak Republic

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Acknowledgements

This Handbook for secondary school teachers was developed and made possible with the support of many educators, students and several organisations. It is the key outcome of the school project “IoT, Big Data and AI: Strengthening Teacher Professionalisation through Innovative STEM Teaching and Learning”, in short V4IoT, a collaboration between the Asia-Europe Foundation (ASEF), five partner schools across the Visegrad region, namely Základní škola Seč in the Czech Republic, Márton Bálint Primary and Secondary School in Hungary, Copernicus Upper-Secondary School in Poland, Obchodná akadémia Rožňava and Spojena Skola in Slovakia, as well as the EdTech provider ScienceScope Ltd from the United Kingdom.

First and foremost, we are grateful to Tomasz Stróż, Principal, and Adam Stepinski, English Teacher, from Copernicus Upper-Secondary School in Poland, who led the partnership consortia over the past year and ensured its smooth collaboration. They were supported by Milan Chalupník, Teacher & Headmaster from Základní škola Seč, Dr Andrea Molnarne Laszlo, Teacher from Márton Bálint Primary and Secondary School, Jana Vidová, Teacher from Obchodná akadémia Rožňava and Pavol Trubac, Teacher from Spojena Skola.

We would like to sincerely thank all participating teachers who joined us during the project journey with their invaluable contributions and strong commitment – despite the challenges that the outbreak of the COVID-19 pandemic posed on their daily school schedules. The development of the five Teaching Modules reflects their creativity and enthusiasm to drive intraregional school collaboration and to integrate innovative practices into STEM teaching & learning. We also want to thank all students who participated directly or indirectly in the ideation process and creation of the Teaching Modules.

Our gratitude goes to Dr David Crellin, CEO and Joshua Wright, Software Engineer from ScienceScope Ltd, who introduced the V4IoT teacher participants to the world of EdTech. Thank you for providing the technical equipment & platforms for collaboration, as well as the hands-on technical trainings on how IoT devices and tools can be creatively used in the classroom.

We highly appreciated our experts on AI, IoT and Big Data, as well as on climate change & environmental protection – Professor Aleksandra

Acknowledgements

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Likewise, our appreciation goes to the Ministries of Education and ASEF's Governors of the V4 countries who supported the outreach of this project amongst their local educator communities and contributed forewords to the Handbook.

We would like to acknowledge Martin Hammerbauer, Czech Republic, Ákos Baumgartner, Hungary, Boguslaw Lubanski, Poland, and Katarína Holjenčíková, Slovakia, for supporting the production of this Handbook and translating several key chapters. We also would like to thank Heiko Seibel for the beautiful design of this publication.

Last but not least, we sincerely thank the members of ASEF's Education Department, Leonie Nagarajan, Director, Jyoti Rahaman and Angie Toh, ASEF ClassNet project coordinators, who conceptualised the V4IoT project, led it from its inception through the various implementation stages and provided guidance to the partnership consortia and participating teachers. This included the design and facilitation of teacher training sessions and the concept creation and editing of this Handbook.

A special thank you to Freya Chow-Paul for assisting with the copyediting, as well as Quentin Fayet, Miguel Pangalangan and Réka Tózsza for their team support over the past year.

Finally, we would like to express our profound gratitude to the Visegrad Fund for financing this project.



Abbreviations

Artificial Intelligence



Abbreviations and Acronyms

AI	Artificial Intelligence
ASEF	Asia-Europe Foundation
ASEM	Asia-Europe Meeting
ASEMME	ASEM Meeting of Ministers' of Education
CSCT	Curriculum, Sustainable development, Competences, Teacher training
DL	Deep Learning
ENSI	Environment and School Initiatives
ESD	Education for Sustainable Development
GAP	Global Action Programme
GCED	Global Citizenship Education
GPT	General Purpose Technology
GUPES	Global Universities Partnership on Environment and Sustainability
ICT	Information and Communication Technology
IoE	Internet of Everything
IoT	Internet of Things
ISCED	International Standard Classification of Education
ML	Machine Learning
MIT	Massachusetts Institute of Technology
NGO	Non-Governmental Organisation
NLP	Natural Language Processing
OECD	Organisation for Economic Development & Cooperation
P21	Partnership for 21st Century Skills
RCEs	Regional Centres of Expertise
RPA	Robotic Process Automation
SCANS	US Secretary of Labor's Commission on Achieving Necessary Skills
SDGs	Sustainable Development Goals
STEM	Science, Technology, Engineering & Mathematics
TVCs	Transversal Competencies
UBI	Universal Basic Income
UN	United Nations
UNDESD	UN Decade of Education for Sustainable Development
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Educational, Scientific and Cultural Organization
V4	Visegrad region
VR	Virtual Reality

Executive Summary



Executive Summary

The Handbook on 'STEM & ESD: Innovative Teaching and Learning through IoT, Big Data & AI' is the outcome of the secondary school project "IoT, Big Data and AI: Innovating STEM Teaching Through Strengthening Teacher Professionalisation", in short V4IoT. The project took place virtually from April 2021 to March 2022 and engaged about 35 teachers and their students from the four Visegrad (V4) countries – Czech Republic, Hungary, Poland and Slovakia – in a peer-to-peer learning and capacity building programme that contributed to enhancing participating teachers' pedagogical competencies.

The Handbook presents a summary of the project's key activities and learning outcomes and includes contributions by secondary school teachers, academics, and education policy makers. It serves as an inspirational tool for secondary school teachers in the V4 countries and beyond on innovative STEM teaching & learning methods in the context of Climate Change and Sustainable Development and consists of two parts: Part One sets the thematic and technical knowledge foundation which was designed by education, EdTech and thematic experts. Part Two introduces five STEM Teaching Modules that participating teachers from the V4 countries developed in partnership with the ASEF Classroom Network Team after receiving thematic and technical trainings.

Part One

Part One outlines the project's concept and provides an overview of the Thematic and Technical Training Sessions as well as Peer-to-Peer Sessions that were part of the programme.

The Thematic Training Sessions focused on Education for Sustainable Development (ESD), with an emphasis on environmental and climate change education, as well as the 21st Century Skills. They underlined the importance of interdisciplinary approaches when addressing opportunities and challenges towards sustainable development. Through this, the participants learnt about the relevance of the two concepts of ESD and 21st Century Skills for innovating STEM teaching to foster positive climate action.

The Technical Training Sessions provided an overview on the basics of IoT, Big Data and AI. Experts shared current trends and discussed potential applications of IoT, Big Data and AI and their impact on daily

Executive Summary

life, in the education section and society at large. Teachers also received hands-on trainings on how to use and integrate IoT equipment in classrooms for climate change education.

The individual chapters in Part One summarise the key content of these topics. The authors are Leonie Nagarajan & Jyoti Rahaman from ASEF's Education Department as well as Professor Aleksandra Przeglasińska from Kozminski University in Poland.

Part Two

Part Two introduces the five V4IoT STEM Teaching Modules that participating teachers from the V4 countries developed over the course of the project in partnership with the ASEF Classroom Network team. The teachers worked in small groups and designed the Teaching Modules based on the knowledge gained from the Thematic and Technical Training Sessions as well as data collected through environmental monitoring. Each V4IoT STEM Teaching Module is presented in one chapter. Illustrations, data charts, graphics, and simple info tables explain the Teaching Module step by step and highlight its learning objectives within the following five areas: 1. Climate Change, 2. Environmental Monitoring, 3. The 21st Century Skills, 4. Global Citizenship Education, and 5. Sustainable Development Goals (SDGs). The Teaching Module chapters also include a section on tips & tricks and recommend digital tools. By including testimonies of teachers and students, the Handbook emphasises the importance of peer-to-peer learning and sharing of good teaching & learning practices in secondary schools. The Teaching Modules deliberately refer to local case studies and scenarios from the V4 countries. However, these examples can be easily adopted and transferred to other regions and the global context.

V4IoT Teaching Module 1: Wind

The first V4IoT Teaching Module on Wind tackles the weather phenomena of wind, its impact on air quality and how wind can be used as an alternative source of energy. The Module guides students to collect data linked to different wind properties, including wind speed, strength, and direction as well as its relation to atmospheric pressure, and explores the impact of wind on other weather phenomena, people's environment, and health. To connect the topic with their local environment, students have to explore wind conditions in different

geographic locations in the Visegrad region and assess the feasibility of setting up a wind park in their region. They also have to predict areas of risk for air pollution in their city depending on seasonal winds. The Module was developed by Adam Stepinski, Copernicus Upper-Secondary School in Tarnobrzeg in Poland, Adrienn Kortvelyesi and Dr Heider Naszer, Bugat Pal Secondary Technical School in Hungary and Mark Daniels, Besst Gymnazium in Slovakia.

V4IoT Teaching Module 2: Rain

The second V4IoT Teaching Module on Rain casts the light on climate change and how it affects the intensity and frequency of precipitation. Teachers and students examine the importance of rain for the environment and human life and discuss examples of extreme weather and precipitation conditions, either heavy rainfall events or droughts. Students also learn about water as a scarce natural resource and how to use water economically and more responsibly in school, at home and in other areas of life. The Module takes an interdisciplinary approach, with the STEM lesson being conducted in the form of a role play and the set-up of a court trial. Students switch into the roles of the accused, the prosecutor, defense attorneys, witnesses and the judge on a legal case that focuses on "man-made violations and crimes" against water: water pollution, water wastage and changes in the water cycle. The Module was developed by Agnieszka Kowal, Magdalena Kosacka and Tamara Sz wajca from the secondary school Zespół Szkół Informatycznych in Kielce, Poland.

V4IoT Teaching Module 3: Temperature

The third V4IoT Teaching Module on Temperature explores the influence of rising temperatures on human health. Students observe and analyse how high and low air temperatures have different impacts on the human body and well-being and learn about potential life-threatening conditions caused by extreme heat or cold. Lesson elements also examine how temperature affects the movement of air and how this affects air pollution. As a key exercise, students are assigned to collect data and conduct research to develop evidence-based policies and actions. The goal: Keep their local communities informed, healthy and safe! The Module is a collaboration between Agnieszka Jadwiszczak, Ewa Rębowska, Alicja Łaska, Joanna Kamock and Jowita Królikowska from the Comprehensive Secondary School in Sieradz (I Liceum

Executive Summary

Ogólnokształcące im. Kazimierza Jagiellończyka w Sieradzu) in Poland and Jana Vidová and Roman Jakobej from the Business Academy Rožňava (Obchodná akadémia v Rožňave) in Slovakia.

V4IoT Teaching Module 4: Solar Radiation

The fourth V4IoT Teaching Module on Solar Radiation tackles the importance of solar radiation for life on earth and examines the different forms and types of solar radiation. In particular, the Module focuses on the advantages and disadvantages of solar power to generate electricity. Students work on the challenge to make their school a pioneer in green energy. They evaluate the option of setting up solar panels on campus and analyse whether or not their schools can entirely rely on renewable solar energy for daily operations. At the end, they have to create a proposal to their school leadership & management. The Module was developed by Aneta Bednarek and Marcin Bernaś from the Liceum Akademickie Da Vinci in Poznań in Poland, Milan Chalupník from Základní Škola Seč in the Czech Republic and Sándor Ujvári from the Láncoz Kornél Gimnázium in Hungary.

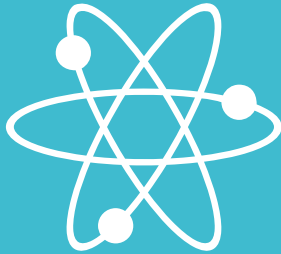
V4IoT Teaching Module 5: Barometric Pressure

The fifth V4IoT Teaching Module on Barometric Pressure tackles elements of various types of weather conditions and examines how atmospheric pressure has an influence on temperature, rainfall and wind. By tracking and reading the barometric pressure using the IoT device, students will learn about atmospheric pressure variations and how to forecast short-term weather changes. They also get insights into the impact of barometric pressure on our health & breathing, daily life activities and even scientific experiments. The Module introduces students to the diverse job scope of a meteorologist and invites them to join a competency race to test their real-world readiness. Who has the knowledge & skills to become the school's meteorologist? This Module was developed by Pavol Trubač from the Spojena Skola, Peter Trubač from SOS Bernolákovo, and Peter Korman from Gymnázium Mikulasa Kovaca, Slovakia, and Gabriella Iles and Patricia Nánási from Szent Piroska Greek Catholic Primary School, Hungary.

More resources on the V4IoT project can be found on the [project's website](#).

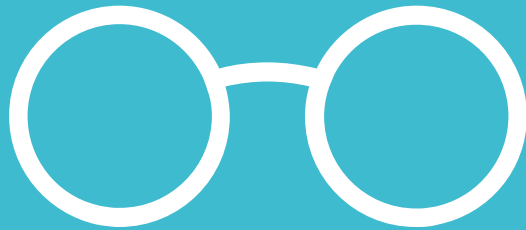


1 Part One: Background



- 1.1 Introduction**
- 1.2 The V4IoT Project:
Teacher Professionalisation for
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1.1 Introduction



1.1 Introduction

Our societies are facing a digital revolution where technology such as the Internet of Things (IoT), Big Data and Artificial Intelligence (AI) provide solutions that tackle global challenges, including climate change, food security and pandemic outbreaks (Yoon, 2020). Although STEM (Science, Technology, Engineering & Mathematics) skills are in high demand in the workforce and are essential for driving innovation, preparing innovative STEM professionals remains a challenge (European Commission, 2015). Teaching and learning STEM embedded in real-life scenarios must therefore start at an early education level to stimulate students' curiosity in the subjects, guide to possible future professional career paths, and highlight the role of science for societal progress.

Teacher training and teacher professionalisation are indispensable in this process: only by providing quality education and by using a variety of formal and non-formal innovative education tools, will teachers be able to provide students with relevant opportunities to build 21st Century Skills and digital competences, and to meaningfully apply their gained knowledge in daily life and in a larger real-world context.

The project “IoT, Big Data and AI: Innovating STEM Teaching Through Strengthening Teacher Professionalisation”, in short V4IoT, focused on building teachers' pedagogical capacity and digital competence in the four Visegrad countries, Czech Republic, Hungary, Poland and Slovakia. The project took place virtually between April 2021 to March 2022. Schools of participating teachers were provided with cutting-edge technological equipment that allowed them to monitor and analyse climate change and weather patterns through joint data collection, such as wind speed, air temperature, rain rate, humidity, solar and UV radiation, etc. A common technical platform connected all schools and enabled an interactive teaching & learning environment that transcended borders and allowed teachers and students to discuss, jointly explore and identify areas for collaboration.

About 35 secondary school teachers and their students participated in this collaborative online programme, which included thematic trainings on Education for Sustainable Development (ESD), 21st Century Skills, and Climate Change as well as technical trainings on how IoT, Big Data, and AI can be embedded in a teaching & learning context. To share their knowledge and encourage peer-to-peer exchange, the teachers worked in small groups and developed STEM Teaching Modules that combine five learning objectives:

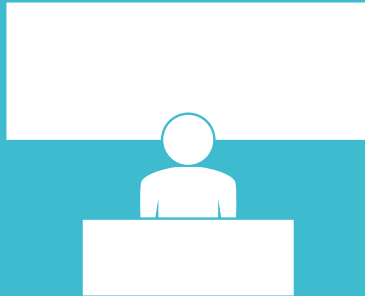
1. Gain deeper insights into the causes and impact of climate change, in particular specific weather patterns and how they affect daily life in the V4 countries and beyond
2. Understand the importance of environmental monitoring for scientific purposes, and examples on how IoT, Big Data and AI can be used to monitor ecosystems, even in a school setting
3. Strengthen the 21st Century Skills in areas such as information literacy, digital literacy, creativity, team work and critical thinking
4. Build a sense of Global Citizenship through intercultural collaboration and interactive teaching and learning opportunities that transcend borders
5. Appreciate the various efforts made by governments and civil society towards the UN Agenda 2030 and become an advocate for the Sustainable Development Goals (SDGs)

The project concluded with the production of this Handbook, which compiles the lessons learnt from the various Training Sessions and the five STEM Teaching Modules created by the teachers. The Handbook aims to inspire those interested and working in secondary education in the V4 countries and across the region, with innovative STEM teaching & learning methods. This Introduction, the Forewords and the Executive Summary have been translated into Czech, Hungarian, Polish, and Slovak. The other chapters in this Handbook are available in English only.

The V4IoT project was coordinated by the Copernicus Upper-Secondary School in Tarnobrzeg, Poland, and the Asia-Europe Foundation (ASEF) in Singapore in partnership with the Základní Škola Seč in the Czech Republic; Márton Bálint Primary and Secondary School in Hungary; Obchodná akadémia Rožňava and Spojena Škola in Slovakia and the EdTech supporter ScienceScope Ltd in the United Kingdom. It was co-financed by the Governments of Czechia, Hungary, Poland, and Slovakia through Visegrad Grants from the International Visegrad Fund. The mission of the fund is to advance ideas for sustainable regional cooperation in Central Europe.



1.2 The V4IoT Project



1.2 Teacher Professionalisation for Innovating STEM Teaching

The project “IoT, Big Data and AI: Innovating STEM Teaching Through Strengthening Teacher Professionalisation”, in short V4IoT, took place virtually between April 2021 to March 2022 and engaged over 100 teachers and students from the four Visegrad countries Czech Republic, Hungary, Poland and Slovakia.

This chapter presents the project’s genesis and objectives and illustrates in detail the activities carried out as part of the nearly one year-long collaboration that led to the creation of this Handbook.

Origin of the Project

The idea of the V4IoT project was born in mid-2020, when the COVID-19 pandemic led to an unprecedented education crisis worldwide: schools in over 188 countries were forced to close, heavily disrupting the learning process of more than 1.7 billion children (UNESCO, 2020). The crisis revealed the digital unpreparedness of the education sector at large and stressed the necessity of training digital competencies of educators and teachers in particular. It also highlighted the importance of multi-sector cooperation and innovation to tackle this unparalleled health, education and human crisis and find solutions – medical, social and economic – to mitigate the negative impact on societies.

Poland took over the annual Presidency of the Visegrad Group (V4) in July 2020. As outlined in its Programme, the pandemic and the process of overcoming its consequences had a significant impact on the course of the Polish presidency. V4 countries “[...] actively cooperate[d] in tackling the effects of the coronavirus pandemic and work[ed] together to bring socio-economic life in the region and the EU back on track”.¹ One of the priorities set by the Polish Presidency was the digital transformation of societies and building digital competencies to prepare for changing labour market needs. In the field of education, this included the creation of activities that would increase people to people connections and networks, enhance learning mobility and facilitate cross-border initiatives within and beyond Visegrad countries.

¹ To learn more about the priorities and programme of the Polish Presidency of the Visegrad Group (V4) 1 July 2020 – 30 June 2021 “Back on track”, do refer to this website and document <https://www.gov.pl/web/v4presidency/priorities-of-polish-presidency#:~:text=Poland%20takes%20over%20the%20annual,societies%20to%20a%20severe%20test.>; and <https://www.gov.pl/attachment/6fbcecec-34a3-4e70-a58b-d0ce194458a9>, as of 1 December 2021

1.2 Teacher Professionalisation for Innovating STEM Teaching

At the same time, several schools from V4 countries that participated in the 15th ASEF ClassNet Conference (ASEFClassNet15) on 'Education for Sustainable Development (ESD) and Artificial Intelligence (AI): The Role and Readiness of Teachers'² in 2019 in Tokyo, Japan, discussed the possibility of spin-off collaborations to follow up on the outcomes of the meeting. Against the background of the ongoing education crisis, the Tokyo conference offered important points of leverage to develop a future project which could provide meaningful training opportunities for secondary school teachers in the Visegrad region. Relevant questions from the conference that could be further tackled were:

1. What roles do teachers play in transforming teaching and learning practices for ESD in the AI era?
2. What level of knowledge on ESD and AI do teachers need to develop appropriate pedagogies?
3. What kind of capacity building and partnership support do teachers need to integrate ESD meaningfully in the school curriculum and to enhance their readiness for the AI era?

Led by Copernicus Upper-Secondary School in Tarnobrzeg, Poland, five V4 secondary schools then formed a partnership consortium and applied to the Visegrad Fund to support the implementation of the project "IoT, Big Data and AI: Innovating STEM Teaching Through Strengthening Teacher Professionalisation". The schools proposed to engage the Asia-Europe Foundation (ASEF) in Singapore with its ASEF Classroom Network (ASEFClassNet) team as project management partner and thematic expert, as well as the EdTech provider ScienceScope Ltd in the UK as technical expert. The Visegrad International Secretariat approved the application from the five partner schools in December 2020, and the project kicked off in April 2021.

Objectives

To adapt to the challenges of classroom teaching in the virtual medium and to prepare for future teaching & learning with technology, the

project partners identified that teachers require more capacity building opportunities to enhance their pedagogical & digital competences. Teachers must learn about and practice latest educational methodologies and be exposed to new technologies to be able to continue deliver high-quality education.

The project partners agreed that the integration of technology in classrooms should however not be considered as the end goal, but as a means to contribute to innovation in education and to enhance the role of education in driving sustainable development. Likewise, the project should not offer capacity building opportunities for STEM teachers only, being traditionally more familiar with the usage and application of technology given the nature of their subjects. The project's activities should allow for cross-fertilisation across other subjects, e.g., the Humanities such as English or Social Sciences, and foster peer-to-peer exchanges among all teachers to enable an interactive and interdisciplinary teaching & learning environment and to set the foundation for a "learning partnership" with their students. With the above points in mind, the project partners defined five project objectives:

1. Build teachers pedagogical expertise & digital competence in areas that shape current technological trends, namely the Internet of Things (IoT), Big Data and Artificial, and Intelligence (AI)

2. Explore and create 21st century teaching & learning settings in classrooms through the development of Teaching Modules that could be used for daily curricula & extracurricular activities

3. Train students in innovation & entrepreneurial skills, as well as soft & intercultural skills such as global citizenship, critical thinking & creativity, aligned with the learning objectives of Education for Sustainable Development (ESD)

4. Contribute to Environmental Education and create awareness and commitment towards the Sustainable Development Goals (SDGs), in particular SDG 13 on Climate Action

5. Foster the collaboration among teachers in V4 countries through peer-to-peer exchanges and empower them as "Edupreneurs" & "DesignThinkers"

² Website of the 15th ASEF Classroom Network Conference (ASEFClassNet15) on <https://www.classnet.asef.org/meetings/asef-classroom-network-conference/>. The Conference took place from 25-29 November 2019 in Tokyo, Japan and was co-organised by the Asia-Europe Foundation (ASEF), Sophia University in Tokyo, the Ministry of Foreign Affairs of Japan, the Ministry of Education, Culture, Sports, Science and Technology – Japan and the United Nations University Institute for the Advanced Study of Sustainability (UNU-IAS)

1.2 Teacher Professionalisation for Innovating STEM Teaching

Concept

The V4IoT project consisted of a variety of activity formats that encouraged formal, non-formal and informal education opportunities and included diverse education methodologies and tools. Instead of a rigid training programme, a strong emphasis was placed on peer-to-peer learning as an important element in education. To share ideas and innovative and interdisciplinary education practices, collaborative platforms were set up to allow teachers to bring in their different subject expertise and skills sets. This approach reflected academic research that highlights that peer learning should be mutually beneficial and promote the sharing of knowledge, ideas, and experience to make the learning move beyond independent to interdependent (Boud, 2001). Furthermore, to become a better educator for Education for Sustainable Development (ESD), teachers need to be in an interactive environment (Sleurs (Ed.), 2008).

In April 2021 the team put out an Open Call for Participation among secondary school teachers from the Visegrad region. 35 teachers from all V4 countries, ranging from STEM to English and Art subjects, were selected to join. The overall project duration lasted until March 2022, with an intensive Teacher Professionalisation Training phase taking place from mid-September to mid-December 2021.

As the basis for the training, each school was equipped with an IoT device, a “weather station”, which was set up in a suitable location on the school's campus. This weather station, developed by the EdTech provider ScienceScope Ltd, captured environmental data, including temperature, relative humidity, barometric pressure, rain rate and total, solar radiation, UV index, wind speed and wind direction. The environmental data generated by the weather stations of all participating schools was then compiled by a virtual platform, the IoT Exploratory”. Both teachers and students were granted access to the IoT Exploratory, to explore and discuss the different results of the environment data, and based on the data, to jointly create and conduct in small working groups activities that would lead to the development of 5 Teaching Modules on Wind, Rain, Temperature, Solar Radiation and Barometric Pressure.

To provide a knowledge foundation as well as technical know-how to the teachers during the process of the Teaching Module development, the project partners engaged different expert organisations and individuals to

conduct Thematic Training sessions on ESD, the 21st Century Skills and climate change as well as Technical Training sessions on IoT, Big Data & AI and the usage of the IoT device.

Key concepts and lessons learnt from the Thematic and Technical Trainings as well as the 5 Teaching Modules are presented in this Handbook, which shall serve as a useful reference for all interested teachers to implement similar activities and support them to innovate their teaching environments.

Programme Description

The V4IoT programme consisted of four activities:

- Activity 1:** Thematic & Technical Trainings to develop Teaching Modules on STEM & ESD
- Activity 2:** Peer-to-Peer Exchange and Knowledge Building Sessions
- Activity 3:** Set up of a dedicated e-Learning platform for participants for in-depth study as well as a public webpage for the larger educator community
- Activity 4:** Production of a Handbook for Teachers on “STEM & ESD: Innovating Teaching and Learning through IoT, Big Data and AI”

A detailed timeline of the activities can be found in the Annex section.

Overview of Thematic Training Sessions

In total, three Thematic Training Sessions were conducted. They focused on Education for Sustainable Development, with an emphasis on environmental and climate change education, as well as the 21st Century Skills development:

The first Session, Understanding Education for Sustainable Development (ESD), explained the origins and framework of ESD and identified its relevant concepts and initiatives. It also highlighted the importance of ESD within the larger context of the UN Agenda 2030 and the Sustainable Development Goals (SDGs), and its implications on education, especially at the secondary level. Team exercises were suggested to deepen the understanding and explore possibilities and challenges of implementing ESD in classrooms/schools. The second Session, Implications of Climate Change, Global Warming, and the Role of STEM, illustrated key trends

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Figure 1: Programme elements of the V4IoT project

that currently dominate the debates on Global Warming and Climate Change. It focused on the role of STEM subjects in raising awareness on environmental issues and in creating a solid knowledge base and trust among secondary students in science. The third and last Thematic Session, Building the Connection: STEM, ESD and the 21st Century Skills, clarified the connection between these three areas and underlined the importance of interdisciplinary approaches when addressing opportunities and challenges towards sustainable development.

The Thematic Sessions were delivered by Leonie Nagarajan, Director, and Jyoti Rahaman, Project Executive, from the Education Department at the Asia-Europe Foundation (ASEF), and Grazyna Pulawska, Associate Director, from ASEF's Department of Sustainable Development & Public Health. Chapter 1.3 on 'Thematic Introduction: ESD and the 21st Century Skills for Climate Action: Igniting STEM Teaching' presents key concepts and relevant information on the topics that were presented and discussed during these three Thematic Sessions. The list of resources and recommendations of reading materials on these topics can be found in the Annex section on page 215.

Overview of Technical Training Sessions

Complementing the Thematic Sessions, five Technical Training Sessions were conducted. As the integration of IoT and AI technologies is still a relatively new concept in education, the first two Technical Training Sessions focused on the basics of IoT, Big Data and AI, their current and potential applications and impact on daily life and society at large. Teachers and students also learnt about IoT and AI in the context of today's

job market and future trends. These sessions were delivered by Professor Aleksandra Przeglasińska, Vice-Rector, Kozminski University, Poland and Senior Research Associate at the Harvard Labour and Work Program.

The other three Technical Sessions were hands-on technical trainings for Teachers facilitated by representatives from the EdTech Company ScienceScope Ltd based in the United Kingdom. As outlined earlier, prior to the start of the project, each school received an IoT device set to monitor environmental changes, including a basic weather station which was set up on the school's roof. Data was collected in the cloud with ScienceScope's IoT Exploratory Platform (<https://exploratory.sciencescope.uk/>) and participating teachers and students could then analyse, visualise, and compare the results with other schools. Dr David Crellin, CEO & Founder, and Mr Joshua Wright, Software Engineer from ScienceScope introduced the teachers to all technical aspects of the IoT device – hardware and software options – as well as ScienceScope's IoT Exploratory platform and trained them to monitor climate change and weather patterns. Teachers could then actively refer to and incorporate received data from the IoT device into their STEM lessons. These hands-on Technical Trainings enhanced the participating teachers' digital competences in implementing IoT and AI-driven projects' activities.

Chapters 1.4.1 and 1.4.2 on 'Technical Introduction: What is IoT, Big Data and AI?' and 'Practical Example of the Integration of IoT, Big Data and AI Tools in Education' give an overview of the technology background and describe how the IoT Exploratory platform and the IoT device were used for this project. The list of resources and recommendations of reading materials on these topics can be found in the Annex section on page 215.

Overview of Peer-to-Peer Exchange and Knowledge Building Sessions

Lastly, two Peer-to-Peer Exchange and Knowledge Sessions were designed to encourage knowledge sharing, group discussions and exchanges on lessons learnt from the thematic and technical sessions. These sessions were an opportunity for informal group learning and team bonding and included several interactive programme elements, education tools and games. Furthermore, individual and team assignments were given to the teachers and their students for further exploration and to deepen their understanding and confidence in the thematic and technical scope of the project. During the Peer-to-Peer and Knowledge Building

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sessions, the five working groups also presented the progress and final results of their Teaching Modules to the whole group for discussion and feedback. The Teaching Modules were then further enriched with the input from the whole group and finalised by the ASEF Classroom Network team.

The sessions were conducted by Leonie Nagarajan, Director, Angie Toh, Senior Project Manager, and Jyoti Rahaman, Project Executive, from ASEF's Education Department.

Virtual Platforms for Collaboration and Documentation

The project partners used three different virtual platforms to document the project and to facilitate collaboration. The functions of these platforms complemented each other.

1. V4IoT Microsite

The V4IoT microsite, embedded on ASEF Classroom Network Website, included information on the project's objectives, partner organisations, programme, participants and resources for public reference.

Link to Public Website

<https://www.classnet.asef.org/asef-classnet-collaborations/iot-big-data-and-ai-innovating-stem-teaching-through-strengthening-teacher-professionalisation/>

2. V4IoT e-Learning Platform

A closed door e-Learning platform was developed for participants to facilitate their online collaboration. This e-Learning platform included recordings of all sessions, additional teaching & learning resources and allows participants to stay connected with each other.

Link to e-Learning Platform (accessible to participants only)

<https://elearning.asef.org/>

3. IoT Exploratory Platform

The IoT Exploratory was maintained by the EdTech provide ScienceScope Ltd and virtually connected the V4 schools with each other by tracking the data from the weather stations that were installed on each of the schools' campuses.

Link to IoT Exploratory Platform (access partially restricted for participants only) <https://www.exploratory.sciencescope.uk/>

Teacher Handbook 'STEM and ESD: Innovating Teaching and Learning through IoT, Big Data and AI'

The V4IoT project concluded with the production of this Handbook as a joint collaboration between all project partners and participating teachers. Capturing their experiences throughout the project the Handbook includes concrete lessons learnt and guidelines on pedagogical, curriculum & technical related matters based on practical examples.

1.3 Thematic Introduction



1.3 ESD and the 21st Century Skills for Climate Action: Igniting STEM Teaching

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Introduction

Recent research on the connection between education and climate change suggests that there could be around 19 gigaton reduction of carbon dioxide by 2050 if sixteen percent of high school students across the world learn about climate change (Cordero et al., 2020). This shows how powerful education can be to enthuse pro-environmental practices among young generations. Having said that, learning about climate change alone is not enough to stimulate stronger climate actions. Learners need to develop timely relevant technical, theoretical, and soft skills that are crucial for finding clean and innovative solutions to tackle the contemporary challenges arising due to climate change (Masterson, 2021). Delivering such an education that not only has the power to stimulate behavioural change but also to equip learners with relevant green skills, requires education institutions to design rigorously thoughtful and timely relevant education programmes and courses. To design such courses teachers themselves need to have the awareness, knowledge, and pedagogical competencies.

During our interactions with the teachers at the beginning of the V4IoT project, we gathered that most of the teacher participants were aware of climate change and its major challenges. However, they did not have a good understanding of ESD and the 21st Century Skills and how integrating them in their teaching practices could make learning climate change more real world driven for their students. Therefore, in addition to providing relevant technical trainings on the IoT, Big Data and AI, we also trained the participants about ESD learning objectives and the 21st Century Skills before they embarked on creating the V4IoT Teaching Modules with their students.

In this chapter we present necessary information on topics that we covered during the thematic training period of the V4IoT project. We first present sufficient information on Education for Sustainable Development (ESD) and briefly introduce the 21st Century Skills that we believe the teachers' community must be aware of. Then we provide an explanation of how integrating ESD and teaching the 21st Century Skills can enhance

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STEM learning that is important to equip learners with green skills to tackle current and future climate challenges. Finally, we conclude by highlighting the significance of transforming STEM teaching and learning at the secondary education level in a way that is technology-supported, interdisciplinary, collaborative, and real-world challenge driven.

Education for Sustainable Development (ESD)

What is ESD? – Definition, Origin, Development and Trends Definition

There is no universally fixed definition of Education for Sustainable Development (ESD). Initiated by the United Nations (UN), ESD is a learning process that encourages changes in knowledge, skills, values, and attitudes on pressing global challenges that concern sustainability, such as climate change and global warming, environmental degradation, or demographic changes (UNESCO, 2017). According to UNESCO, the lead UN agency for carrying out ESD related initiatives, ESD envisions:

“a world where everyone has the opportunity to benefit from quality education and learn the values, behaviour and lifestyles required for a sustainable future and for positive societal transformation. ESD is a process of learning to make decisions that consider the long-term futures of the economy, ecology, and the equitable development of all communities.” (UNESCO, 2018a, p. 81)

This vision establishes that the learning process of ESD needs to be interdisciplinary and real-world driven that integrates ongoing social, economic, and environmental attributes (UNESCO, 2018b).

Origin and Development

The concept of ESD was born when policy makers and global leaders identified the need to address sustainable development challenges through education (UNESCO, 2018b). Therefore, before understanding the origin and concept of ESD, we need to first reflect on understanding sustainable development briefly. Like ESD there is no universal definition for ‘Sustainable Development’. It has a three-pillar conception, which are social, economic, and environmental sustainability. The emergence of this 3-dimensional idea of ‘Sustainable Development’ can be dated back

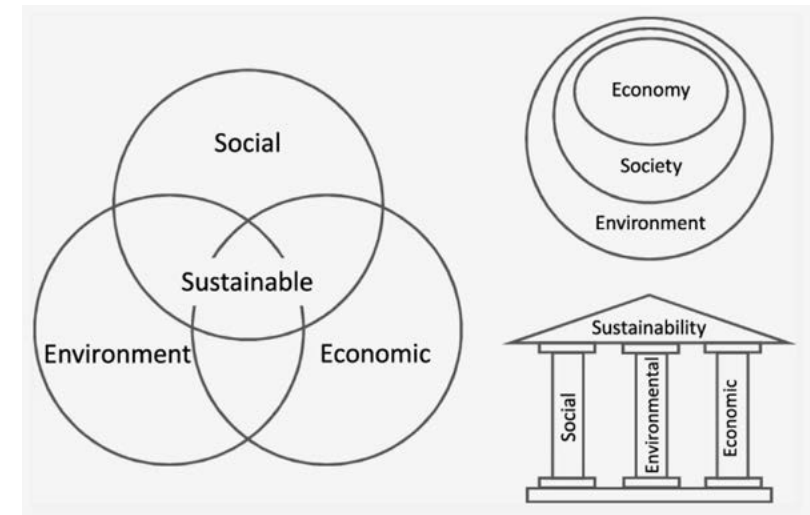


Figure 2: The three dimensions of sustainability (Purbis et al., 2018, p. 682)

to the 1970s when scholars started discussing the risks and challenges humankind will face if non-renewable resources run out (UNESCO 1972; Purbis et al., 2018).

Then during the late 1980s discussions on informing people about sustainable development became a major concern among various high-level stakeholders (Brundtland, 1987; UNESCO, 1996; UNESCO, 2018b). As a result, they tried to find ways to advocate for sustainable development and educate citizens about the significance of leading lives by embracing sustainable practices. During these discussions the concept of using education as a means to raise awareness about sustainability became more prominent.

The first international document to officially recognise education as an essential means for addressing sustainable development challenges is the UN Agenda 21 (UNCED, 1992; UNESCO, 2018c). The document highlighted areas of action for education where ESD was part of an indicator for SDG 12, ‘Responsible Consumption and Production’ (UNESCO, 2018c). The SDG 12 target 8 ‘Understanding of Sustainable Lifestyles’ states to “ensure that people everywhere have the relevant information and awareness for

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sustainable development and lifestyles in harmony with nature by 2030” (UNESCO, 2017). The first indicator of this target, 12.8.1, states the “extent to which (i) global citizenship education and (ii) education for sustainable development (including climate change education) are mainstreamed” (SDG Tracker). Ever since ESD has become instrumental in education policy discussions to prepare the future generations with knowledge and awareness necessary for having both an attitude and will towards sustainable living.

The development of ESD started with a strong focus on educating and informing people about sustainable development. Scholars and education experts have recently observed that such approach could limit the full potential of ESD. They believe that while the sustainability angle is a crucial part of ESD, educators must incorporate it into their teaching in a way that can address a wide variety of subjects and topics through the sustainable development lens (UNESCO, 2018b).

Key Trends on ESD: Past and Present at a Glance UNDESD

UNESCO is the lead UN agency for driving ESD. It has a key role to advance ESD in formal, non-formal and informal education. One of UNESCO’s leading efforts on actualising ESD in mainstream education is the ‘UN Decade of Education for Sustainable Development (UNDESD)’, carried out between 2005 to 2014 (UNESCO, 2005a). The UNDESD established the unique relationship between quality education and ESD strongly for the first time in 2005 (UNESCO, 2005a). UNESCO highlighted that building the capacity for a future-oriented sustainable planet is a key task of education (UNESCO, 2020), and ESD in this context is considered an integral part of SDG 4 (Quality Education) and the key enabler of advocating for and advancing all of the SDGs (UNESCO, 2018). Through the creation of various meaningful platforms such as the ‘Regional Centres of Expertise (RCEs)’ network and ‘Global Universities Partnership on Environment and Sustainability’ (GUPES), UNDESD increased awareness that contributed to fostering transformation of education in countries around the world. All in all, over the last two decades ESD has gained significant attention due to the various activities of UNDESD. It not only paved the road for actively spearheading the principles, values, and practices of sustainable development across the world but also informed decision makers about

new scopes for accelerating efforts to implement ESD at all education levels.

Global Action Programme (GAP)

Building on the achievements of UNDESD and to further advance ESD, UNESCO launched the Global Action Programme (GAP) in 2014 during the UNESCO World Conference on ESD and implemented it between 2015 to 2019 (UNESCO, 2020). GAP identified five priority action areas: 1. advancing policy 2. transforming training & learning environments 3. building capacities of educators and trainers 4. empowering and mobilising youth and 5. accelerating sustainable solutions at a local level. Over the last few years various activities on these 5-priority action areas advanced ESD strategically by preparing education systems and driving key stakeholders across the world (UNESCO 2014a; UNESCO 2014b).

ESD Roadmap 2030

Reflecting on lessons learnt from GAP, the ESD Roadmap 2030, a global framework for ESD, was approved during UNESCO’s 40th General Conference and acknowledged by the UN General Assembly during its 74th Session in 2019 (UNESCO, 2020). UNESCO officially introduced a detailed plan in May 2020 during the Virtual UNESCO World Conference on ESD. According to UNESCO, the objective of the ESD Roadmap 2030 is “to fully integrate ESD and the 17 SDGs into policies, learning environments, capacity-building of educators, the empowerment and mobilization of young people, and local level action” (UNESCO, 2020, p.14).

Learning Domain of ESD and Key Competences of Sustainability

Significant changes in curriculum at all levels of education are often related to the fundamental societal and global challenges (OECD, 2018a). Therefore, at the curriculum level, introducing specific learning goals on ESD at all education levels is strongly recommended by several international organisations, such as UNESCO and UNECE (Sleurs (Ed.), 2008). As part of preparing education systems and educators to integrate and measure ESD learning progress, UNESCO introduced three domains of learning – cognitive, socio-emotional, and behavioural (UNESCO, 2017).

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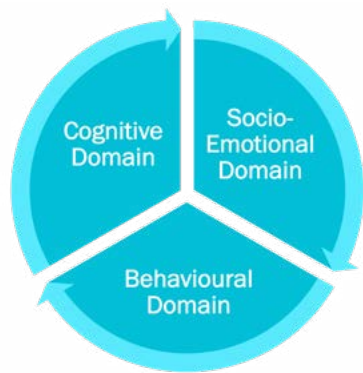


Figure 3: Three Learning Domains for ESD by UNESCO [Visual Image by ASEFClassNet]

The learning objectives based on these three areas aim to equip learners with knowledge, awareness, skills, and attitudes on all 17 SDGs. To learn more about the various learning objectives for all the SDGs under these three domains we advise that school leaders and teachers consult this document by UNESCO (2017), “Education for Sustainable Development Goals: learning objectives”, as listed in our list of reading recommendation (page 215). The learning goals under these domains support educators to understand the various learning indicators and design lesson plans that can help learners develop the various cross-cutting competencies of sustainability. Scholars have “a general agreement that citizens need certain competencies to engage constructively and responsibly with today’s world” (UNESCO, 2017). Experts highlight that these competencies cannot be taught but learners need to develop them through self-realisation, actions and experiences and reflection on a daily basis (Jensen & Schnack, 1997; UNESCO, 2017). The key sustainability competences gathered by de Haan (2010), Riekmann (2012) and Wiek et al. (2011), as cited in UNESCO (2017, p.10) are presented in the box below:

System thinking competency: the abilities to recognize and understand relationships; to analyse complex systems; to think of how systems are embedded within different domains and different scales; and to deal with uncertainty.

- Anticipatory Competency:** the abilities to understand and evaluate multiple futures – possible, probable and desirable; to create one’s own visions for the future; to apply the precautionary principle; to assess the consequences of actions; and to deal with risks and changes.
- Normative competency:** the abilities to understand and reflect on the norms and values that underlie one’s actions; and to negotiate sustainability values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge and contradictions.
- Strategic competency:** the abilities to collectively develop and implement innovative actions that further sustainability at the local level and further afield.
- Collaboration competency:** the abilities to learn from others; to understand and respect the needs, perspectives and actions of others (empathy); to understand, relate to and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving.
- Critical thinking competency:** the ability to question norms, practices and opinions; to reflect on own one’s values, perceptions and actions; and to take a position in the sustainability discourse.
- Self-awareness competency:** the ability to reflect on one’s own role in the local community and (global) society; to continually evaluate and further motivate one’s actions; and to deal with one’s feelings and desires.
- Integrated problem-solving competency:** the overarching ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive, and equitable solution options that promote sustainable development, integrating the above-mentioned competences.

Box 1: Key Competencies for Sustainability (UNESCO, 2017, p. 10)

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These competencies in the above table are understood as transversal, multi-functional and context independent (UNESCO, 2017). They do not replace the other competencies such as the 21st Century Skills but encompass them (Rychen, 2003; Weinert, 2001, as cited in UNESCO, 2017, p.17). Teachers are advised not to position the ESD learning objectives under the three learning domains separately from the sustainability key competences stated above. Both are supposed to be pursued together by reflecting on how and what competencies and learning objectives teachers are achieving through various educational practices to monitor the ESD learning progress (UNESCO, 2017).

Teachers as Enablers of ESD Learning Goals: Roles and Preparedness

Educators in all educational settings are expected to help learners understand the complex choices that sustainable development requires and motivate them to transform themselves and society (UNESCO, 2018a). There is no doubt that teachers at all education levels play a crucial role in educating the next generation about sustainable development (UNESCO, 2014).

To ingrain sustainable principles amongst young learners, teachers are required to innovate the learning process in a way that is learner-centred, enquiry-based, real-world driven, more creative and that allows the students' engagement with local communities (OECD, 2018b; UNECE, 2012). Hence, teachers remain as key actors in facilitating the learners' transition to sustainable ways of life. Nonetheless, educators themselves need to be empowered and equipped with the knowledge, skills, values, and behaviours that are required for this transition to empower learners with sustainability competencies. This includes understanding key aspects of each of the 17 SDGs and their interlinkages, as well as understanding how transformative actions occur, and the type of transformative pedagogical approaches can be adapted. A document published by UNESCO (2018b, p. 134-135) highlights 3 key competencies for teachers proposed by the UNECE for teaching ESD successfully in meaningful ways (see the box below):

1. A Holistic approach that promotes integrative thinking and practice

2. Envisioning change as a means to explore alternative futures, learn from the past and inspire engagement in the present; and

3. Achieving transformation in the way that people learn and in the systems that support learning

The competencies for teachers are further sub-categorised into 4 groups of learning goals to reflect the overall learning experience for ESD:

Learning to know: understanding the challenges facing local and global societies and the potential role of educators and learners;

Learning to do: developing practical skills and competencies for action in relation to ESD;

Learning to live together: contribution to the development of partnerships and acquiring an appreciation of interdependence, pluralism, mutual understanding and peace;

Learning to be: developing personal attributes and the ability to act with greater autonomy, judgement, and personal responsibility in relation to sustainable development (Delors, 1996).

Box 2: Competencies for Teaching ESD (UNESCO, 2018b, p. 134-135)

Various organisations and institutions, as well as researchers, carried out case studies, workshops and seminars to translate how to understand ESD learning goals better to support the teachers' community over the last two decades. Some of the discussions and frameworks developed emphasise on partnerships and connecting real-world and community driven education programmes for teaching and learning ESD. For example, one of the key frameworks developed is the CSCT framework, as a

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response to the call of the UNECE Ministers of the Environment in 2003 for including ESD in curricula from pre-school to higher and adult education (Sleurs (Ed.), 2008). The development of this framework took place in several stages that addressed various questions and competencies. In this framework scholars move the role of the teacher as an instructor and put more emphasis on teachers as individuals who are connected to not only their students but also to their teacher colleagues and other individuals in the wider society. The framework developers stress that genuine teaching and learning of ESD is only possible when teachers consider themselves and reflect on their day-to-day actions as part of this dynamic environment with various relationships. The social connection and network are crucial for human cognitive development as highlighted by Vygotsky (1978) in the book *Mind & Society*. Vygotsky argues that the human is the only animal that uses tools to alter his own perception and to understand the world around him, and the human mind cannot be understood separately from its society. Through this CSCT framework we can also see the importance of teachers being in an interactive environment with various social networks to be a better educator for ESD.

Though UNESCO has been promoting and implementing ESD to prepare education systems and educators for more than two decades, recent research evidence suggests that many teachers at various education levels are still not fully aware of ESD and sustainability competencies. When it comes to understanding teachers' roles in delivering ESD, some questions policy makers have been focusing on are whether teachers are equipped sufficiently to teach ESD, whether teachers understand the core objectives of ESD and whether there are appropriate learning environment and professional development opportunities required to teach ESD effectively.

Significance of ESD at the School Level Education

UNESCO emphasises that secondary-level education is one of the most important education levels to ingrain relevant values amongst young learners. It states, "Secondary-level education needs to be much more than skills training or civics: it should be concerned with the holistic development and empowerment of the total human person in a societal context (UNESCO, 2005c, p.13). Various ESD and the GAP initiatives conducted over the last two decades highlight that secondary-level education is an important stage for learners to develop sustainable lifestyles and values. As a consequence, a lot of pressure has been put

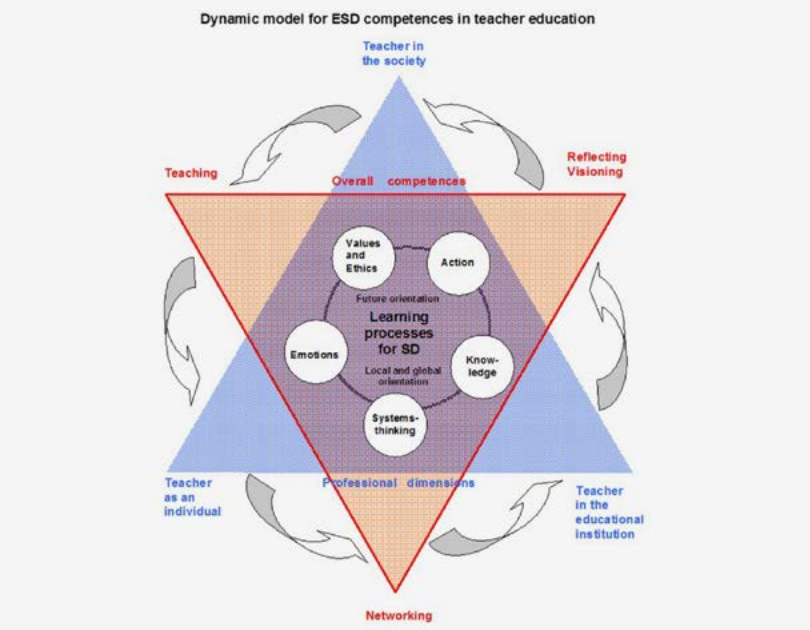


Figure 4: 3rd version of the CSCT Framework for ESD for Teachers as presented by Sleurs (Ed.), 2008, p. 26

on teachers and schools, especially the secondary level educators, to implement ESD meaningfully.

However, when it comes to the role of schools and teaching learners about sustainability, different scholars have different outlooks. Some scholars argue that schools are not organisations that can be used for solving societal problems (Scott, 2002). However, they believe that ESD should encourage schools to stimulate their learners to reflect on their own lifestyle regarding sustainability issues (Scott, 2002). Scott argues that learners should be able to reflect on the concept of 'Sustainable Development' with regards to decisions they take in the context of their own life. However, most researchers who are involved with ESD believe that ESD by definition cannot be merged with the definition of education. They suggest that teaching ESD should be a whole school approach and schools should integrate it in various aspects of the schools' learning environment rather than as a standalone topic (UNESCO, 2018b).

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Without doubt, schools and teachers at the secondary education level alone cannot achieve the learning objectives of ESD. To enable schools and educators, relevant partnerships are important: partnerships where schools can work with relevant entities to deliver strong learning experiences that have the power to shape learners' attitudes and behaviours towards sustainable development.

What are the 21st Century Skills? History and Background

The idea and discussion about the 21st Century Skills can be dated back to the 1980s when various stakeholders such as governments, corporate representatives, business institutions and education experts carried out various initiatives to understand the skills next generation needs. The research and discussions focused on the fact that our societies are changing rapidly due to the industrial, global, and technological advancement. As a result, lifestyles and workforces are also dramatically evolving (World Economic Forum, 2015). Hence, rethinking new skills and the understanding of them for a changing workforce was needed. Slowly the idea of the 21st Century Skills has started to be part of the Education

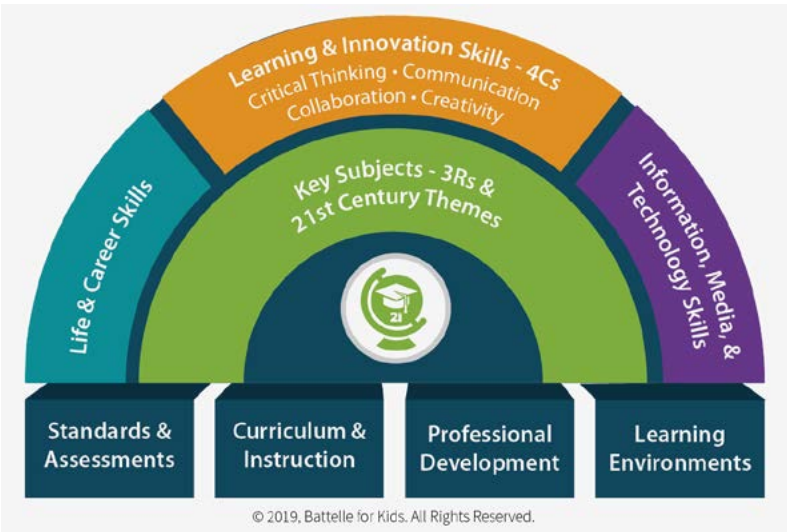


Figure 5: The 21st Century Skills Framework by P21

Policy discussions around the world. It is important to note that there is no fixed and unique definition or framework for the 21st Century Skills (Joynes et al., 2019).

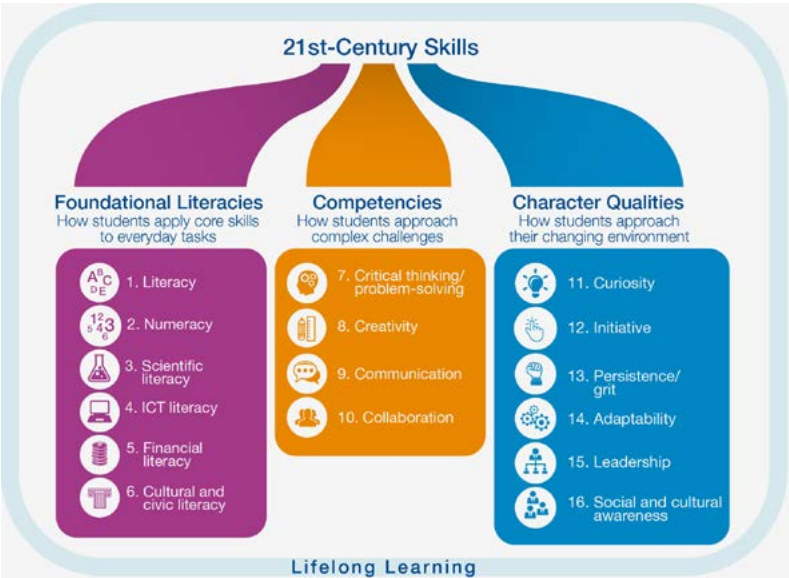


Figure 6: 21st Century Skills Categories as presented in World Economic Forum (2015, p. 3)

The idea became widely popular and embraced by various education levels, particularly higher and secondary education levels across the globe. The pioneer organisations who put significant efforts in developing and categorising the 21st Century Skills are namely the US Secretary of Labor's Commission on Achieving Necessary Skills (SCANS), a national coalition called the Partnership for 21st Century Skills (P21)¹, the international Organisation for Economic Co-operation and Development (OECD), the American Association of College and Universities, researchers at MIT and other institutions of higher learning, and private organisations.

¹ P21 is a network of Battelle for Kids, an USA based not-for-profit organisation committed to promote 21st Century teaching & learning among school systems and communities in the USA. To learn more check P21's history (<http://www.battelleforkids.org/networks/p21>) and Framework (<http://www.battelleforkids.org/networks/p21/frameworks-resources>)

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	Skill	Definition
Foundational literacies	Literacy	Ability to read, understand and use written language
	Numeracy	Ability to use numbers and other symbols to understand and express quantitative relationships
	Scientific literacy	Ability to use scientific knowledge and principles to understand one's environment and test hypotheses
	ICT literacy	Ability to use and create technology-based content, including finding and sharing information, answering questions, interacting with other people and computer programming
	Financial literacy	Ability to understand and apply conceptual and numerical aspects of finance in practice
Competencies	Cultural and civic literacy	Ability to understand, appreciate, analyse and apply knowledge of the humanities
	Critical thinking/ problem-solving	Ability to identify, analyse and evaluate situations, ideas and information to formulate responses and solutions
	Creativity	Ability to imagine and devise new, innovative ways of addressing problems, answering questions or expressing meaning through the application, synthesis or repurposing of knowledge
	Communication	Ability to listen to, understand, convey and contextualize information through verbal, nonverbal, visual and written means
	Collaboration	Ability to work in a team towards a common goal, including the ability to prevent and manage conflict
Character qualities	Curiosity	Ability and desire to ask questions and to demonstrate open-mindedness and inquisitiveness
	Initiative	Ability and desire to proactively undertake a new task or goal
	Persistence/ grit	Ability to sustain interest and effort and to persevere to accomplish a task or goal
	Adaptability	Ability to change plans, methods, opinions or goals in light of new information
	Leadership	Ability to effectively direct, guide and inspire others to accomplish a common goal
	Social and cultural awareness	Ability to interact with other people in a socially, culturally and ethically appropriate way

Sources: ES20 Skills Hierarchy for Transversal Skills (<https://ec.europa.eu/esco/web/guest/hierarchybrowser/-/browser/Skills>); Partnership for 21st Century Skills; "Framework for 21st Century Learning," NECT, Washington DC, 2001; Burkhardt, Gina, "enGauge 21st Century Skills: Literacy in the Digital Age," North Central Regional Educational Laboratory and The Metiri Group, 2003, (www.ncrel.org/engauge/); Learning Metrics Taskforce, "Towards Universal Learning: What Every Child Should Learn," Center for Universal Education at the Brookings Institution and UNESCO Institute for Statistics, Washington, DC, 2013; The Economist Intelligence Unit, "The Learning Curve: Education and Skills for Life," Pearson: London, 2014. Other sources considered but not included: AT21CS, WorkSkills, Iowa Dept. of Education's 21st Century Skills, and Tony Wagner's Seven Survival Skills.

Figure 7: 21st Century Skills Definitions gathered by the World Economic Forum (2015, p. 23)

The ‘Partnership for 21st Century Skills’ also known as P21 comprehensively defined the 21st Century Skills into four categories: 1. Core Subjects, 2. Learning & Innovation Skills, 3. Information Media and 4. Technology Skills, Life and Career Skills.

Later many other institutions across the globe started comparing and analysing the skills by collecting them from various organisations. For example, the World Economic Forum nicely gathered and summarised the definitions of the 21st Century Skills by various organisations (World Economic Forum, 2015). An overview of the definitions is shown in the image below:

Across various education policy documents and discussions, scholars and education leaders have strongly emphasised that teaching 21st Century

Skills is more crucial today than ever (Rychen, 2016). The significance of these skills is multifaceted. However, in the context of tackling sustainable development challenges, learners need to be taught these skills for new discovery and innovative solutions to tackle global challenges. Education and industry experts strongly argue that although technology tools are rapidly replacing human roles in many areas, technology on its own cannot solve the issues of human societies nor can it enhance the progress of human civilisation by itself. Only by mastering skills such as creativity, critical thinking, problem solving and collaboration, today’s learner can be prepared to tackle both existing and uncertain challenges in our societies.

The connection: STEM, ESD Learning Goals and the 21st Century Skills

"We are the first generation to feel the effect of climate change and the last generation who can do something about it." Barack Obama, Former President of the United States of America states in the 2022 Netflix Docuseries, Our Great National Parks

We live in the era of Industry 4.0 that is driven by innovation and rapid technological advancement. At the same time this era is dealing with various socio, economic, political, and environmental challenges. For such a world, educators are expected to constantly innovate their teaching practices to prepare all students with the relevant skills and knowledge needed for thriving in both professional and personal endeavours (OECD, 2018a).

In this context, educators are advised particularly to transform teaching STEM subjects as they have the potential to generate innovative solutions for solving contemporary global challenges (Masterson, 2021). Education experts emphasise that transformative STEM teaching at the secondary education level must go beyond teaching the subject knowledge and content of the specific STEM field. They must address issues like Climate Change and Global Warming. As stated above teaching ESD requires transforming the process of how a student learns, and teachers across the world have a crucial responsibility to find ways to deliver the core learning outcomes of ESD. However, ESD in general still lacks concrete structural implementation in educational contexts, especially at the lower education levels like primary and secondary education. This means that integrating ESD learning objectives into various STEM subjects and by adopting the sustainability lens, educators can deliver better learning experiences

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for learners (Zoller, 2013). Integrating ESD into STEM subjects can help educators achieve both goals – delivering the ESD learning objectives and innovating STEM teaching that are timely and relevant. On the other hand, without real-life driven education settings the integration of teaching and learning goals of the 21st Century Skills is not easy for teachers. Although the idea was introduced around the 1980s and has gone through the transformation by various organisations, not many schools and teachers around the world are strongly implementing teaching these skills in classrooms. Education policy makers suggest that more innovative teaching and learning is needed to teach these skills, especially teaching them in a way that is connected with real-world scenarios (OECD, 2008).

Conclusion

For innovative and timely teaching and learning, both building strong thematic knowledge and being aware of their current trends are highly important. Even with the right technical tools, technical expertise and pedagogical approaches, teachers can struggle if they are not aware of what learning goals they must deliver and why such goals are important for the world we live in today. We believe that teachers can create truly meaningful STEM learning experiences for students by embedding the learning objectives of ESD and teaching 21st Century Skills simultaneously. With this goal in mind, we designed the V4IoT project in a way that gave the participant teachers a solid scope to build knowledge on relevant thematic areas. We hope that the teacher participants benefitted from the lessons shared and the thematic knowledge helped them to create the Teaching Modules we present in 'Part two' of this Handbook. To conclude, based on our experience of conducting the thematic sessions, we stress that more efforts and initiatives are needed to prepare education systems and support the teachers' community with training programmes like the V4IoT project: to foster ESD learning objectives and teaching the 21st Century Skills and to improve STEM learning, for positive climate actions.



1.4 Technical Introduction



1.4.1 What is IoT, Big Data and AI?

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Introduction

The Internet of Things (IoT) is a concept whereby uniquely identifiable objects can directly or indirectly collect, process, or exchange data via a smart electrical system or computer network. The term was first used by British entrepreneur and startup founder Kevin Ashton in 1999, during a presentation to Procter & Gamble and it generally referred to “a network of interconnected objects” (Greengard 2015).

The concept is used in manufacturing, urban management, healthcare delivery, home appliances, mobility and wearables. It is estimated that there will be between 25 billion and 50 billion connected devices in 2020. The IoT market was estimated to be worth \$200 billion in 2016 and \$1.3 trillion in 2019. In 2019, the market structure of the Internet of Things technology, considering applications in various human activities, is as follows: smart cities – 26%, industrial IoT – 24%, connected health – 20%, smart homes – 14%, connected cars – 7%, wearables – 4%, smart utilities – 3%, and others – 2%. The number of applications of Internet of Things technology is growing rapidly. It is predicted that over 125×10^9 connected devices will be created in the next 10 years. Investment in these technologies was estimated at $\$120 \times 10^9$ in 2021, with an annual growth rate of 7.3% (Kozlov, Veijalainen, and Ali 2012).

One should note that there is also the term Internet of Everything (IoE), which is a term for a network of people, processes, data and things connected to the Internet. This term was originally coined by CISCO and is now often used interchangeably with the term Internet of Things. A counter has also been created that counts the approximate number of elements of the Internet of Things (Gubbi et al. 2013/9).

Artificial intelligence (AI), on the other hand, is a form of (computational) intelligence demonstrated by programmes or robots based on various algorithms, which, unlike natural intelligence demonstrated by humans and animals, does not include consciousness or emotionality (Kok et al. 2009). In practical terms, artificial intelligence is a whole range of algorithmic methods for working with large data sets. These methods include

1.4.1 What is IoT, Big Data and AI?

supervised learning (various regression or classification algorithms), unsupervised learning (clustering, dimension reduction) and reinforcement learning. In addition to these techniques, self-supervised learning is also increasingly being discussed. These methods will undoubtedly increase in the future. AI can be used for diagnostic purposes (e.g., market segmentation, credit scoring) and predictive purposes (forecasting various trends).

AI will rely in the future on real-time data streams provided by IoT (sensors, wearable technologies, cameras, etc.). Already today, AI together with IoT is transforming the health, finance, sales and agriculture sectors, among others. As far as the educational sector is concerned we can see changes, but the increase in popularity of AI solutions depends on reskilling processes in this sector and building competencies that allow the use of machine learning models (something we will refer to later on in this handbook). Undoubtedly, a favourable element is the gradual simplification of interfaces for using artificial intelligence, and even the fact that some predictive tasks will soon be able to be performed completely without coding (Shaikh 2020).

The educational sector of the future will certainly benefit from the predictive capabilities of IoT and AI, which will allow for better matching of study offers to future students, more accurate student “market” segmentation (even at a very local level), as well as performing advanced analytics such as students’ overall performance, depending on a large number of variables. There is also no doubt that the educational sector will see the emergence of a new speciality of people who will conduct such analyses and thus feed other specialities responsible for contacting clients (students and their parents). Implementing supervised and unsupervised machine learning does not have to be expensive (and these costs will also decrease in the future, as such tools become more widespread), but it does depend on the resources and quality of the data held by a given entity. Therefore, it is already worth taking care of the data, collecting it and binding it with metadata. It may not be profitable to invest in advanced algorithms when this data is missing. The implementation of artificial intelligence also has an important ethical dimension.

From the perspective of the real estate market, it seems particularly important to pay attention to the so-called algorithmic bias, i.e., a situation in which the model, not having a good representation of the



1.4.1 What is IoT, Big Data and AI?

external world in the data, starts to lean and, for example, indicates completely inappropriate offers for the profile of a given person or starts to discriminate against certain people.

Another possible deployment of IoT is related to their usage in actual school settings. Various sensors can become building blocks for educational experiences, both at the elementary and more advanced level (for instance in the context of physics or biology classes) (Reyna et al. 2018).

IoT and Artificial Intelligence in the context of the job market of today and tomorrow

Both IoT and artificial intelligence are classified as general-purpose technologies (GPT). It is a term reserved to describe technologies that are fundamentally transforming our lives, that is, technologies like the steam engine and the Internet that are causing significant and widespread social and economic impact. AI has already and will continue to undoubtedly have a significant impact on how people live and work. The cumulative extent of AI-driven change remains largely unknown, and thus often leads to either alarmist, dystopian visions of a future without human labour, even though the annual rate of change, as far as the labour market is concerned, is unlikely to sound the alarm.

Currently, neither AI nor any other GPT could (and in a normative sense should not either) replace human workers, but it can increase their productivity and even satisfaction. Some researchers (Acemoglu and Restrepo 2017) link increased intensity of use of AI and robots to reduced employment and wages, suggesting the need for welfare systems to adopt to the so-called “universal basic income” (Universal Basic Income – UBI). In contrast, others argue that millions of jobs around the world will be rapidly automated, and many more jobs will disappear than will be created (Furman and Seamans 2019; Goolsbee 2018). Some labour market transformation trend analysts agree with these admittedly bleak visions, but others predict the opposite. AI will displace about one-third of existing jobs globally within a decade, with the United States (up to 40%) and Japan (50%) among the hardest hit. However, according to the OECD AI Policy Observatory, AI, together with IoT, Blockchain and 5G will create more jobs than they will eliminate. Companies that are pioneering the development and scaling of AI have so far not eliminated jobs on the net. According to

the OECD AI Policy Observatory, there is no indication that this trend will not continue for the foreseeable future. In a similar vein, a recent report by Stanford University’s Human-Centered Artificial Intelligence on the transformation of work in the post-Covid era highlights the same trend. This makes it all the more worthwhile to invest in digital skills that enable more effective use of emerging technologies.

Predictions for further development of the Internet of Things and Artificial Intelligence

In psychology (Conoley and Conoley 2010), collaboration is defined as “the act or process of two or more people working together to produce an outcome desired by all” or “an interpersonal relationship in which the parties demonstrate sensitivity to the needs of others”. Collaboration in economic terms, on the other hand, is cooperation defined as the ability to perform tasks and solve problems together to achieve common goals (Barbara and Celebrate 1989).

As a rule, collaboration occurs mainly between people, but it leaves room for technology as well. Thus, collaboration between humans and machines can take many forms (Jemielniak and Przeglasińska 2020). For example, various tools designed and used for communication have long allowed for remote contact (email, video conferencing tools, or other technologies that enable telepresence, such as VR), but they have also become intermediaries of collaboration, allowing for collaborative, remote, and often asynchronous project management (such as Slack and other communication/collaboration platforms).

However, we are now entering the next level of human-technology collaboration. This happens when a system can create synergistic effects with humans: generating added value that would not exist if such collaboration did not occur. A proponent of the collaborative approach to emerging technologies such as IoT and AI is Tom Malone of the MIT Sloan School of Management (Malone and Laird 2018) – an author who, in his recent book “Superminds”, argues for the power of humans and machines working and thinking together. He argues that advances in artificial intelligence can allow for the emergence of novel ideas and even solutions to the most pressing current problems. It is worth mentioning that the convergence of human and robot capabilities is also often discussed as a possible solution to the dystopian scenario according to which AI will

1.4.1 What is IoT, Big Data and AI?

annihilate humanity, often postulated by many prominent futurologists. According to Malone's concept, AI should develop domain knowledge rather quickly and become expert in specific tasks. Equipped with such artificial intelligence, humans would more effectively use their own talents, abilities, and skills (including knowledge synthesis) to solve problems. For example, a recent experimental study showed that productivity can be enhanced (Seamans and Raj 2018; Manyika et al. 2017) when developing an assembly system for human-robot collaboration. More such examples can be found, such as: systems that support creative work (music composition or film scriptwriting or drafting marketing campaigns), and intelligent systems used in factories.

In the short to medium term, AI development will most likely follow two distinct paths. The first is an extrapolation of what AI is today – highly specialised deep learning algorithms applicable to clearly defined problems in a more complex, contextual, and nuanced way. The second path involves creating AI systems capable of processing information in a manner similar to the human brain. Today, deep neural networks have become a key paradigm in AI due in part to an algorithm called “backpropagation” (Hecht-Nielsen 1992; Schrittwieser et al. 2020). They are also the ones that make best use of real time data collected from sensors and the Internet of Everything. This backpropagation enables deep neural networks to learn from data and thus achieve capabilities such as language translation, speech recognition, and image classification – again here, data from IoT is key. Narrowly specialised artificial intelligence is unlikely to affect the number of jobs per se, but like previous technological revolutions, it will cause a profound shift in the economy and redefine the very tasks facing workers, transform business models and strategies, and the ways in which various institutions operate.

The second path of biologically inspired AI requires IoT and real-time data. It has great potential to transform the capabilities of AI and overcome its current limitations, creating more robust and complex systems capable of more abstract levels of reasoning. However, it remains in its infancy and therefore many years away (Tegmark 2017) (McAfee and Brynjolfsson 2017) (McAfee and Brynjolfsson 2016) and it is difficult – at least for now – to address how it will change the labour market and how it will affect the nature of the relationship between humans and technology. To do so would be pure speculation.



1.4.1 What is IoT, Big Data and AI?

Citizen Developers

A “citizen developer” model is emerging with non-technical developers coming to the fore of digital transformation. Citizen developers may use no code or low code platforms to create simple automations for themselves, their teams and departments. They may have roles in HR, finance, sales and marketing, legal, procurement and other business functions. They are not a substitute for a company’s IT team, but they play a critical role in creating smaller automations that require a deeper understanding of individual tasks and departmental processes.

Only around 40 percent of tasks can be automated when you allow employee-driven demand. To reach the full potential of automation, citizen developers will amplify and evangelize automation. In many cases, automations created by citizen developers for a particular team are found to have greater use across the organization. In order to achieve this organisation will need to invest in education and training. Some companies even run bot-a-thons to encourage employees to create their own robots, RPA-based solutions and IoT applications. Other companies are offering self-selected upskilling courses, or their employees are taking advantage of robotic process automation trainings found online.

The financial benefit of fostering a citizen developer community should also not be underestimated. If used effectively and developed in conjunction with a culture of learning and collaboration, citizen developers will lead the charge of AI development and automation in the future.

Models for using IoT and Artificial Intelligence and skills required

Recent significant advances in AI, deep learning, natural language understanding, signal processing and real-time IoT-driven data analysis, as well as machine vision, have led to the emergence of new human-centered collaborative systems (Haenlein and Kaplan 2019). Systems such as AlphaStar, AlphaGo (Vinyals et al. 2019; Wang et al. 2016), OpenAI Five (OpenAI 2018), and IBM Watson (Swan 2012) have proven that in many cases human-machine exchange should not be considered as competition and/or substitution, but rather as an area of potential collaboration where human talents can be augmented with machine computational intelligence.

This approach to implementing emerging technologies in organisations and institutions, especially knowledge-based ones, is advocated by Malone (T. W. Malone 2018), already cited above, who argues in his publications for the power of humans and machines working and thinking together. Malone argues that advances in artificial intelligence and connectivity could allow novel ideas to emerge, and by inducing collective intelligence, solutions to the most pressing current problems could be discovered.

Malone distinguishes several models of collaboration between machines and humans. We can talk about parallel work, independent work. We can also talk about working on several “sections” of one task or project or about a situation of interdependence, such as when the decision made by a tech-system (for example in medical diagnostics where patient data retrieved from sensors is cross-pollinated with existing historical data) is a support for the doctor, who then verifies it. The most desirable and, according to Malone, achievable system would be full cooperation with artificial intelligence, giving synergy effects. In such case, a human uses those dimensions of intelligence in which he or she is the best, and his or her cognitive and decision-making horizon is supported by advanced, albeit specialized, artificial intelligence.

Taking all this into account, there are at least several levels of use and corresponding technical skills. The first level corresponds to basic skills in the use of tools and interfaces that do not require coding corresponding to the “product” approach to IoT and artificial intelligence.

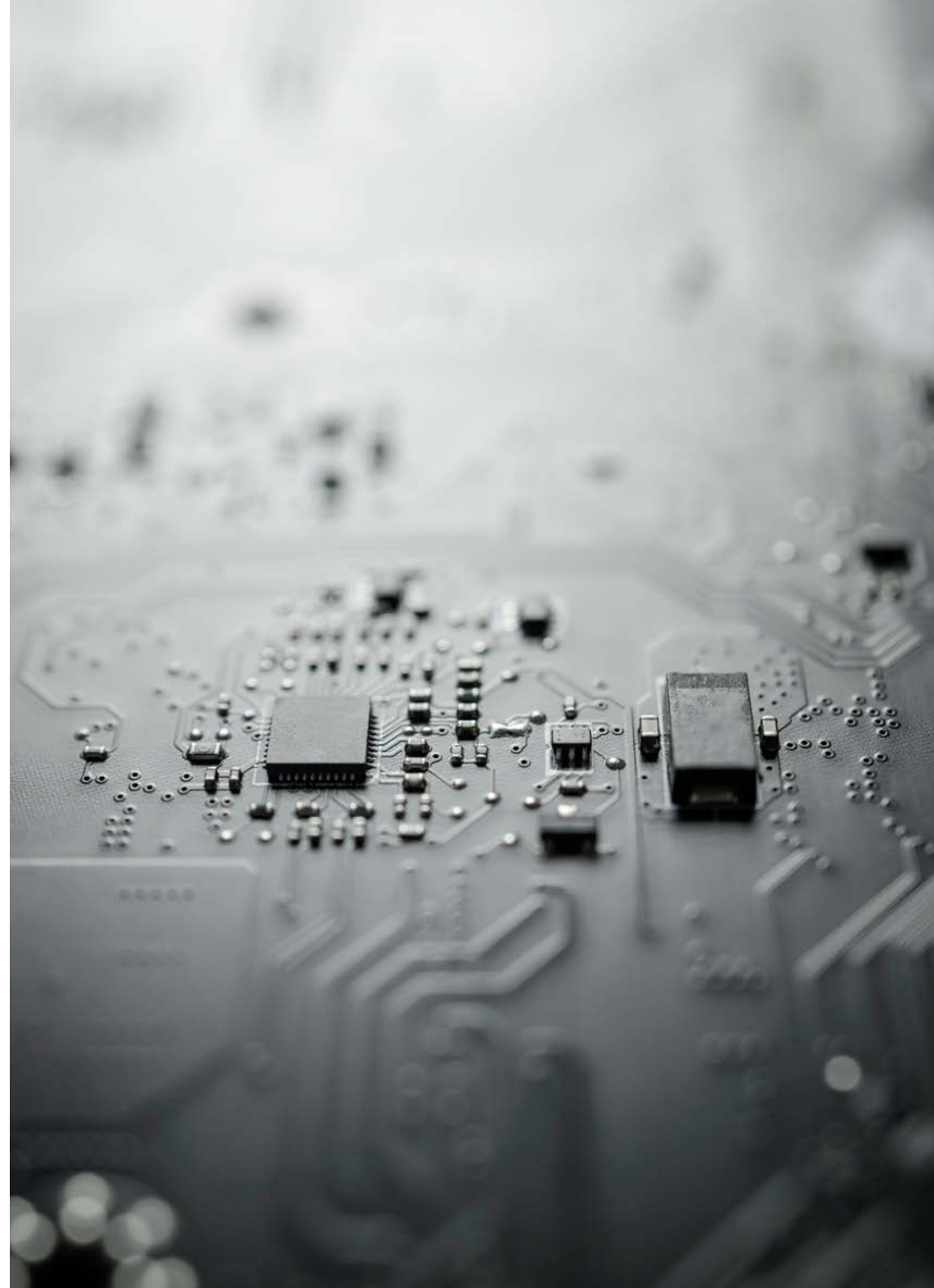
Any person proficient in social media or applications will be able to use artificial intelligence in this area. This is already evident from marketers using transformative solutions such as the AI21 Labs, or Facebook users using the simple Chatfuel platform to build chatbots that can also be transferred to IoT devices.

The second level corresponds to the level where people already know the basics of coding (for example, in Python or Javascript) and a basic understanding of machine learning algorithms, including NLP algorithms, which allows you to apply Machine Learning (ML) and NLP in various problem spaces. Here, it is possible to use ready-made platforms and, to some extent, independently build and optimise IoT and AI tools, and choose the most appropriate algorithms for a given problem.

1.4.1 What is IoT, Big Data and AI?

The penultimate stage will be advanced skills in Natural Language Processing (NLP) programming, which allows you to use all libraries and tools, including deep learning (DL) to implement projects using AI. The final stage is the creation of AI tools and conversational AI from scratch and having extensive knowledge and experience in deep learning algorithms and reinforcement learning.

In summary, we can distinguish 4 levels of competence in the context of application and development of emerging technologies: from no code, through low code, basic programming and data science skills, advanced and expert level.



1.4.2 Practical Example of the Integration of IoT, Big Data and AI tools in Education

The ability to leverage technology in the classroom played an essential role in the execution of the V4IoT project. While teachers and students were accustomed to using general ICT tools in class during the COVID-19 lockdown (e.g., Zoom, Google Meet and MS teams for meetings, Mentimeter and Answergarden for online polling or Mural, Miro and Padlet for brainstorming activities), the usage of technology in this school project had a different objective: to provide a platform for teachers and students to teach and learn IoT, Big Data & AI concepts in an innovative and creative manner within the context of Climate Change and Sustainable Development – while creating a network for collaboration across schools in the Visegrad region.

Each participating school received an IoT device, (the “weather station”), which was set up at a suitable location in the school’s campus. Most schools mounted the weather station on the roof of the main building – away from buildings, trees and other obstructions. The weather station included two components: external weather sensors and a base station which allowed for outdoor and indoor environmental monitoring. The base station connected the external weather sensors to the Internet via Wi-Fi. It also had an LCD backlit screen to display the current sensor readings.

Teachers and students could monitor the local weather conditions and track the following data from the weather station:

- Air Temperature** (°C)
- Barometric Pressure** (mbar)
- Relative Humidity** (% RH)
- Rain** (mm)
- Solar Radiation** (W/m²)
- Wind Speed** (m/s)
- Wind Direction** (° and 16 cardinals)

The base station had two additional sensors to capture the indoor environment:

- Air Temperature** (°C)
- Relative humidity** (% RH)

In addition to the weather station equipment, schools had access to a common technical platform, the IoT Exploratory (<https://www.exploratory.sciencescope.uk/>), which gathered the environmental data generated by the weather stations of all participating schools. Teachers and students could utilise this repository to compare and analyse data between different schools and geographic locations. The IoT Exploratory also included download tools that allowed participants to extract data, integrate them into other systems such as Microsoft Excel, use graphing features to view data over defined periods of time as well as live dashboard features.

By providing access to this technology, the V4IoT project engaged both teachers and students in technology development and in understanding how technology could be used to address real-world problems and challenges. Participants worked on practical, enquiry-based and data-driven teaching and learning activities with a focus on local weather conditions and Climate Change. As a result, participants developed five Teaching Modules on Wind, Rain, Temperature, Solar Radiation and Barometric Pressure that illustrated real-life scenarios and how technological innovations such as IoT, Big Data and AI have an impact on our daily lives and sustainable development.

For the implementation of the V4IoT project, the school project partners selected the EdTech provider ScienceScope Ltd in the United Kingdom as tech partner.

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2 Part Two: Teaching Modules



2.1 Introduction to Teaching Modules

2.2 Teaching Module 1: Wind

2.3 Teaching Module 2: Rain

2.4 Teaching Module 3: Temperature

2.5 Teaching Module 4: Solar Radiation

2.6 Teaching Module 5: Barometric Pressure

2.7 Conclusion and Recommendations

2.1 Introduction to Teaching Modules

The V4IoT project aimed to strengthen the professional capacity of teachers on a pedagogical, curriculum & technical level by providing a peer-to-peer platform for joint learning and collaboration. The development of the V4IoT Teaching Modules was a crucial part of this process.

The development phase of the Teaching Modules was designed as an engaging avenue for participants to practically and creatively use the skills gained during the Thematic and Technical Training well as the Peer-to-Peer Exchange and Knowledge Building Sessions. Teachers worked in small teams of up to 7 people, mostly coming from different schools, to ideate together with their students in a learning partnership and to co-create Teaching Modules that could inspire and empower educators in and beyond the V4 region. Through this co-creation process, the participants not only enhanced their own teaching & learning competencies in the short term but also contributed to the larger school community in the long term.

In total, 5 Teaching Modules were co-developed by the participants in collaboration with the ASEF ClassNet Team and with technical and data inputs from ScienceScope Ltd. Each Teaching Module tackled a different environmental topic and incorporated five elements to ensure their relevance for today's learners.

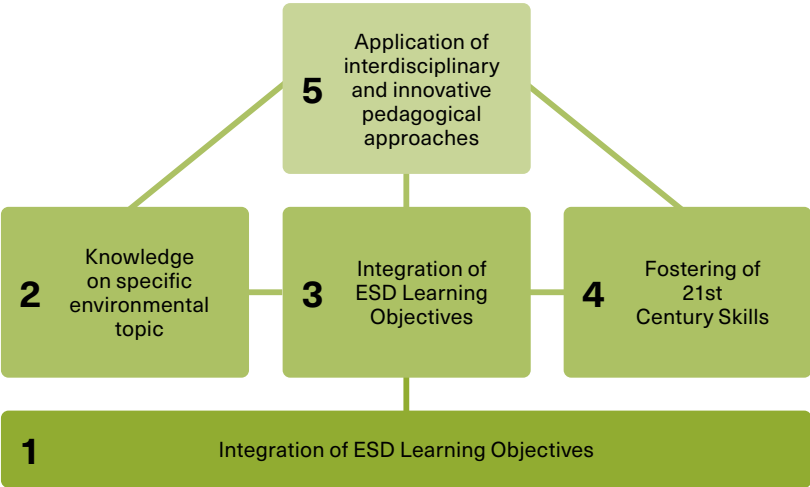


Figure 8: Elements embedded in the Teaching Modules

First, the content of the V4IoT Teaching Modules had to be based on real-life environmental data sets, for example wind speed and direction, total amount of rainfall, solar radiation, etc. Students could either retrieve this data from the IoT Exploratory platform, which collected data from the IoT devices (weather stations) of each participating school, or from official weather monitoring platforms, Statistic Offices and relevant Ministries in the V4 countries. When developing the Teaching Modules, each team selected the relevant data sets, evaluated these and designed lesson plans & questions accordingly. This process stimulated the students' curiosity and deepened their understanding on the importance of environmental monitoring for scientific purposes, and on how IoT, Big Data and AI can be applied in their school setting to innovate teaching and learning practices.

Second, each team had to tackle one specific environmental topic and challenge for their Teaching Module under the overall theme of "Climate Change & Climate Action", e.g., whether solar energy as a renewable energy can be used to green the school campus. Students had to take a holistic approach and critically reflect on the topic. This meant to come up with questions from an interdisciplinary perspective and to discover issues that were not purely STEM related but also explored potential linkages with the Humanities or Social Sciences.

Third, as stated in the 2017 UNESCO Report on Education for Sustainable Development, "ESD can develop cross-cutting key competencies for sustainability that are relevant to all SDGs. ESD can also develop specific learning outcomes needed to work on achieving a particular SDG". (UNESCO, 2017). These outcomes include cognitive, socio-emotional and behavioural learning objectives. Hence, each Teaching Module should contribute to a better understanding of the Sustainable Development Goals (SDGs), their interconnectedness and create a stronger awareness and commitment among students towards sustainable practices and sustainable development.

Fourth, participants were asked to design their Teaching Modules in such a way that they foster one or more of the 21st Century Skills – either by actively building a specific teaching/learning component in the module or by developing activities that would hone 21st Century Skills among the students as a positive, expected outcome of the overall teaching module.

2.1 Introduction to Teaching Modules

Lastly, interdisciplinary knowledge is indispensable for building innovative and inclusive solutions that address the complex challenges of sustainable development. All V4IoT Teaching Modules focused on interdisciplinarity and provided a teaching and learning framework that was engaging, creative and facilitated cross-thematic and out-of-the box thinking.

The following chapter presents five V4IoT Teaching Modules that focused on the topic of Wind, Rain, Temperature, Solar Radiation and Barometric Pressure. Each Teaching Module is presented in three distinct sections:

The Module starts with a **Reflection by Teachers**. Conducted in the form of an interview, teachers describe the various stages of the collaboration, learning objectives and key activities as well as personal and their students' experiences throughout the project.

A **Practical Worksheet** illustrates the module ideas and steps how to conduct an innovative STEM lesson on the specific weather topic. The worksheet consists of seven building blocks:

1. context setting
2. scope of module and main task or challenge for the students
3. learning goals for students
4. connections with the SDGs
5. scientific concepts, data collection & analysis
6. ideas for individual learning, team & peer collaboration among students
7. materials, tools & equipment

The last part of each Teaching Module documents the collaboration among teachers and students and provides **Examples and Results** of the project work. These include photos, e.g., the set-up of the weather stations on the school campuses, students in action in the classrooms, or the results of the data collection and analysis.

“The whole project experience was really educational. It made me understand that it is possible to combine completely different types of activities for the students’ advantage.”

Adam Stepinski
Copernicus Upper-Secondary School in Tarnobrzeg, Poland



Reflections by Teachers

The first V4IoT Teaching Module on Wind tackles the weather phenomena of wind, its impact on air quality and how wind can be used as an alternative source of energy. The Module guides students to collect data linked to different wind properties, including wind speed, strength, and direction as well as its relation to atmospheric pressure, and explores the impact of wind on other weather phenomena, people's environment, and health. To connect the topic with their local environment, students have to explore wind conditions in different geographic locations in Visegrad countries and assess the feasibility of setting up a wind park in their region. They also have to predict areas of risk for air pollution in their region depending on seasonal winds.

This Module was developed by a team of four teachers based in Hungary, Poland and Slovakia in partnership with the ASEF Classroom Network Team. They share their experiences and lessons learnt during the development of the Module.



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Why did you choose the theme “Wind” for your V4IoT Teaching Module?

Burning fossil fuels, particularly coal, is one of the biggest contributors to climate change. In addition, air pollution caused by coal-powered plants or domestic purposes poses a major threat to the environment and human health. We feel the direct impact in our region. Especially in winter, smog and bad air quality is a serious problem in our cities. With wind discharging and transporting hazardous pollutants to far distances, air pollution turns from a local to a regional problem no matter the source. So, the topic was of great interest and relevance not only for students from the leading school in Tarnobrzeg in Poland, but also for all the schools participating in this Module, and their students in Hungary and Slovakia. We also wanted to explore with our students the opportunity of wind as a clean, renewable energy source to generate electricity for commercial and private usage. According to the Visegrad+ for Renewable Energy Platform (V+RE), within the EU, Poland is the country with the highest share of coal energy but there are developments to invest in offshore wind parks in the Baltic region. The Czech Republic, Hungary and Slovakia have the lowest share of wind power in electricity production in Europe, which means there is much room for improvement. We believe it is important for students to learn about these environmental challenges and renewable energy sources as solutions to mitigate climate change at an early stage. Especially as they can directly experience these problems and solutions in their own communities, they will develop an environmentally conscious and action-oriented mindset.

What research questions did you tackle with your students?

During the project phase, our students collected data linked to different wind properties, including wind speed, strength, and direction, as well as its relation to atmospheric pressure, and explored the impact of wind on other weather phenomena such as temperature or humidity, but also people's environments, their cities and their health. By monitoring and analysing wind related data over time, our students learnt to make preliminary predictions on weather variables such as temperature or the number of sunny, cloudy, or snowy days and developed dependencies and trends for specific seasons. While working on the activities, we also discussed questions that are relevant for environmental and energy planning and social studies, for example: Would your town be a suitable

location to establish a wind farm? Why or why not? What can local authorities do to reduce air pollution and smog? These larger discussions were in particular interesting for the students, and some of them even contacted academic institutions by phone or email for further research and analysis.

What kind of activities did you conduct during the project phase and include in your Teaching Module?

We prepared and conducted a Teaching Module which consists of two parts: Two warm-up activities and four core assignments. The warm-up activities serve to introduce the topic and key vocabulary; the four core activities focus on the environmental monitoring and data evaluation to make predictions and recommendations.

For the warm-up activities, we started during our project phase with a brainstorming exercise to find out what our students associate with and know about wind, wind speed and wind direction. We used the online tools AnswerGarden and Mentimeter. They are easy to integrate in any face-to-face or online session and easy to use by students with different language backgrounds. It was interesting to see the students' diverse insights to the question: “What comes to mind when you hear the word ‘Wind’?” We then divided the students into small groups of ca. 4 pax and gave each group a word list from the brainstorming exercise to come up with a definition for each word. Using this material, students had to create a LearningApp quiz for their peers. They had lots of fun during the process and also used photos to make it visually more appealing. The second warm-up activity was a virtual tour of our project partner schools, using Google Earth.

After this warm-up, we conducted four core activities with each of them tackling one specific learning objective. Core activity 1 focused on Data Analysis to train students' digital and technical skills. The students explored different properties of wind (wind speed, wind direction, barometric pressure), collected data with the IoT Exploratory Platform from their own towns and evaluated the impact of wind on the overall weather conditions, people's health and the environment. They learnt how to read environmental data and graphs, created data charts and prepared mini presentations to illustrate their conclusions. Core activity 2 focused on wind conditions, geographic location & data comparison. Students from the 4 schools collected data on wind speed and wind direction with their

school's weather station and analysed and compared the different results between their countries. Based on this data comparison, students tried to determine prevailing wind directions by analysing one month of data; the average wind speed at different times (in km/h or m/s); and relationship between wind speed and atmospheric pressure and humidity. Core activity 3 and 4 focused on local wind conditions and impact on daily life. Through wind data collection & online research on wind farms, they had to assess whether or not their towns would be suitable locations to build wind parks. By evaluating wind data and air pollution levels in their region, they also had to identify possible man-made sources in their region which caused the pollution.

The V4IoT project aimed to strengthen the 21st Century Skills among teachers and students in areas such as information literacy, digital literacy, creativity, teamwork and critical thinking, and build a sense of Global Citizenship, in line with the goals of Education for Sustainable Development. In which way(s) did your project contribute to these objectives and provided learning opportunities that transcended borders?

Thanks to the hands-on and experiential approach of the project our students learnt a lot about IoT, Big Data and AI. They took part in online training sessions by AI and environmental specialists, conducted research, used technological equipment and worked on project tasks. By analysing the weather station data, they realised how new technologies might be used for interpreting information and solving real life problems. It was great for them to apply scientific concepts and see the role of the elements, in our case wind, in the bigger context of Climate Action.

Due to the combination of the STEM tasks and concepts of the Humanities, the whole project process became even more interdisciplinary and innovative. Students developed an in-depth understanding of global issues. For example, in our core activity 3 and 4, we discussed SDG 7 Affordable and Clean Energy as participants learnt about various kinds of wind farms used in Europe and discussed their usefulness in our area. We also touched upon SDG 3 Good Health and Well-Being, SDG 12 Responsible Consumption and Production and, of course, SDG 13 Climate Action. The seasonal smog becomes a highly debated issue in our region every year, and our students were able to learn more about this phenomenon from local examples, the local media and got familiar with the solutions

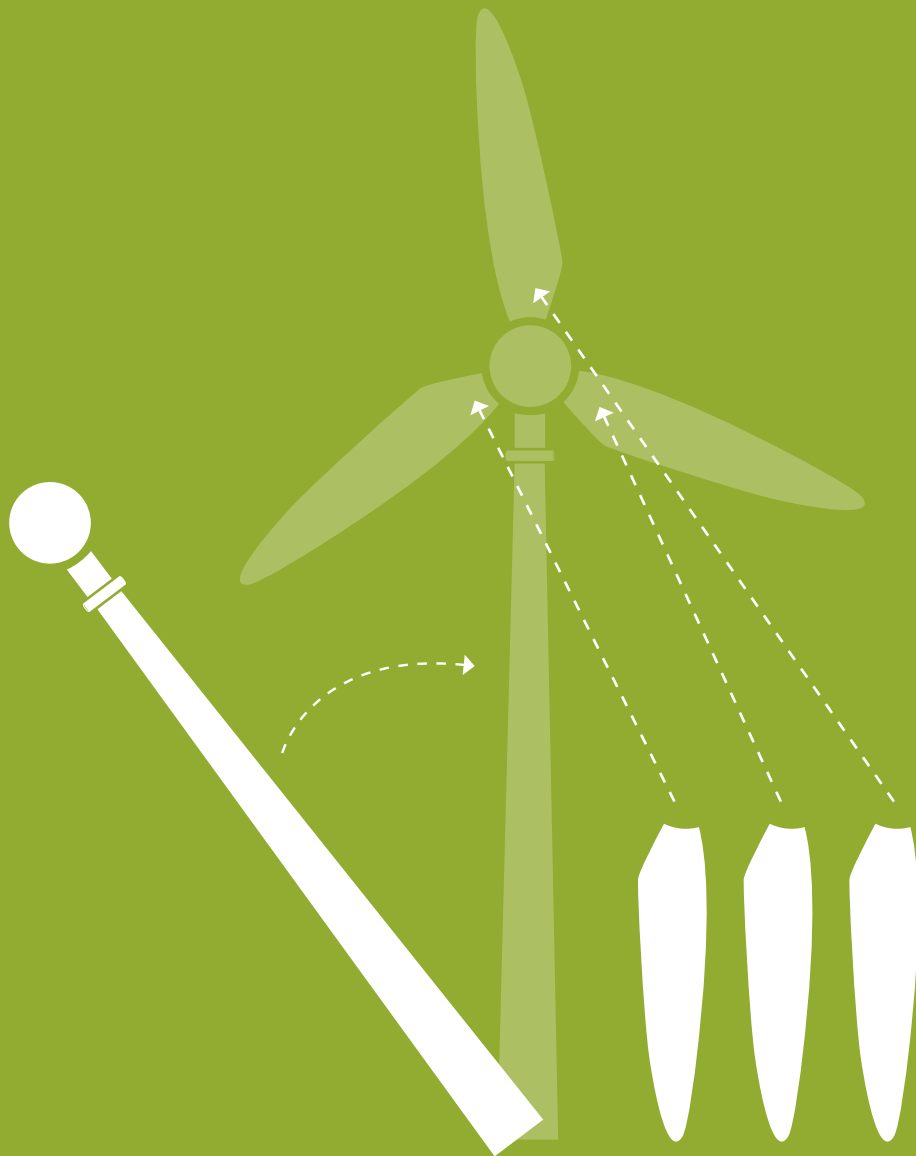
proposed by our governments and the local authorities. While they worked in groups on their various tasks, our students had the chance to give presentations, cooperate with each other and widen their horizons by using the IoT device and exploratory tools. The project offered many opportunities to train 21st Century Skills. Apart from strengthening skills such as innovative ways of thinking, problem solving or ICT skills by using various online platforms and applications, we think two areas of learning and development were particularly meaningful: the project instilled in our students a greater feeling of personal and social responsibility for the world, and they were able to demonstrate initiative and leadership towards Climate Action.

As teachers, how would you describe the overall experience of conducting the session and developing the Teaching Module?

The whole project experience was greatly educational. It made us understand that it is possible to combine completely different types of activities for the students' advantage. Our team of teachers aimed at mixing two dimensions of the tasks: didactic and entertaining ones. Observing the students' engagement and smiles on their faces was the most rewarding part. Another benefit was that we could introduce STEM education by using new, innovative pedagogies and technologies. As for the challenges, it was sometimes difficult to pack the project tasks into the school curriculum work and to cope with the various restrictions and constraints by the ongoing COVID-19 pandemic. At the end, however, we succeeded in designing and conducting a lesson plan that can be integrated within the existing curricula and can be used in two versions: for classroom-based lessons and online teaching.

Looking ahead, we would like to present our work to more teachers at our schools and beyond. Our Teaching Module is without doubt an exciting activity for special project weeks in schools which focus on environment and climate change related issues. We are also interested in introducing the activity to our peers from the eTwinning community through workshops, online trainings, or a conference. Many eTwinning projects are STEM-oriented, and our ideas might be inspirational for other European educators.

2.2 Teaching Module 1
Wind
Module Ideas



Worksheet Teaching Module 1

Wind

CONTEXT

Burning fossil fuels, particularly coal, is one of the biggest contributors to climate change. In addition, air pollution caused by coal-powered plants or domestic purposes poses a major threat to the environment and human health. With wind discharging and transporting hazardous pollutants to far distances, air pollution turns from a local to a regional problem no matter the source.

FIND A SOLUTION!

What are options of non-fuel combusting renewable energy as clean energy sources to generate electricity for commercial and private usage?

How can we leverage on the power of wind?

LEARNING GOALS FOR STUDENTS

Gain deeper insights into the causes and impact of climate change, in particular wind weather patterns and how they affect daily life in the V4 countries

Understand the importance of environmental monitoring for scientific purposes, and examples on how IoT, Big Data and AI can be used to monitor wind weather patterns

Strengthen the 21st Century Skills in areas such as information literacy, digital literacy, creativity, team work and critical thinking

Build a sense of Global Citizenship through intercultural collaboration and interactive learning opportunities

Appreciate the various efforts made by governments and civil society towards the UN Agenda 2030 and become an advocate for the Sustainable Development Goals (SDGs)

INVESTIGATE & EXPLORE!

Be a Global Citizen! Leading questions for students

What are the possible man-made sources of pollution in your region and what is their impact on the public's health?

Is your town a suitable place to set up a wind park? Why or why not?

How can individuals, communities and businesses commit to more sustainable consumption and production?

What role can each of us play to promote Climate Action and Walk the Talk?

What can local authorities do to reduce smog and air pollution? Who are the key stakeholders that need to be engaged to mitigate the problem and find a solution?

INVESTIGATE & EXPLORE!

Reveal the Data Analyst & Scientist within you! Leading questions for students

Get the basics right: Gentle, moderate, fresh, strong breeze – near gale, gale, severe gale or storm? How do we measure wind speed and wind direction?

Dig deeper: Wind travels over land or water. What are the environmental and geographical factors that affect the different strength and direction of wind?

Apply science in daily life: There are five major wind zones on earth: polar easterlies, westerlies, horse latitudes, trade winds, and the doldrums. How do these wind zones affect each other? In which wind zone are the V4 countries located and are there typical wind patterns?

IDENTIFY, UNDERSTAND & APPLY! Ideas for Individual Learning, Team and Peer Collaboration among Students

Warm-up Activities

Brainstorming: ... Hurricane, windmill, headache, autumn ... What do you associate with wind? Brainstorm, collect ideas and create a word cloud with Mentimeter or Answergarden.

Gamification: Use the ideas from the word cloud, define each term and develop a quiz with Learningapp Quiz.

Virtual Visit: Get to know how your peers study, visit them virtually and enjoy a guided tour on their schools campus through Google Earth.

Core Activities

Embark on a data collection journey & analyse!

Understand the technical basics of the IoT device and the usage of the IoT Exploratory Platform

Learn key terms & the process of data collection. Collect data on various aspects of wind speed direction with the IoT device

Learn how to record data in a science log and conduct data analysis

Evaluate and present data findings

1

INTERDISCIPLINARY ELEMENTS: Think STEAM not only STEM!

Wind in Visual Arts: Wind is invisible, but many artists have found techniques and motifs to capture it in their paintings. Visit a nearby art museum and/or take a virtual tour through famous art galleries. The element of wind is seen everywhere!

Wind as a Movie Theme: There are many action movies on the destructive force of strong winds, but one movie in particular from the late 1930s is different. "Gone with the Wind" won 10 Oscars and belongs to the classics in movie history. A must watch!

Wind as a Theme in Songs: Have you heard about the rock band 'Scorpions'? In the early 1990ies, their song "Wind of Change" topped the music charts worldwide. Listen to the song on YouTube and find out the meaning of the lyrics.

Wind in Literature: Wind has always been a popular theme in literature and was used to describe change, direction, destruction, freedom, love or travel, amongst others. What does it symbolise to you and your peers?

Explore wind conditions in different geographic locations and compare the findings!

Determine prevailing wind directions, average wind speed, the relationship between wind speed and atmospheric pressure and humidity in the different geographic locations

Compare the findings between your schools

2

Understand and apply: Assess the feasibility of setting up a wind park in your region!

Conduct online research on the establishment and operations of a wind park

Evaluate the feasibility of setting up a wind park in your town/region

Prepare a mind map and identify relevant stakeholders in this process

Present your findings and conclusions

3

Understand and apply: Make predictions for air polluted areas!

Conduct online research on air pollution levels in your city and region, and their various causes

Predict areas of risk for air pollution in your city and region depending on seasonal winds

Prepare a mind map and identify relevant stakeholders to mitigate future air pollution scenarios

Present your findings and conclusions

4

MATERIALS, TOOLS AND EQUIPMENT

Computer and Internet Access
Microsoft Office (Excel, PowerPoint & Word),
Google Docs, Google Earth, YouTube
Answergarden, Mentimeter, Learningapp Quiz
IoT Device set up on school campus to record data, IoT Exploratory Platform

2.2

Teaching Module 1

Wind

Examples of the Project Work and Results

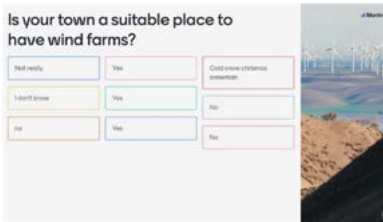


Warm-up Activities:

2.2 Brainstorming, Knowledge Foundation and Virtual Visits to project schools



Brainstorming exercise for students using the online tool AnswerGarden



Poll with students using the online tool Mentimeter



Quiz on wind developed by students using the online tool LearningQuiz



Quiz on wind developed by students using the online tool LearningQuiz



Google Earth view on Bugat Pal Secondary Technical School, Székesfehérvár, Hungary



Google Earth view on Copernicus Upper-Secondary School, Tarnobrzeg, Poland



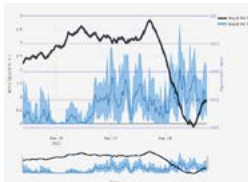
Google Earth view on Besst Gymnazium Trnava, Slovakia

Core Activities:

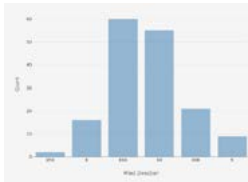
Data Analysis, Wind Conditions and Impact on Daily Life



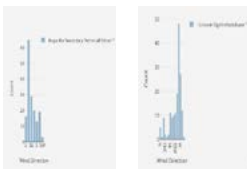
Example of data collection of wind direction and wind speed with IoT device



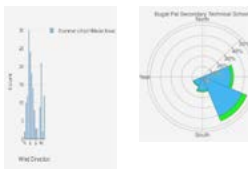
Example of data collection of wind direction and wind speed with IoT device



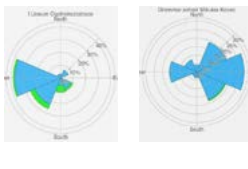
Example of data collection of wind direction and wind speed with IoT device



Example of data collection of wind direction and wind speed with IoT device



Example of data collection of wind direction and wind speed with IoT device



Example of data collection of wind direction and wind speed with IoT device



Example of research by students on air pollution; Source: European Air Quality Index <https://airindex.eea.europa.eu/Map/AQI/Viewer/>



Example of research by students on air pollution and smog in Poland; Source: European Air Quality Index



Example of research by students on air pollution and smog in Poland; Source: Radio leliwa

2.3 Teaching Module 2 Rain



Reflections by Teachers

The second V4IoT Teaching Module on Rain casts the light on climate change and how it affects the intensity and frequency of precipitation. Teachers and students examine the importance of rain for the environment and human life and discuss examples of extreme weather and precipitation conditions, either heavy rainfall events or droughts. Students also learn about water as a scarce natural resource and how to use water economically and more responsibly in school, at home and in other areas of life. The Module takes an interdisciplinary approach, with the STEM lesson being conducted in the form of a role play and the set-up of a court trial. Students switch into the roles of the accused, the prosecutor, defense attorneys, witnesses and the judge on a legal case that focuses on “man-made violations and crimes” against water: water pollution, water wastage and changes in the water cycle.

This Module was developed by a team of three teachers based in Poland in partnership with the ASEF Classroom Network Team. They share their experiences and lessons learnt during the development of the Module.



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Teaching Module 2

Rain

Why did you choose the theme “Rain” for your V4IoT Teaching Module?

Water is the source of all living things on earth: plants, animals and human beings. Over 70% of the earth's surface is covered by water. 97% is saltwater and only 3% is freshwater, mostly frozen in glaciers and ice caps or found as groundwater deep below the surface. Although water is one of the most precious natural resources, it is under extreme threat due to pollution and the increasing demand by industry, agriculture and private consumption.

Many scientists warn about the impact of climate change on the water cycle. Just look at how climate change effects precipitation patterns: the intensity and frequency of rainfall and, hence, water availability, are becoming less and less predictable. Over the last two years, several countries in the Visegrad region have been hit by severe and disastrous floods due to excessive rainfall. People had to be evacuated from their homes and several died. The damage on buildings and infrastructure was tremendous. Likewise, we experienced long periods of no rainfall and our local agriculture, production as well as health suffered from heat waves and droughts. On top of it, water pollution and acid rain have devastating effects on our ecosystems and we need to find solutions for a more sustainable and efficient water usage.

We developed this Module so that students learn about how essential water, in this case rain, is for our life, as well as, how both the impact of climate change on the water cycle and water pollution bring great dangers.

Your Teaching Module places a great emphasis on interdisciplinarity. What kind of activities did you design during the project phase and how did you blend elements and content from STEM subjects with those of other subjects?

We decided to design a Teaching Module in the form of a Court Trial through role-play to give students an opportunity to think in an interdisciplinary way and to develop a framework for diverse interactions and cooperation. Students had to choose their roles and prepare prior to the lesson. It was a fresh and highly motivating activity and teachers only had to supervise and help where necessary.

Students could play one of the following parties: 1. the prosecutor: Mrs WATER, 2. the accused: MANKIND, 3. the defence attorneys: MANKIND, 4. the witnesses: Mr AIR, Mrs LIQUID WATER, Mr RAIN and Mr SOIL, and 5. the judge: Mrs SDGs.

The court trial started with an 'Introductory Speech' by the prosecutor, Mrs WATER, supported by WATER party experts. The WATER experts – all played by students – had to build a case on the importance of water for the environment and humanity, present the unique structure and features of water and highlight MANKIND's violations towards water. The WATER experts also informed the trial attendees about the dangers of extreme weather conditions – excessive rainfall or lack of precipitation – and the destructive forces by water.

A summons to witnesses was issued and interviews were conducted with four witnesses: Mr AIR presented the case of acid rain and its danger to the soil and aquatic environments such as marshes, streams, rivers or lakes. Mrs LIQUID WATER made allegations of water pollution and sewage against MANKIND and pointed out their consequences for the environment. Mr RAIN highlighted its role for the environment and human life and how climate change leads to extreme weather and unpredictable precipitation conditions. Mr SOIL accused MANKIND of deforestation and biodiversity degradation which affects the depletion of groundwater in many regions.

The defence attorneys, who represented MANKIND at the trial, were then allowed to respond to the allegations and present their proof of actions towards environmental conservation and combatting climate change.

The court trial ended with a 'Closing Speech' and the 'Verdict' by the judge, Mrs SDGs. Not surprisingly, MANKIND was found guilty and Mrs WATER won the case, being indispensable for life on earth. The judge sentenced MANKIND to indefinite community service and to commit to concrete actions towards water conservation and environmental protection.

The teachers did their best to employ interactive, project-based and learner-centred pedagogy in this Teaching Module. Through the court trial and role-play, students were encouraged to put themselves into

2.3 Teaching Module 2

Rain

the shoes of diverse stakeholders and think for present and future generations. To prepare for their different roles, students had to collect and analyse weather data both from the IoT device as well as official data from the Polish Central Statistical Office. When presenting their conclusions at the trial, this data served as proof and evidence for their case.

The Teaching Module offers a myriad of options for interdisciplinary approaches and different subject teachers are encouraged to cooperate. In our case, we included elements from the environmental sciences and social studies in the form of a court trial where students had to act and debate. Beyond these, Maths teachers could for example focus on liquid units, calculate water capacity and density. Health Education teachers could analyse the symptoms of dehydration and the ways to cope with them. English teachers could support and connect with schools abroad. Together with STEM teachers, they could arrange online conferences for students to compare water management and challenges linked to changes in the water cycle in in their respective countries.

The V4IoT aimed to strengthen the 21st Century Skills among teachers and students in areas such as information literacy, digital literacy, creativity, teamwork and critical thinking. What were your experiences during the project?

Our students became much more aware of how essential 21st Century Skills are nowadays for one's personal, educational and professional growth. We tried to achieve this in various ways through our Teaching Module: our agile framework taught time management, joint tasks and team collaboration promoted responsibility and accountability, and we trained students to adapt to new circumstances. By exposing the students to fake and real news as part of the lesson elements, they further developed critical thinking skills. Throughout the whole project, students had to analyse and synthesise what they hear and at the end, come to personal conclusions based on evidence-based information and a thorough assessment. Overall, we had a very rewarding experience. We gathered a group of highly committed teachers and students and closely collaborated despite different personal schedules and responsibilities. Of course, we also experienced some challenges during the cooperation and had to encourage a few teachers to follow up, while simultaneously

dealing with a time-consuming project schedule. We do hope that the group can continue to work successfully on some other projects in the future.

How did your project address the Sustainable Development Goals (SDGs), which build the foundation for Education for Sustainable Development?

We addressed several Sustainable Development Goals during our project work, starting with SDG4 – Quality Education: our participation in the V4IoT project was a unique and lifelong learning opportunity, not only for the students but also for the teachers. By providing each school with an IoT device, all of us had access to new information, large data sets to explore, and various tools to work with on the IoT Exploratory platform. We could share knowledge with other schools and exchange ideas on lesson plans. As we focused on the topic of water and rainfall, discussions and project activities naturally tackled issues that fall under SDG6 – Clean Water and Sanitation. Research questions for our students included for example: What are effective local and national drought policies? What kind of mitigation measures can governments take to respond to droughts? What is the responsibility of each individual in saving water? SDG13 – Climate Action – was at the centre of our Teaching Module. We collected data on rainfall rates and analysed the effects of excessive and lack of rain in our city and region. In this context, we also discussed the problems of acid rain and desertification. As mentioned earlier, we designed the activities of the Teaching Module in the format of a court trial and approached the topic of Climate Change and rainfall in a very interdisciplinary way. Apart from STEM related issues, this allowed our students to get familiar with our legal system and to learn that every citizen is equal and has the right to get a just verdict – as promoted by SDG16 on Peace, Justice and Strong Institutions. Lastly, this Handbook presents the outcome of our three-month long collaboration. It will hopefully inspire educators in other schools and academic institutions and promote sustainable development. Through this, we make our contribution to strengthen SDG17 – Partnerships for the Goals.

In terms of future outlook and sustainability efforts of your school, do you have already have plans?

UNESCO's Associated Schools Network (ASPnet) connects schools across the globe with the objective to promote Global Citizenship Education (GCED) and Education for Sustainable Development. We are not yet an official member of ASPnet, but we do already meet several criteria that are aligned with the Network's principles for sustainable development: for example, the school is introducing solutions on how we can reduce our carbon footprint on an operational level and in classrooms. We actively participate in local community activities and do voluntary work in animal shelters. We are also planning to build bee hotels to support sustainable development in the neighbourhood and plant trees and various herbaceous plants to protect local biodiversity. The school promotes a healthy lifestyle and efforts on well-being, and we take pride in organising many sports events and workshops on depression, violence, discrimination, as well as trainings in CPR (cardiopulmonary resuscitation) for both students and teachers. To advocate for equal treatment, we are currently developing an official school policy called 'The Code of Equal Treatment'.

We definitely aspire to become a school that drives sustainable development, and constantly explore how we can play our role and contribute to the achievement of the SDGs.

“The project helped me to sensibilise my students and make them aware of the various impacts of Climate Change. It was an international collaboration, but it also motivated us to take actions in our community to support local biodiversity.”

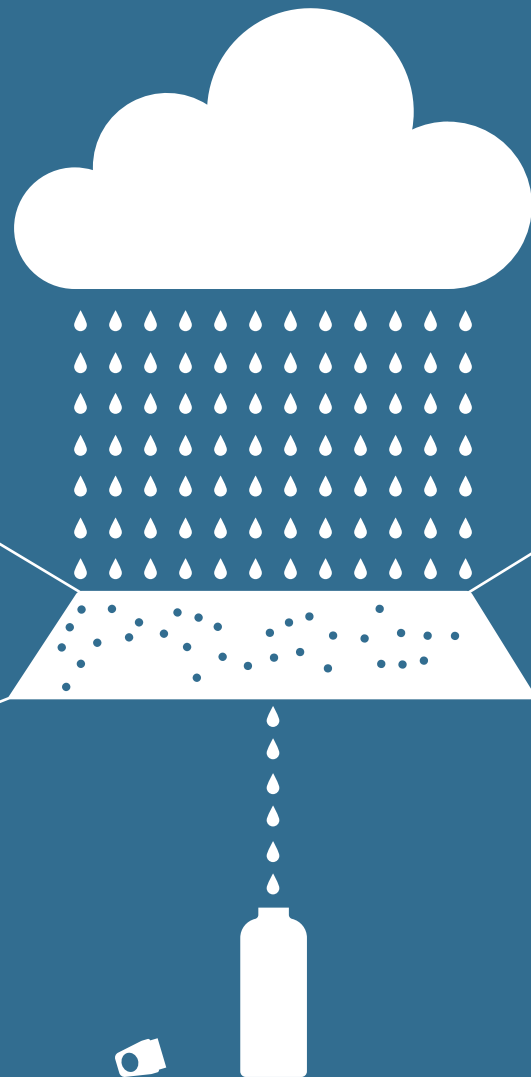
Agnieszka Kowal
Zespół Szkół Informatycznych, Poland

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Teaching Module 2

Rain

Module Ideas



Worksheet Teaching Module 2

Rain

CONTEXT

Water is the source of all living things on earth: plants, animals and human beings. Although water is one of the most precious natural resources, it is under extreme threat due to pollution and the increasing demand by industry, agriculture and private consumption. Furthermore, the impact of climate change on the water cycle – evaporation and precipitation patterns – is severe, which is shown by the increase in devastating floods or periods of drought.

BUILD A CASE TO PROTECT WATER!

What are the main properties of water and their importance for the environment?

Which role does the water cycle play in a balanced ecosystem?

What commitments are needed by civil society, business and government – to protect and save water?

LEARNING GOALS FOR STUDENTS

Gain deeper insights into the causes and impact of climate change, in particular how changes in precipitation patterns affect your local environment and the V4 region

Understand the importance of environmental monitoring for scientific purposes, and examples on how IoT, Big Data and AI can be used to monitor the water cycle as well as water pollution

Strengthen the 21st Century Skills in areas such as information literacy, digital literacy, creativity, team work and critical thinking

Build a sense of Global Citizenship through intercultural collaboration and interactive learning opportunities

Appreciate the various efforts made by governments and civil society towards the UN Agenda 2030 and become an advocate for the Sustainable Development Goals (SDGs)

INVESTIGATE & EXPLORE!

Be a Global Citizen!

Leading questions for students

What are the main causes for water pollution? How can we better protect water ecosystems, such as rivers, lakes and wetlands, in the V4 countries?

How can we overcome the challenge of water scarcity? What role do individuals, communities and businesses play in using water more efficiently and sustainably?

Do you know of any V4, regional and international initiatives and collaborations that focus on water and water disaster management? What are the benefits of such cross-country collaborations?

Sustainable Development requires partnerships at all levels. How can we ensure that all stakeholders are committed and engaged in an inclusive and participatory cooperation? What do you expect from an effective, accountable and transparent institution, as set in SDG target 16.7, to combat climate change?

INVESTIGATE & EXPLORE!

Reveal the Data Analyst & Scientist within you!

Leading questions for students

Get the basics right: Water has unique physical properties, so unique that it is called "the weirdest liquid on planet" or "the most unusual substance on earth". What makes water special?

Dig deeper: Climate change has a strong impact on the water cycle. It increases the risk of both heavy rains and extreme droughts. Why is this not a contradiction?

Apply science in daily life: Water is also called the "universal solvent", which makes it highly vulnerable to pollution. Polluted water is unusable for drinking, cooking, swimming, and other activities. What are the different levels for water quality?

How is water made safe in the public water supply? Is the tap water at your home safe?

IDENTIFY, UNDERSTAND & APPLY!

Ideas for Individual Learning,

Team and Peer Collaboration among Students

Immerse into the topic of climate change and water pollution through a role-play:

Attend the court trial against MANKIND

Main protagonists, played by students:



Prosecutor
Mrs WATER



Accused
MANKIND



Defense attorneys
Representatives of
MANKIND



Witnesses
Mr AIR
Mrs LIQUID WATER,
Mr RAIN
Mr SOIL



Judge
Mrs SDGs

Phase 1 of Court Trial

Opening Statement and Introduction

Script: The Prosecutor, Mrs WATER, supported by WATER party experts, opens the trial and highlights the importance of water for life on earth. She builds her case and accuses MANKIND of violations against water, as seen in water pollution, water wastage and changes in the water cycle. The WATER experts also remind the attendees of past devastating floods and droughts, which are an evidence of the impact of climate change on the water cycle.

Proposed Topics to be covered

Unique properties & structure of water

Complexity of the water cycle and its importance for our ecosystem

Water usage by private households, industry and agriculture; water wastage and pollution by various stakeholders

Socio-economic impact of extreme weather conditions (excessive or lack of rainfall) and natural disasters such as floods or droughts

Legislative system, court procedures and processes

Group Work

Mind map on Water and Rain

Water always finds a way... Create a mind map to discover how water is connected to our daily life and map out what you associate with water and rain

Quiz on SDG6 'Clean Water and Sanitation': These two infographics by the UN can inspire with statistics and provide food for thought on the topic! Refer to the stats and create a short quiz, for example with Mentimeter.

<https://www.unwater.org/publications/sdg-6-infographics/>

https://www.un.org/sustainabledevelopment/wp-content/uploads/2019/07/E_Infographic_06.pdf

2

Phase 2 of Court Trial

Interviews of Witnesses and Responses to Allegations

Script: The Prosecutor, Mrs WATER, supported by WATER party experts, opens the trial and highlights the importance of water for life on earth. She builds her case and accuses MANKIND of violations against water, as seen in water pollution, water wastage and changes in the water cycle. The WATER experts also remind the attendees of past devastating floods and droughts, which are an evidence of the impact of climate change on the water cycle.



Proposed Topics to be covered

Critical reflection on causes and effects of water pollution on the ecosystem

Discussion on sewage, sewage plant and sewage treatment process

Look into the future of wastewater, water usage and risks research: sensors might be able to analyse how many people have an infectious disease. How could such sensors be used to improve our environment and reduce risks.

In-depth analysis of causes, chemical composition and effects of acid rain

Research on the influence of deforestation and biodiversity degradation on desertification and ground water levels

Study of weather conditions and factors that influence frequency and intensity of rainfall

Comparison of excessive rainfall or no precipitation on the ecosystem

Group Work

Nulla poena sine culpa (Latin) –
“No punishment without fault/culpability”

Be careful with your data collection and analysis using the IoT device, exploratory platform and other sources for environmental monitoring!

Prepare your arguments in this trial based on evidence only!

Put yourself in the shoes of the accused and defense attorneys to foresee possible counter arguments



3

Phase 3 of Court Trial

Closing Speech and Verdict

Script: After a thorough deliberation, the judge, Mrs SDGs, addresses the court attendees and summarises the key points presented by the prosecutor, the four witnesses and the defence attorneys. In the verdict, MANKIND was found guilty of all charges. As the judge reads the sentence, she stresses the aggravating and mitigating factors to MANKIND's offence which must be taken into consideration for the sentence. MANKIND is sentenced to indefinite community service, which includes a number of policies and actions in the areas of environmental protection.

Group work and assignment

Conduct research and create a priority list of policies and actions for 3 key stakeholder groups:

Private Households
Industry
Government

Make a “Climate Action and Water Protection” checklist for your class and demonstrate over a period of one month your commitment to the SDGs! Who will you select as SDG6 and SDG13 Class Ambassador?

MATERIALS, TOOLS AND EQUIPMENT

Computer and Internet Access
Microsoft Office (Excel, PowerPoint & Word)
Google Docs
IoT Device set up on school campus to record data, IoT Exploratory Platform

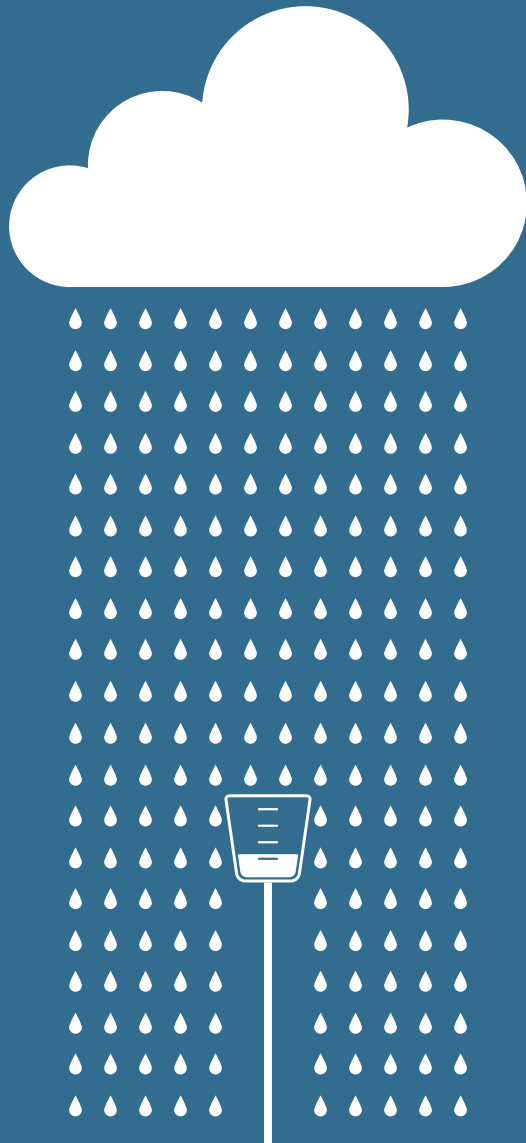


2.3

Teaching Module 2

Rain

Examples of the Project Work and Results



2.3 Photo Gallery and Examples of Data Collection during Project Phase



Teacher introduces the assignment



In action: students from Zespół Szkół Informatycznych collaborate on a project assignment



In action: introductory speech by student from Zespół Szkół Informatycznych during the role play, representing the prosecutor Mrs. WATER



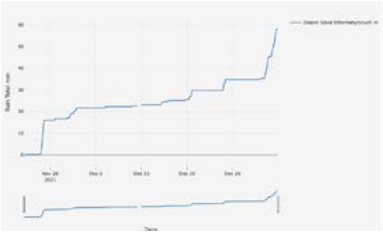
In action: students from Zespół Szkół Informatycznych during the role play while listening to the verdict



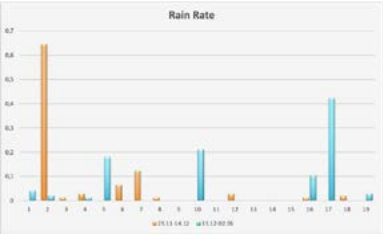
Demonstration of experiments during the Teaching Module



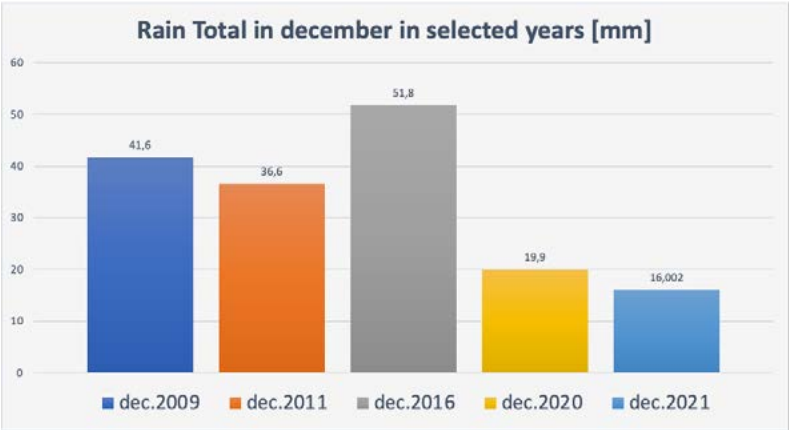
Brainstorming in small groups during the Teaching Module



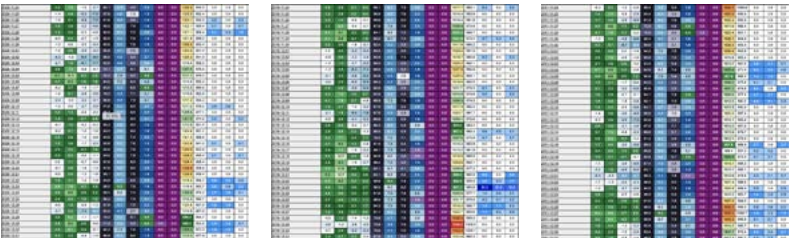
Example of data collection of rainfall with IoT device



Example of data collection of rainfall with IoT device

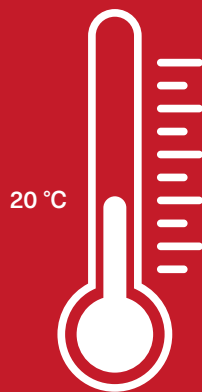


Example of research and data presentation by students: historical data of rainfall in city in December over the last decade



Example of research and data comparison by students: historical data of rainfall in city in December over the last decade
<https://meteomodel.pl/dane/histeryczne-dane-pomiarowe/?data=2020-12-31&rodzaj=st&imgwid=350200570&dni=60&ord=asc>

2.4 Teaching Module 3 Temperature



Reflections by Teachers

The third V4IoT Teaching Module on Temperature explores the influence of rising temperatures on human health. Students observe and analyse how high and low air temperatures have different impacts on the human body and well-being and learn about potential life-threatening conditions caused by extreme heat or cold. Lesson elements also examine how temperature affects the movement of air and how this affects air pollution. As a key exercise, students are assigned to collect data and conduct research to develop evidence-based policies and actions. The goal: Keep their local communities informed, healthy and safe!

This Module was developed by a team of seven teachers based in Poland and Slovakia in partnership with the ASEF Classroom Network Team. They share their experiences and lessons learnt during the development of the Module.



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Comprehensive Secondary School
Sieradz, Poland



Jowita Królikowska
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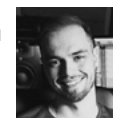
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Jana Vidová
Business Academy Rožňava
Rožňava, Slovakia



Alicja Łaska
Comprehensive Secondary School
Sieradz, Poland



Roman Jakobej
Business Academy Rožňava
Rožňava, Slovakia



Joanna Kamocka
Comprehensive Secondary School
Sieradz, Poland



2.4 Teaching Module 3

Temperature

Why did you choose the theme “Temperature” for your V4IoT Teaching Module?

We wanted to create a Teaching Module that connects two Sustainable Development Goals (SDGs): SDG13 on Climate Action and SDG3 on Good Health & Well-being.

Climate change poses a great threat to sustainable development and public health. All of us have already experienced weather conditions that have an impact on the human body and can lead to different physiological and behavioural reactions. For example, changes in atmospheric pressure increase the likelihood for some people of getting a headache. Others tend to be more irritable and aggressive, or people feel that their ability to concentrate worsens. High temperatures lead to heat cramps, exhaustion, or heat strokes. Extreme temperatures during heat or cold waves can impair the human body and even cause a rapid increase in mortality, particularly among the most vulnerable groups – young children and the elderly. Heat can also affect the air quality, as it increases the number of air-born allergens and pollutants.

It is crucial to create early warning and mitigation systems against unfavourable weather conditions. Moreover, people should be provided with thorough information about the dangers of extreme weather and temperature conditions on their health and how to protect themselves.

The Carpathians belong to the hotspots in Europe where frequent heatwaves occur in summer. In general, all Visegrad countries have experienced several and severe droughts over the last decade caused by long periods of relatively warm or hot weather and less rainfall. Notable was the multi-year drought between 2014 and 2018 and since then, our governments have developed actions plans to mitigate the negative impact of droughts – the Slovak Drought Action Plan and in Poland the Drought Counteracting Plan (PPSS).

Our students will most likely experience scenarios such as extremes of heat and cold waves more frequently in the future. Therefore, it is important for them to learn about these as early as possible.

What research questions did you tackle with your students and how were they engaged in the process?

During our lessons, we built a general knowledge foundation on how extreme temperatures affect public health and focused, in particular, on the impact of temperature on the concentration of air pollutants. Together with our students, we systematically explored three questions: First, does temperature affect air pollutants concentration, and if so, how? Second, how do changes in temperature and extreme temperature affect people's health? And third, as a concluding question, is there a correlation between air pollutants concentration and an increase in diseases and mortality?

Our students were highly involved in the development process of this Teaching Module. First of all, it was them who put together and activated the weather station at our school's campuses. The students retrieved data from the IoT Exploratory platform and other online sources, analysed it and drew conclusions about the independence of the variables in question. They also created a correlation coefficient calculator which can be used not only for the purpose of this lesson but future ones. It was an intense learning journey and a great jump-start into basic data science and data analysis. For example, when our students calculated the correlation coefficient, they learnt a few important lessons on correlation and causation:

1. The existence of a correlation does not necessarily indicate a direct cause-and-effect relationship.
2. There is no cause-and-effect relationship without correlation, but correlation does not mean a cause-and-effect relationship.
3. If a correlation exists then it is valuable to design an experiment to establish whether the correlation is based on a cause and effect relationship.

In the case of our Teaching Module and key questions, the students found a direct relationship between air temperature and the level of Particulate Matter (PM10) dust concentration. As the air temperature drops, the PM10 dust concentration increases – one reason being that more people increase the heating in their homes. The students also confirmed a strong influence of meteorological factors – in particular changes in temperature

Teaching Module 3

2.4 Temperature

– on human health and illness. However, based on their research and data analysis the students concluded that the prevalence of diseases and illnesses and a higher mortality rate were not only influenced by temperature changes, but many other factors, including the ongoing COVID-19 pandemic, challenges in the national health service, etc.

What kind of activities did you conduct during the project phase and include in your Teaching Module?

We started with light exercises to introduce the topic and to allow students to get familiar and practice the terminology and basic concepts of temperature. The main activity of our Teaching Module focused on data research and data analysis. Our students had to find out: Which groups are the most vulnerable to the dangers of rising temperatures and air pollution caused by heat, and why? What kind of early warning and protection mechanisms can be set up to mitigate the impact on these groups?

First, we divided the students in three working groups and assigned different research assignments to each group. The three groups then had to identify and collect relevant data sets, prepare the data, analyse and interpret the results. In Working Group 1, students collected and analysed data on temperature, humidity and wind and used the IoT Exploratory Platform website by ScienceScope as the main data resource platform. Students in Working Group 2 retrieved data on PM10 dust concentration and had to find out in which month the PM10 dust concentration was the highest. They used the website of the National Research Institute NASK, which is a government institution under the supervision of the Chancellery of the Prime Minister of Poland. Students of Working Group 3 had to do research on mortality rates during different periods of the year. We decided that they should analyse the data for people of different ages with respiratory and blood circulation related health issues. They used the website of the Polish Central Statistical Office.

As a second step, students presented their findings to the other groups and discussed the results. They then tried to find a correlation between the different variables – temperature, air pollution level and death rate – using a correlation coefficient calculator. If they discovered a correlation, the students then brainstormed ideas, referred to different data sources and discussed a possible cause-and-effect relationship between the data. Questions in this process included, for example: What does the

data imply? What can be done to prevent this situation and what kind of protection mechanisms have to be put in place to mitigate the impact on people's health? At the end, they had to compile their results and present their conclusions. These two exercises for students, the research assignments and the data evaluation and presentation, can be conducted in the classroom in the form of a scenario planning. We have presented an example for such scenario in our Teaching Module where students have to imagine to spend one week at a workplace to support a research & policy team, in this case the Environment Office of their local municipality. Their job is to assist the team in their daily work on environmental monitoring, evaluation and reporting. You will be also assigned to do some research on the development of policies and actions that keep local communities informed, healthy and safe.

The V4IoT aimed to strengthen the 21st Century Skills among teachers and students in areas such as information literacy, digital literacy, creativity, team-work and critical thinking, and build a sense of Global Citizenship, in line with the goals of Education for Sustainable Development. In which way(s) did your project contribute to these objectives and provided such learning opportunities?

Our project and Teaching Module did not follow linear and theoretical teaching methods. To the contrary, we emphasised a learning-by-doing approach based on team-work and real-life scenarios which were supported by data collection and analysis.

In terms of 21st Century Skills, especially digital literacy, students gained great insights into the concept of IoT and its implementations in daily life. They also learnt how to critically choose and use data sets and statistic information, understood the importance of Big Data for environmental monitoring and forecasting, and practiced how to draw conclusions based on the analysed data. The opportunity to engage in this project helped them to train their mathematical, scientific, and technological competences: master numerical literacy, understand the laws of nature, use technology in finding solutions towards Climate Change, etc.

With regards to the ESD learning objectives, students improved their ability to critically reflect on sustainable development, how to question current policies and practices, how to make informed decisions and acknowledge misdoings in relation to sustainability issues. During our

Teaching Module 3

2.4 Temperature

discussions, they learnt about the inter-connectedness of the Sustainable Development Goals, how policies and actions on a local, national, and global level are linked with each other and that the challenge of Global Warming can only be solved through collaboration and multi-stakeholder partnerships on a global level. In general, interdisciplinary projects like our V4IoT collaboration encourage participants to reflect on their own and other people's norms and values, and learn to handle conflicts of interest, uncertain knowledge and contradictions.

As teachers, how would you describe the overall experience of conducting the session and developing the Teaching Module?

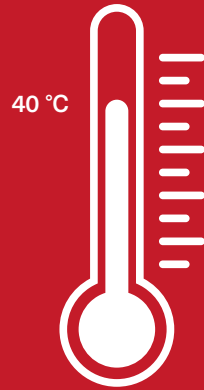
We had a very positive experience. Most of us are non-STEM teachers, but we thoroughly enjoyed discovering with our students new grounds of teaching & learning. It was a novelty for us to work with IoT platforms, to retrieve and analyse data – these are activities we do not do on a daily basis at all. Participation in this project was an opportunity to broaden our knowledge on the concepts of IoT, Big Data and AI and to develop a project on the SDGs and 21st Century Skills based on data coming directly from our own weather station on the school's roof. In fact, this was the most rewarding part of the activity: to work with real life data and implement newly acquired tools into the teaching process. We helped each other using individual online sessions and discussed the topics in detail. Throughout the whole process we have been an inspiration to each other with a great deal of understanding of our shortcomings. Lastly, we believe that there is a need to change some teachers' attitudes towards new approaches in education. Although the concepts of the 21st Century Skills and ESD have been already been around for a couple of years and many initiatives have been conducted to put their principles and objectives into practice, there are still educators who seem not to have noticed the changes.

“The project was a very valuable and positive experience for me, especially gaining insights on teaching & learning approaches that are based on ESD and 21st Century Skills and integrate IoT technology.”

Jana Vidová
Obchodná akadémia Rožnava, Slovakia

2.4

Teaching Module 3 Temperature Module Ideas



Worksheet Teaching Module 3

Temperature

CONTEXT

Climate change and rising global temperatures have a severe direct and indirect impact on people's health and well-being. Extreme temperatures during hot or cold waves can impair the human body and lead to temperature-related morbidity and mortality, diseases, injuries and deaths, and undernutrition. Heat can also affect the air quality, as it increases the number of air-borne allergens and pollutants. Vulnerable groups, including children, the elderly and those already experiencing economic and health challenges, are most affected by these dangers.

PREVENT AND PROTECT VULNERABLE GROUPS!

Which groups are the most vulnerable to the dangers of rising temperatures and air pollution caused by heat, and why?

What kind of early warning and protection mechanisms can be set up to mitigate the impact on these groups?

Protection is important, prevention is crucial. What must mankind do – and you, too, to keep global warming to well below 2 degrees, and preferably limit it to 1.5 degrees?

LEARNING GOALS FOR STUDENTS

Gain deeper insights into the causes and impact of climate change, in particular how rising temperature affect daily life in the V4 countries and can trigger a chain reaction of other extreme weather conditions

Understand the importance of environmental monitoring for scientific purposes, and examples on how IoT, Big Data and AI can be used to manage and minimize the negative impact of extreme heatwaves on the local community

Strengthen the 21st Century Skills in areas such as information literacy, digital literacy, creativity, team work and critical thinking

Build a sense of Global Citizenship through intercultural collaboration and interactive learning opportunities

Appreciate the various efforts made by governments and civil society towards the UN Agenda 2030 and become an advocate for the Sustainable Development Goals (SDGs)

INVESTIGATE & EXPLORE!

Be a Global Citizen!

Leading questions for students

What are the direct and indirect effects of Global Warming on human health and who are the most vulnerable groups in each category? Is the magnitude of the indirect impact potentially more critical?

Is Global Warming only caused by humans or are there any other factors for the rise in temperatures? Which human activities contribute the most to Global Warming?

Do you know about any controversial or fake news about Climate Change where education and awareness raising of the public would be important?

INVESTIGATE & EXPLORE!

Reveal the Data Analyst & Scientist within you!

Leading questions for students

Get the basics right: Why are there still record-breaking winters in the V4 region despite Global Warming? The terms Climate Change and Global Warming are often used interchangeably but have different meanings. Can you explain these?

Dig deeper: Some places on earth are more susceptible to higher temperature changes. Which areas are more likely to be affected by these large extremes and why?

Apply science in daily life: Science is not only about big questions. The average body temperature is 37 degrees. What is the ideal ambient temperature for humans – indoors and outdoors? How can people survive in heat zones like deserts?

IDENTIFY, UNDERSTAND & APPLY!

Ideas for Individual Learning,

Team and Peer Collaboration among Students

Imagine the following scenario ...

You are in your final year in Secondary School. To gain first-hand work experience, all students spend one week at a workplace of their choice. Your STEM teacher connects you with the Head of the Environment Office in your municipality who offers you to join his research team.

Your job is to assist the team in their daily work on environmental monitoring, evaluation and reporting. You will be also assigned to do some research on the development of policies and actions that keep local communities informed, healthy and safe. An exciting week is ahead of you and your supervisor has already prepared your job scope:



Your Assignment

During the past months, the Environment Office received many enquiries by local residents about the high air pollution in the city. Air quality is at poor to very poor levels and the residents are concerned about their health. Several of them report on respiratory irritations, ranging from milder symptoms such as shortness of breath to severe asthma periods and chest pains.

The local authorities are alarmed and review the situation. An in-depth evaluation shall provide evidence and recommendations to develop a strategy and action plan that improves and safeguards the air quality. Your supervisor asks you to work with the research team on the following three questions:

1. How do temperature changes affect people's health?
2. Does air temperature affect the concentration of air pollutants, and if so, how? Is there a difference during winter and summer months, and between cold and heat waves?
3. What are the major air pollutants and how is human health affected by short-term and long-term exposure? Could there be a correlation between the concentration of air pollutants and an increase in specific diseases and illnesses, or even the mortality rate among residents – as seen recently in the municipality's statistics?



IDENTIFY, UNDERSTAND & APPLY!

Ideas for Individual Learning, Team and Peer Collaboration among Students

1

Research Assignment 1

Support your team with background research and collect and analyse data on temperature, humidity and wind speed & direction in your city over the past 2 months! Create relevant charts as an individual assignment and then discuss the results with your team.



Investigate correlations between wind direction, speed and temperature at different times of the year.

Investigate how humidity levels are influenced by temperature and explain why.

Data source: IoT Exploratory Platform

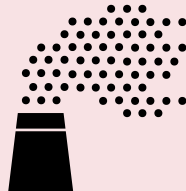
2

Research Assignment 2

Go deeper into the topic and retrieve data on PM10 dust concentration in your city. Analyse the data and find out in which month the PM10 dust concentration was the highest! Ensure that you document your findings in a presentable way.

Use data from the IoT Exploratory and identify weather factors that correlate with high PM10 pollution levels.

Data source: National Statistical Offices – Czech Statistical Office, Hungarian Central Statistical Office, Polish Central Statistical Office, Statistical Office of the Slovak Republic



3

Research Assignment 3

This task is about research on the local population, which can be an emotionally demanding task. You have to do research on morbidity and mortality rates, analysing the data for different periods of the year and people of different ages. What kind of data is available? Do you find statistics on the most vulnerable group of people with regards to air pollution and heat – those with respiratory and blood circulation related health issues? Do your individual research and compare your results with the ones of your team members.



Data source: National Statistical Offices – Czech Statistical Office, Hungarian Central Statistical Office, Polish Central Statistical Office, Statistical Office of the Slovak Republic

IDENTIFY, UNDERSTAND & APPLY!

Ideas for Individual Learning, Team and Peer Collaboration among Students

Analysis and Conclusion

Causation and/or Correlation? What is a correlation coefficient calculator?

Dig deeper, learn about the difference between causation and correlation from your supervisor at the Research Team (in this case your STEM teacher) and answer the following question: Is there a causation and/or correlation between the different variables – temperature, air pollution level, morbidity and death rate?

Develop early warning measures and protect the local community!

Liaise with the Communication Department of the Municipality and create a communication campaign on a Public Health Advisory for A) Healthy People, B) Elderly, Pregnant Women And Children, C) Persons With Chronic Lung Or Heart Diseases. What kind of factual information needs to be included, what recommendations do you give and what are the best ways for the Health Advisory to communicate with and reach the relevant target groups?

Walk the talk! Each stakeholder plays a role in combatting Global Warming!

In 2015, the Paris Agreement was adopted by 196 Parties at the Conference of Parties (COP21) in Paris. It is a legally binding international treaty on climate change. Countries and organisations agreed to set the goal to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. Do a stakeholder mapping in class, work in groups and select a specific stakeholder group: Which role do you play to fight Global Warming and, with it, decrease environmental pollution. What are your choices of actions? Arrange a roundtable with all stakeholder groups and discuss each expectations towards each other and achievements.



MATERIALS, TOOLS AND EQUIPMENT

Computer and Internet Access
Microsoft Office (Excel, PowerPoint & Word)
Google Docs
IoT Device set up on school campus to record data, IoT Exploratory Platform



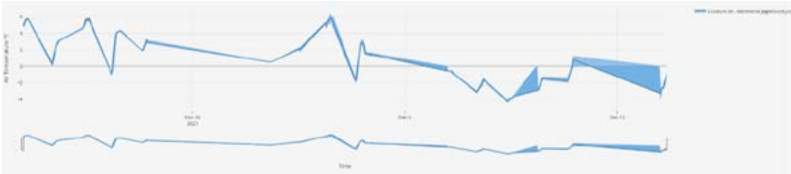
Teaching Module 3

2.4 Temperature

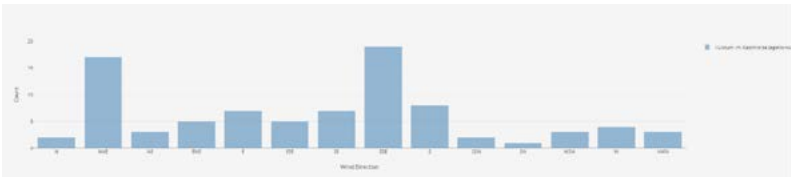
Examples of the Project Work and Results



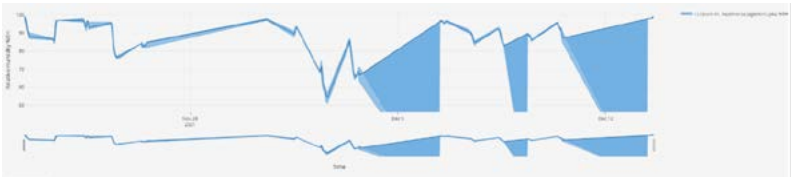
2.4 Research Activity 1: Data collection – Temperature, Wind Direction and Relative Humidity



Example of data collection of air temperature with IoT device



Example of data collection of wind direction with IoT device



Example of data collection of relative humidity with IoT device

Students' data collection on temperature, wind and humidity with the IoT device
Source: <https://exploratory.sciencescope.uk/>

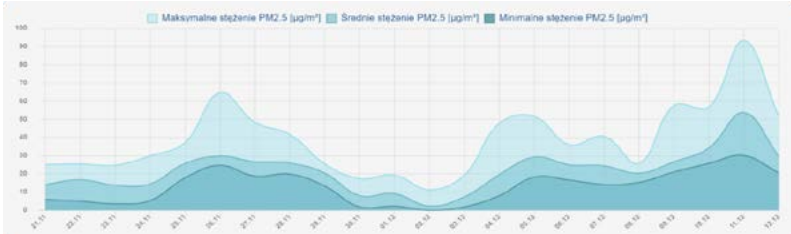


Students from Business Academy Rožňava, Slovakia, join the virtual session with their teacher participants



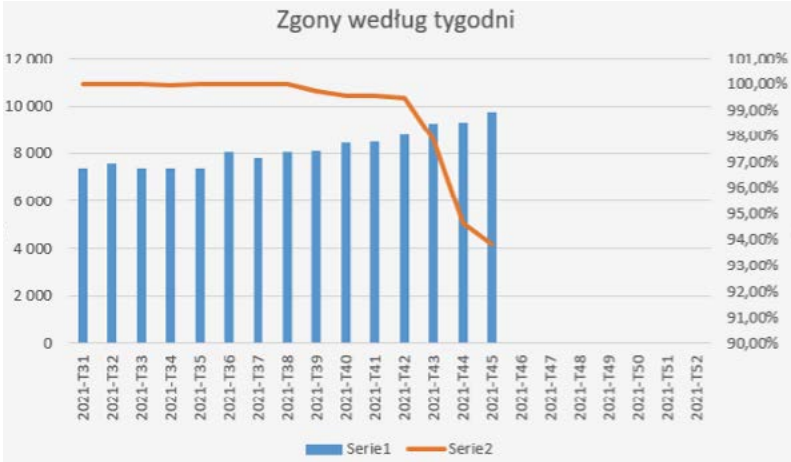
Weather station installed on the rooftop of Comprehensive Secondary School in Sieradz, Poland

Research Activity 2: PM10 dust concentration

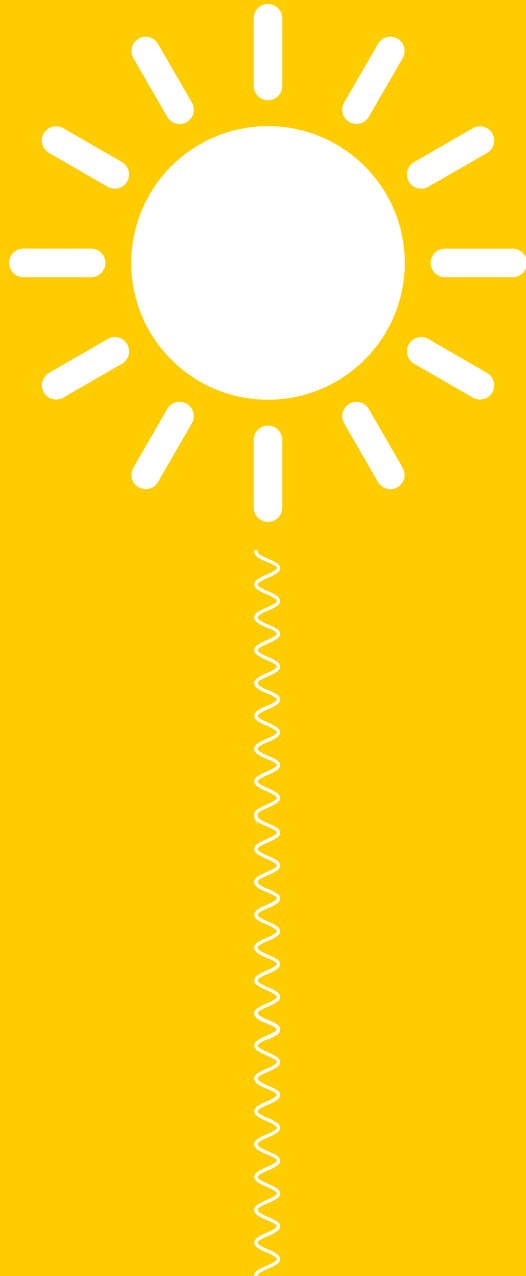


PM10 dust concentration data in Sieradz City from the detector installed in the school over the period from 21 November to 12 December 2021. Source: <https://esa.nask.pl/szkola/id/755>

Research Activity 3: Data collection on Mortality



Mortality rate in Lodz Voivodship, covering the 31st week of 2021 till 45th week of 2021
Source: <https://stat.gov.pl/obszary-tematyczne/ludnosc/ludnosc/zgony-wedlug-tygodni,39,2.html>



Reflections by Teachers

The fourth V4IoT Teaching Module on Solar Radiation tackles the importance of solar radiation for life on earth and examines the different forms and types of solar radiation. In particular, the Module focuses on the advantages and disadvantages of solar power to generate electricity. Students work on the challenge to make their school a pioneer in green energy. They evaluate the option of setting up solar panels on campus and analyse whether or not their schools can entirely rely on renewable solar energy for daily operations. At the end, they have to create a proposal to their school leadership & management.

This Module was developed by a team of four teachers based in the Czech Republic, Hungary and Poland in partnership with the ASEF Classroom Network Team. They share their experiences and lessons learnt during the development of the Module.



Milan Chalupník
Základní škola Seč
Czech Republic



Sándor Ujvári
Lánczos Kornél Gimnázium
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Poznań, Poland



Marcin Bernaś
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Teaching Module 4

Solar Radiation

Why did you choose the theme “Solar Radiation” for your V4IoT Teaching Module?

The transition towards cleaner energy sources is a priority for all V4 countries to meet electricity needs for private, public and business consumption. The sun is one of the most important energy sources. Solar energy is sustainable and inexhaustible and, therefore, increasingly used as an alternative to fossil fuels. Solar energy technologies harness the energy of solar radiation in different ways. The two main technologies are solar thermal and solar photovoltaic systems. With regards to the latter, several large-scale solar plants are currently planned in V4 countries, for example near Belchatow in Southern Poland or near Felsőzsolca in Northern Hungary. When thinking about solar panels, most of us still associate them with residential and commercial buildings. But solar panel installations are not only popular in the private and business context to “go green” and to cover electric bills. Why not install solar panels on a school campus to demonstrate the eco-friendliness of education institutions and to reduce operational costs? There is plenty of unused roof space.

With the IoT devices set up on our respective school campuses, we were able to measure solar radiation at our locations and to develop interesting Teaching Module questions: is the amount of solar radiation on our school campus sufficient to switch from fossil fuel-based energy to solar energy? How much sunlight is needed to make a solar renewable energy system on our school buildings worthwhile? These are great questions for hands-on teaching and learning opportunities.

What research questions did you tackle with your students and what kind of activities did you conduct during the project phase and include in your Teaching Module?

Our Teaching Module encouraged students to conduct data research and then evaluate the results. We used the tools on the IoT Exploratory as well as other platforms that provide weather and solar related data. The Module included tasks for group work but also research assignments which students could complete independently. At the beginning, we focused on the basics and students learnt about the different forms and types of solar radiation. In this context, we briefly spoke about the

dangers of solar radiation, especially the adverse effects of high UV exposure on people’s health.

Our main question that guided the lesson’s activities was: Can we set up solar panels on our three school campuses and rely entirely on renewable solar energy for our school operations?

We first tackled this question from a macro-perspective. Students had to collect data from public statistic offices and assess the general feasibility and potential of using solar radiation to generate electricity in the Czech Republic, Hungary & Poland. We also compared the results with data from other regions in the world and discussed how these would differ throughout the seasons.

We then zoomed in and used the data from our IoT device and the Exploratory Platform to analyse the solar radiation on our schools’ campuses. Students conducted a few experiments to check variations in solar radiation, for example by putting the collector in the shade or by changing the location of the IoT devices.

Our goal was then to find out the electricity consumption and costs of our respective schools. This exercise was important as the students had to calculate the number of solar panels required to power the entire school building during winter and summer months and to make a cost comparison later. How much energy would be stored during different seasons, and would the school require additional energy sources for less-sunny periods throughout the year? What would be the best location for the solar panel on the school campus?

The students then had to do research on appropriate solar panels available on the market, and find out purchase, installation and any maintenance costs. At the end, students had to make an assessment whether the installation of solar panels on their respective school campuses was financially viable. As part of this exercise, students created a balance sheet on gains and losses related to the use of solar energy.

The V4IoT project aimed to strengthen the 21st Century Skills among teachers and students in areas such as information literacy, digital literacy, creativity, teamwork and critical thinking. What were your experiences during the project?

The key characteristic of the project was its interdisciplinarity as it connected several disciplines: ICT, Physics, Geography, Biology, Social Sciences, etc. The fact that our students had to study and interpret data collected from our own weather stations which were set up on the schools' campuses, use the data on the IoT Exploratory and do additional research on other, official data platforms opened new learning opportunities and helped them in gaining a more global perspective.

The students enjoyed the active and hands-on involvement in the project and the use of various IT tools, including the IoT device, computers, and their mobile phones. In fact, instead of banning the use of mobile phones in class we took advantage of their potential when assigning individual tasks. This approach is transferable to other areas.

Overall, the module enabled our students in various ways to strengthen their 21st Century Skills, such as critical thinking, showing leadership and taking responsibility, improving their ICT literacy or cooperation in groups. While using their smart devices, they gained useful insights into the concept of data, setting up databases for evaluation, visualising data and preparing graphs, etc.

As mentioned earlier, by selecting the topic of solar radiation, they not only gathered ideas on how to convert solar energy efficiently and learnt about renewable energies, but also applied these concepts creatively in a real-life context.

How did your project address the Sustainable Development Goals (SDGs), which build the foundation for Education for Sustainable Development?

Due to the interdisciplinary nature of the project, we touched upon several Sustainable Development Goals during our discussions and project work. With solar energy being an instrumental alternative energy resource, the most prominent Goal that we dealt with was SDG 7 – Affordable and Clean Energy. This topic is very pertinent within the V4

countries and the EU. It is a good exercise to organise a debate among students about an energy transition. They can discuss efficiency and the environmental impact of different energy sources, and the actual and environmental costs of renewable energies compared to fossil fuels. Slovakia, the Czech Republic and Hungary are still ranked at the bottom of the EU member countries with regards to solar power share in electricity production.

Of course, there is also a strong connection between solar radiation and its impact on people's health, which falls under SDG3 – Health and Well-being. SDG Target 3.d makes a reference to early warning, risk reduction and management of national and global health risks. We did not have much time to discuss these topics in detail, but it is worthwhile for students to do research on how changes in temperature, light levels and ultraviolet radiation affect human and animal health and explore the relationship between solar radiation and ozone in the stratosphere.

Likewise, meaningful exercises can be conducted on the impact of solar radiation and the targets that are addressed by SDG 14 – Life below Water and SDG 15 – Life on Earth, or SDG 2 – Zero Hunger. The IPCC warns about the imbalance between incoming solar radiation and outgoing thermal radiation, which causes Global Warming. For SDG2, an interesting question for discussion could be: how does the amount, the temporal and spectral distribution of solar radiation affect agriculture and food production? Within the V4 countries, we have already experienced the move of fruit or vegetable productions to other regions due to a changing climate.

As teachers, how would you describe the overall experience of conducting the session and developing the Teaching Module?

Our students showed a genuine interest in the topic of climate change, and we were very happy about their commitment to work on this crucial issue by collecting and evaluating relevant data. All of them have heard but could only now directly see and understand the impact of climate change on their lives. Our teams collaborated with great enthusiasm. COVID-19 posed a number of health challenges and constraints on us, and we faced some initial delays in our work. We then had to carefully plan our meetings to catch up with the tasks, which was not easy given our busy daily schedules at school. The most rewarding experience was

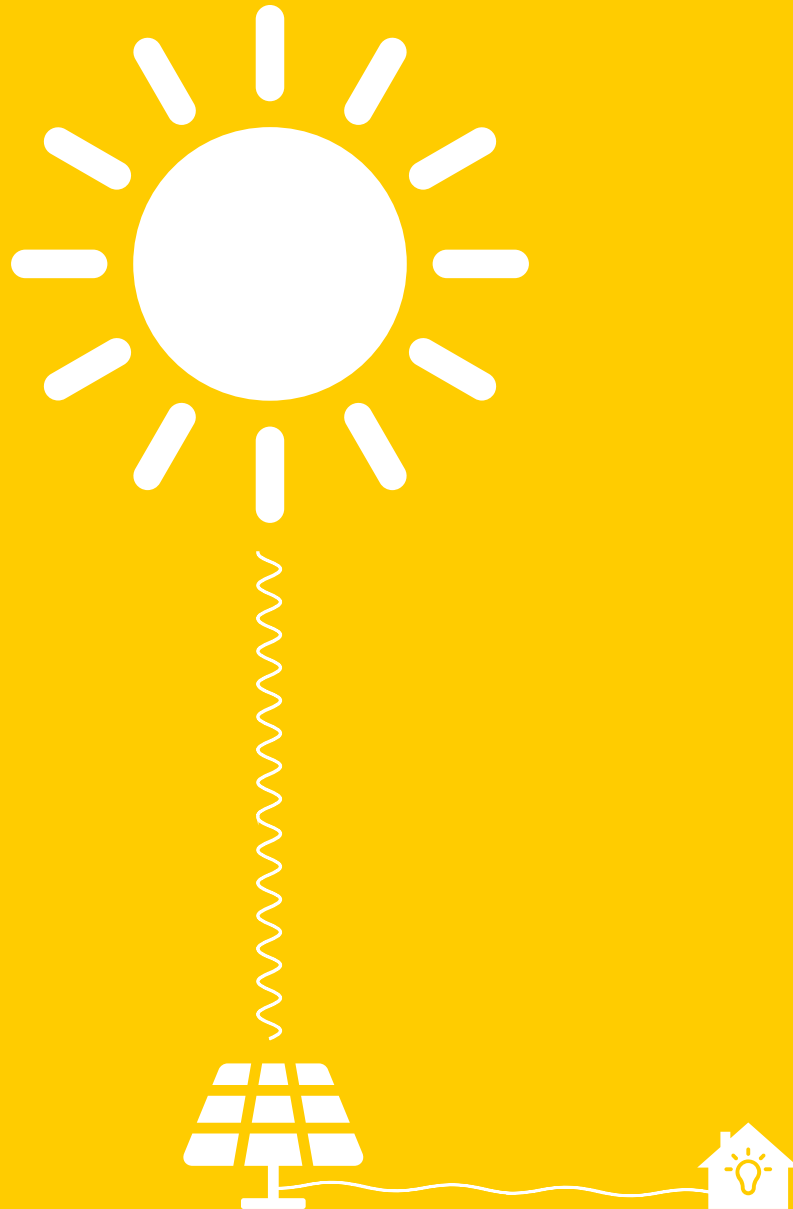
Teaching Module 4

2.5 Solar Radiation

that all participating schools had one common goal and we could rely on each other. All of us enjoyed the intensive and effective collaboration over the past months and had the opportunity to learn from each other.

“Educators and students worked with much enthusiasm on monitoring and analysing real-life data from the weather stations at our schools. This collaboration gave us exposure to move beyond regular teaching practices and opened new doors for teaching creatively and collaboratively.”

Milan Chalupník
Základní Škola Seč, Czech Republic



Worksheet Teaching Module 4

Solar Radiation

CONTEXT

The transition towards cleaner energy sources is a priority for the V4 countries to meet electricity needs for private, public and business consumption. The sun is one of the most important energy sources. Solar energy is sustainable and inexhaustible and, therefore, increasingly used as an alternative to fossil fuels to "go green" and to cover electric bills.

YOUR SCHOOL: A PIONEER IN GREEN ENERGY

Why not installing solar panels on your school campus? There is plenty of unused space on the roof ...

Create a proposal to your school leadership & management and help demonstrate the eco-friendliness of your school and to reduce operational costs.

LEARNING GOALS FOR STUDENTS

Gain deeper insights into the causes and impact of climate change, in particular the role of solar radiation and how it affects daily life in the V4 countries and beyond

Understand the importance of environmental monitoring for scientific purposes, and examples on how IoT, Big Data and AI can help making an informed decision on energy transition

Strengthen the 21st Century Skills in areas such as information literacy, digital literacy, creativity, teamwork and critical thinking

Build a sense of Global Citizenship through intercultural collaboration and interactive learning opportunities

Appreciate the various efforts made by governments and civil society towards the UN Agenda 2030 and become an advocate for the Sustainable Development Goals (SDGs)

INVESTIGATE & EXPLORE!

Be a Global Citizen! Leading questions for students

How does solar radiation affect agriculture and food production, two key factors in fighting poverty?

Extended exposure to a high UV-climate poses many health risks. Apart from protection, what is done to prevent the further thinning of the ozone layer around the globe? Think about local, national and global initiatives and discuss their possible impact!

Create an energy map for the V4 countries and compare the share of renewable energy in the overall energy mix! Make a comparison and rank the V4 countries globally!

High UV radiation is not only harmful to humans. What kind of effects does UV radiation have on aquatic ecosystems, or plants and animals on land? How can these be protected or even saved?

INVESTIGATE & EXPLORE!

Reveal the Data Analyst & Scientist within you! Leading questions for students

Get the basics right: Solar radiation is made up of different types of radiation. What is the difference of infrared rays, visible rays, ultraviolet rays and other types or rays? Can you measure them with your IoT device?

Dig deeper: Why does the amount of solar radiation vary at different locations? What role do factors such as geography, time of day, season, local landscape & environment or local weather play? Team up with schools in your vicinity and other V4 countries and compare the data on solar radiation on a sunny day!

Apply science in daily life: How does a solar panel work and how much of the sun's energy that reaches the solar panel can be turned into electricity?

IDENTIFY, UNDERSTAND & APPLY! Ideas for Individual Learning, Team and Peer Collaboration among Students

The Challenge

Help your school become a pioneer in green energy! Can your school set up solar panels on its campus and rely entirely on renewable solar energy for its daily operations? Be a green consultant and develop a proposal for the school leadership and management.

INTERDISCIPLINARY TEACHING & LEARNING

3 Steps to develop a proposal for "My solar powered school"

- 1 Background Research
- 2 Data Collection & Evaluation
- 3 Proposal Writing

Step 1: Background Research

Every proposal requires thorough research at the beginning, to build the knowledge foundation on the issue, to understand the context and to prepare for potential challenges and/or opportunities to meet your set objectives. Start to get a general overview first, and then focus on the details.



1.1 The Macro-Perspective

Collaborate with your peers and create a brief on the feasibility and potential of solar energy production in your V4 country. Official government websites will help you for your research, e.g., the Ministry responsible for energy and/or environment, statistical offices, etc. For this exercise, it is interesting to compare your results with student teams from other V4 countries.

What is the status quo of solar energy production in your country? What is the current demand & supply?

What kind of regulations & incentives for solar energy does your government provide?

What are existing collaborations between the government, research & industry that drive solar energy technology & production?

MATERIALS, TOOLS AND EQUIPMENT

Computer and Internet Access
Microsoft Office (Excel, PowerPoint & Word)
Google Docs
IoT Device set up on school campus to record data, IoT Exploratory Platform

1.2 The Micro-Perspective

Collaborate with your peers and your school's facility management and prepare an overview of the school's energy & electricity consumption and costs. Are there differences throughout the year, for example between summer and winter? Identify the reasons for higher energy & electricity usage!

1.3 Zoom in even closer

Collaborate with your peers and your school's facility management and prepare an overview of the school's energy & electricity consumption and costs. Are there differences throughout the year, for example between summer and winter? Identify the reasons for higher energy & electricity usage!



Step 2: Data Collection & Evaluation

From observations to assumptions to facts to evidence: Collect relevant data & statistics on the IoT device and other data platforms to be able to make an analysis and proper evaluation. Evidence-based recommendations are the prerequisite for informed decision making.



Solar Potential

Measure the solar radiation with your IoT device and collect your data over a period of 1,3 and 6 months.

How much potential solar energy does your school campus have?

How does the summer and winter compare?

Peak time

At what times during the day and on which days did your local environment have the greatest potential for solar energy?

Can you make a prediction for other months in the year?



Location

Identify a potential area on the campus where solar panels could be set up.

What direction and tilt should the panels be facing for optimal performance?

Consider not only the maximum output but the time of the day when energy is needed.

Panel Size

Based on your initial research on solar panels in Step 1, what size and power of solar panels would you require to power the entire school building during winter and summer?

When does the school need most energy?



Efficacy

Why is the efficacy of solar panels important?

This can also be affected by air pollution, air temperature and the temperature of the solar panel.

Visualisation

Create the relevant data graphs & tables and calculate: Will your school be able to fully cover its electricity usage with its own generated solar energy?

When and on which occasion do you expect a bottleneck in energy supply?



Costs

Prepare a cost analysis of the solar panels.

How much will it cost to buy and install the hardware and how long will it take to get a return in investment (e.g., 5 years, 10 years 15 years etc.)?

Battery Storage

Should your school consider also making an investment into battery storage?

This would be for the energy generated to be stored for later use.

This could be useful when schools close early in the afternoon but there is still a lot of solar energy that can be produced until sunset. This also applies during holidays and weekends when the building is not in use.



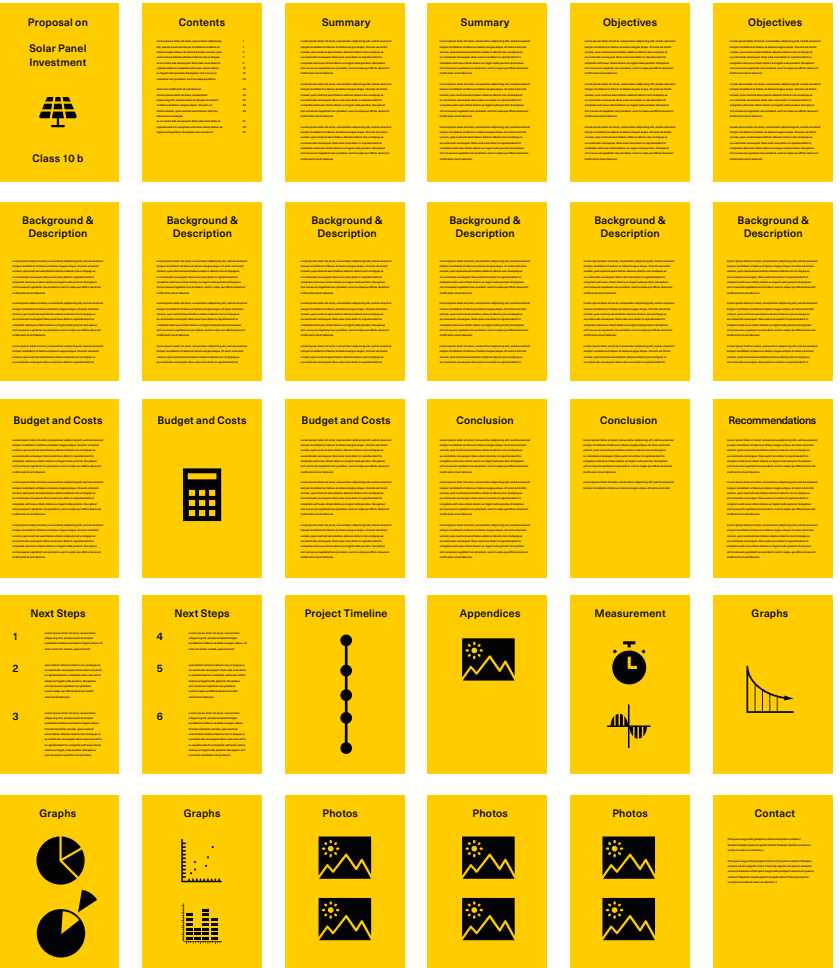
Step 3: Proposal Writing

Content and presentation are equally important to convey your message. Learn the basics of writing a good proposal. This exercise can be either done as an individual or as a group task with each member being responsible for one chapter. Don't forget to clearly list the authors and contact details.

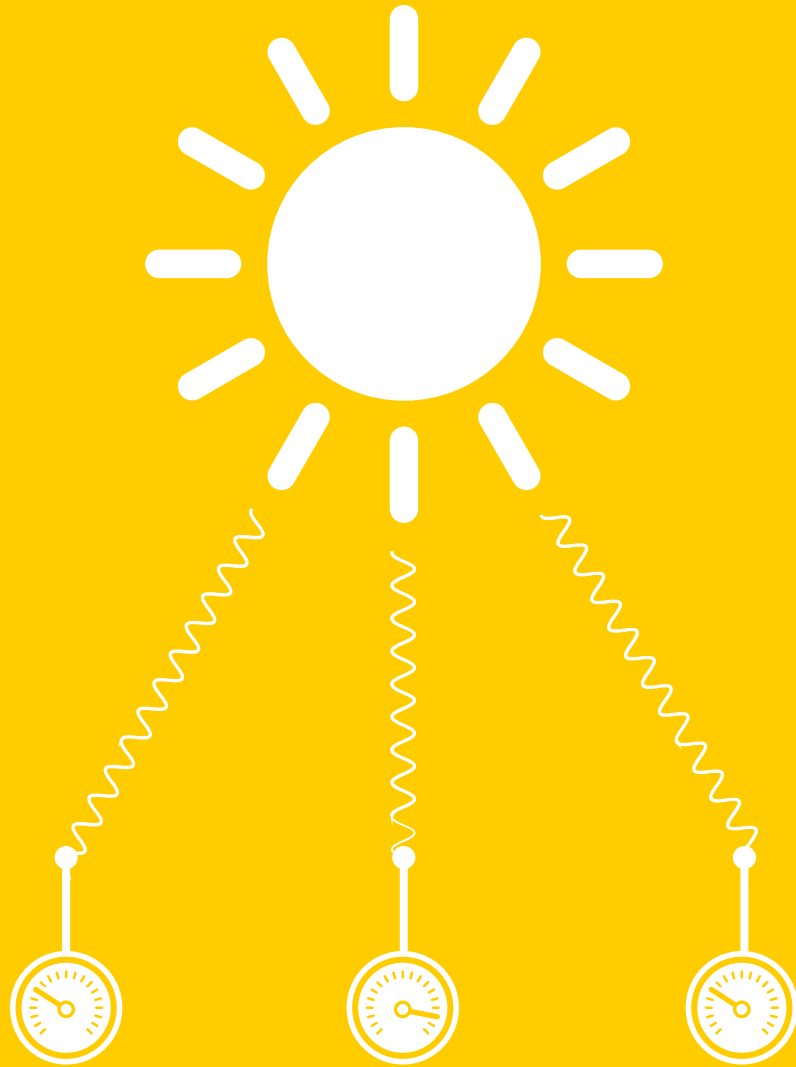
Proposal Content



Cover
Table of Content
Summary
Objectives
Background & Description
Budget, including Cost Comparison
Conclusion & Recommendations
Next Steps and Timeline
Appendices (e.g., tables, graphs for data evidence, photos, contact, etc.)



2.5 Teaching Module 4
Solar Radiation
Examples of the Project Work and Results



2.5 Examples of set up of IoT device on the school campuses



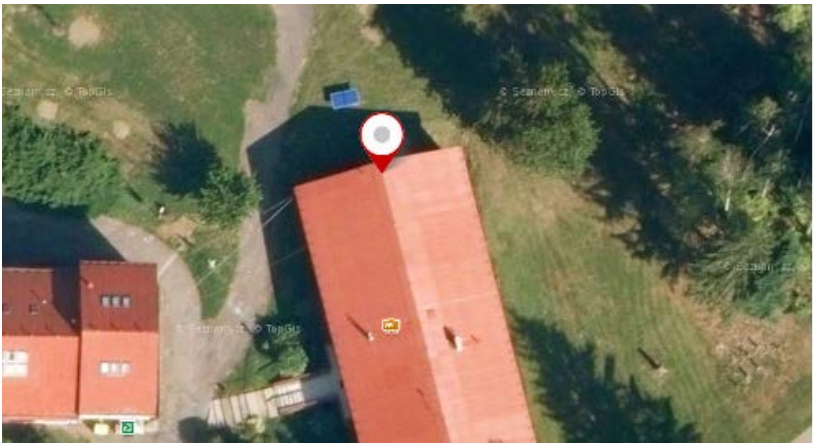
IoT device showing the data collected directly from Weather Station in Liceum Akademickie Da Vinci



Weather station installed on a streetlamp at Liceum Akademickie Da Vinci at a height of about 3 meters above the ground



Weather station installed at the rooftop of Základní Škola Seč



A bird's eye view on the weather station located on the roof of the Základní Škola Seč school building at a height of about 6 meters above the ground



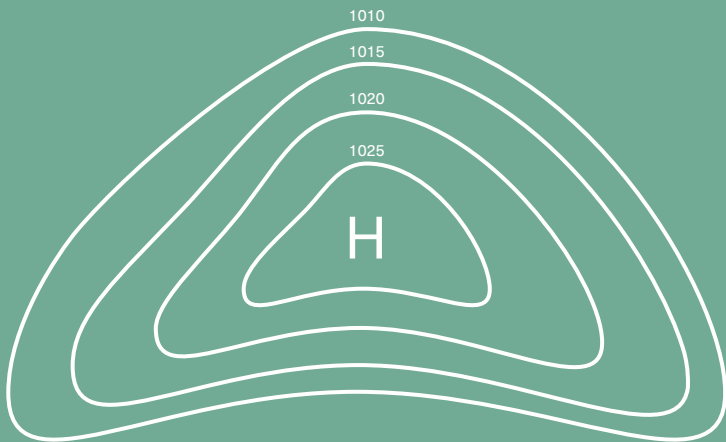
Weather station installed at the balcony of Lánczos Kornél Gimnázium about 6 meters from the ground floor, on a pole welded to the railing



2.6

Teaching Module 5

Barometric Pressure



Reflections by Teachers

The fifth V4IoT Teaching Module on Barometric Pressure tackles elements of various types of weather conditions and examines how atmospheric pressure has an influence on temperature, rainfall and wind. By tracking and reading the barometric pressure using the IoT device, students will learn about atmospheric pressure variations and how to forecast short-term weather changes. They also get insights into the impact of atmospheric pressure on our health & breathing, daily life activities and even scientific experiments. The Module introduces students to the diverse job scope of a meteorologist and invites them to join a competency race to test their real-world readiness. Who has the knowledge & skills to become the school's meteorologist?

This Module was developed by a team of five teachers based in Hungary, Poland and Slovakia in partnership with the ASEF Classroom Network Team. They share their experiences and lessons learnt during the development of the Module.



Gabriella Illés
Szent Pirooska Greek Catholic Primary School
Nyírácsád, Hungary



Patricia Nanansi
Szent Pirooska Greek Catholic Primary School
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Pavol Trubac
Spojena Skola
Ivanka pri Dunaji, Slovakia



Peter Trubac
SOS Bernolákovo
Bernolákovo, Slovakia



Teaching Module 5

Barometric Pressure

Why did you choose the theme “Barometric Pressure” for your V4IoT Teaching Module?

Atmospheric pressure is an important indicator of weather. It determines wind and temperature patterns, as well as rainfall across the world. We chose the topic “Barometric Pressure” as atmospheric pressure has a stronger impact on our climate than many of us would have thought. Although we live far away, changing air pressure in the North Atlantic can, for example, influence the rainfall intensity in the V4 region, or affect the number of warm days we enjoy during spring.

Most of our students were already familiar with the basics of atmospheric pressure. As the weather forecast reminds us daily, our students also knew that low-pressure areas usually lead to inclement weather: the sky is cloudy, it is windy and often rains. High-pressure areas bring clear skies and fair weather. However, we need to go deeper into the topic. Atmospheric pressure is not visible yet is an all-surrounding factor in life. This makes it an interesting area to explore. Students are curious to understand not only key environmental questions, but also daily life issues linked to atmospheric pressure: Why do our ears pop when we are in an elevator, hike a mountain, or when a plane takes-off or lands? Why do many people feel a headache or migraine after a drop in barometric pressure? In the context of science, why can some experiments not be replicated in laboratories in other geographical areas?

What research questions did you tackle with your students and what kind of activities did you conduct during the project phase and include in your Teaching Module?

During our Teaching Module, we emphasised a hands-on, practical, and data-driven approach. We wanted our students to understand the topic of atmospheric pressure in-depth, to know how to measure it and feel confident in making a weather forecast. The lessons intended to enable students to find correlations between air pressure, temperature and precipitation and apply certain meteorological laws. Hence, the majority of our student exercises focused on understanding key concepts in meteorology, data collection and data analysis from the IoT device on our school campus and other weather data to develop correlation graphs.

Atmospheric pressure is not constant. It fluctuates at any given point on the earth's surface around a certain value. Based on this, we formulated

different tasks for the students where they had to learn how to read, prepare and interpret the data. For example, the relationship between atmospheric pressure and temperature is affected by a number of atmospheric effects. What correlations can students identify during short term and long-term investigations and which results are more valid? Or: Compare the lowest temperature at night with the air pressure each night over a number of weeks and create a set of statistics to analyse the results and draw a conclusion.

The V4IoT project aimed to strengthen the 21st Century Skills among teachers and students in areas such as information literacy, digital literacy, creativity, teamwork, and critical thinking. What were your experiences during the project?

In general, the project was a great opportunity for our students to obtain, verify, evaluate, and work with data and get first-hand experience. Students collected weather data from the IoT device and the Exploratory Platform, analysed it, compared the data between different time periods and then summarised their findings. We suggest to gamify this exercise and conduct a competency race to find out who has the skills to become the school's meteorologist.

This experiential learning approach helped them to sharpen a critical mindset towards facts and figures and to use and communicate data and information in an accurate and reliable way. Without doubt, our students deepened their understanding and recognised the importance of science and data-driven technologies in the 21st century in the context of environmental monitoring and protection – and they are not even IT experts or IT teachers yet. Being able to use your own IoT device to collect relevant data played a key role in the students' learning journey of developing IT literacy and in showcasing their creativity.

How did your project address the Sustainable Development Goals (SDGs), which build the foundation for Education for Sustainable Development?

As mentioned earlier, we selected this topic as changes in the atmospheric pressure can have a significant effect on our climate. Atmospheric pressure controls the atmosphere's circulation and has a strong influence on humidity, precipitation, temperature, and winds. All of these have an impact on human life and animal life – be it on land or below the sea. Some

of our V4IoT teacher colleagues have developed a module on temperature and its impact on people's health; others worked on the topic of wind and air pollution. As the Sustainable Development Goals are interconnected, the different elements of weather are also closely linked and interact with each other while creating different atmospheric conditions and weather events. In this regard, we touched on several SDGs, albeit indirectly: SDG 3 – Good Health & Well-being, SDG 13 – Climate Action, SDG 14 – Life Below Water, SDG 15 – Life on Land.

What is important in the context of Education for Sustainable Development is to hone the interest and the ability among our students to contribute to solutions on critical issues and problems at the local, national, and global level. In our case, we focused on the above-mentioned sustainable development goals to critically reflect on climate change. Through the V4IoT project, our students could independently collect data and information in a self-organised and target-oriented manner from the IoT device and other sources and tools. They were responsible to assess the quality of the data, analyse it and then construct knowledge that is helpful to find relevant solutions. As different schools collaborated, they had to prove their competences in communicating effectively and constructively in a foreign language with each other during the process. The interdisciplinarity of the topic and different methodologies of the project brought our students a step closer to become global citizens.

As teachers, how would you describe the overall experience of conducting the session and developing the Teaching Module?

For us, the project or the overall process of collaboration has not finished. Unfortunately, during the project implementation, we faced periods of lockdown which slowed down the organisation of some activities. We definitely need and want to spend more time to collaborate with our students on this. In the future, we can use the module during both environment and English classes – each time practicing a different skill and digging in deeper into a specific learning objective. There are so many diverse communication and collaboration tools that can be integrated, from YouTube for simple information sharing & support in initial research, to Kahoot for fun quizzes, to google.meet to connect with each other across borders, to the IoT Exploratory platform for evidence-based data collection and evaluation. We can leverage on the existing modules or creatively design new lesson ideas by using the IoT device and weather station on our school campus.

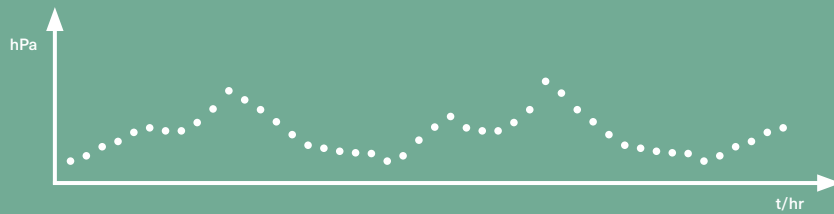
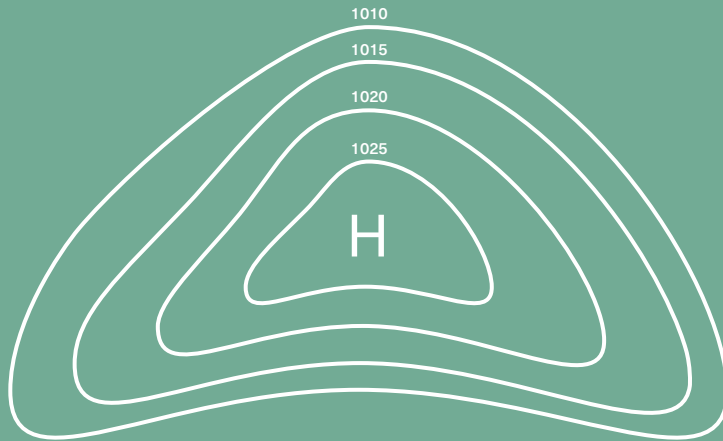
“It has been an insightful journey to participate in the project and develop a teaching module with the other teachers in V4 countries. It is definitely one of the rare opportunities where teachers and students collect real-life weather data and can directly evaluate the effects on the environment.”

Gabriella Illés

Szent Piroska Greek Catholic Primary School, Hungary

2.6

Teaching Module 5 Barometric Pressure Module Ideas



Worksheet Teaching Module 5

Barometric Pressure

CONTEXT

Atmospheric pressure is an important indicator of weather. It determines wind and temperature patterns, as well as rainfall across the world. As the weather forecast reminds us daily, most of us are familiar with the impact of low-pressure or high-pressure areas, leading to either inclement or fair weather respectively. But this is just the beginning of understanding atmospheric sciences ...

HOW IS THE WEATHER TODAY?

Switch your role: from student to your school's meteorologist

Don't just stay in your classroom! Explore your school's environment and even travel around the V4 countries and become a weather scientist! Collect, analyse and compare various kinds of weather data locally and from the V4 region. Learn more about severe weather patterns, test your technical, scientific and communication skills and keep people safe! Will we see you on your school's and the V4IoT Weather News soon?

Learning Goals for Students

Gain deeper insights into the causes and impact of climate change, in particular the role of atmospheric pressure on other weather conditions

Understand the importance of environmental monitoring for scientific purposes, and examples on how IoT, Big Data and AI can be used to make important weather predictions

Strengthen the 21st Century Skills in areas such as information literacy, digital literacy, creativity, teamwork and critical thinking

Build a sense of Global Citizenship through intercultural collaboration and interactive learning opportunities

Appreciate the various efforts made by governments and civil society towards the UN Agenda 2030 and become an advocate for the Sustainable Development Goals (SDGs)

INVESTIGATE & EXPLORE!

Be a Global Citizen!
Leading questions for students

How do you feel? How is the weather? People can be 'human barometers', as they sense and are affected by changes in atmospheric pressure. What kind of impact does atmospheric pressure have on human health and living conditions? Think about a few scenarios and share your knowledge & maybe even personal experiences!

Scientists have observed that the number of atmospheric blocking events – stalled high-pressure systems which stay in place over a longer period of time and which cause deadly heat waves – have increased. Discuss with your peers the effects of these events on the local environment, and their impact on people, life on land and life below water in even further regions.

INVESTIGATE & EXPLORE!

Reveal the Data Analyst & Scientist within you!
Leading questions for students

Get the basics right: Air pressure, atmospheric and barometric pressure are often used interchangeably, but there is a small distinction. Can you explain it?

Dig deeper: Barometric pressure is measured either in standard atmospheres (atm), Pascals (Pa), inches of mercury (inHg), or bars (bar). What is the difference? Did you know that there is no standard barometric pressure as it depends on altitude? Give some examples!

Apply science in daily life: Atmospheric pressure affects everything in the environment, from temperature to humidity and evaporation. Do some research and find out why atmospheric pressure has an impact on the work & activities of bakers, mountaineers, pilots and scientists! Explain why!

IDENTIFY, UNDERSTAND & APPLY!

Ideas for Individual Learning, Team and Peer Collaboration among Students

Your Dreamjob?

Travel beyond the school campus with the clouds ...

Most of us know meteorologists from the TV: people who present the daily weather news and make predictions for the coming days. But the job profile of a meteorologist is much more diverse than a mere broadcast personality: Developing a weather forecast is not easy, and meteorologists are adventurers, observers and researchers alike. The job is both 'out there' during sunshine and rain, and 'inside' behind highly sophisticated technical equipment. You can do both by becoming your school's meteorologist!

Job Description

Help with the set up, maintenance and data collection of the IoT device on your school

Study maps, data from satellites, radar, weather balloons and sensors

Compare different kinds of weather data from your school compound, local and regional sources

Use mathematical and physical formulas and computer modelling applications to analyse weather conditions

Support environmental monitoring and examine how weather affects air pollution and water resources

Write summaries, reports and research papers
Prepare/make forecasts which not only help your local government services and the public, but also agriculture and different industry sectors, such as aviation and shipping, to plan their activities and to keep safe

Declare time off from school because of weather conditions (NOTE: Be sure to get approval from your school principal first!)

Are you the one we are looking for? Demonstrate your Information & Technical Literacy as well as your Analytical and Communication Skills in this one-week Competency Race!

This race includes five stages. In stage 1, you must first demonstrate your information literacy to move on to the next level at stage 2, where your technical and digital literacy skills will be tested. In stage 3, you must prove that you can interpret and analyse the collect data correctly and thoroughly. In stage 4, make sure that you convince the jury and selection committee with your communication and presentation skills.

MATERIALS, TOOLS AND EQUIPMENT

Computer and Internet Access
Microsoft Office (Excel, PowerPoint & Word)
Google Docs
IoT Device set up on school campus to record data, IoT Exploratory Platform

1

Race Stage 1 Information Literacy

The race begins with a research and presentation challenge. You have one day to collaborate with your team members and prepare a 10 min pitch on atmospheric pressure and its relation to other weather conditions.

Identify the key concepts and information that you deem most important to present, showcase your knowledge and find a suitable pitch format that would convey the content well (e.g., ppt presentation, info video production, quiz, etc.)

Do consult with your teacher on your approach!

Race Stage 2 Digital Literacy

Get familiar with the school's IoT device and collect weather data from the last month!

Focus on the data for atmospheric pressure and select one of these three options:

1. precipitation,
2. temperature and
3. wind.

Do also search for local and regional weather data resources and platforms to complement your data findings.

Document your data by building relevant graphs & charts, using a programme of your choice (e.g., excel, ppt, PowerBI, etc.)

2

3

Race Stage 3 Analytical Skills

Interpret and analyse your data findings:

Look at the overall shape of your different graphs for barometric pressure, precipitation, rainfall and/or wind! Are the lines steep or gentle? Are there any changes throughout the month? Compare the data from your school's IoT device with weather data recorded for the V4 region. What do you observe?

Identify the extremes – the highest and lowest value (e.g., barometric pressure, precipitation or temperature or wind) and reflect on your own experiences on this day/during this period.

Evaluate if you can find possible correlations between atmospheric pressure and the weather condition of your choice (i.e., precipitation, temperature and wind) and create correlation graphs and dynamic images. What are the meteorological laws behind these phenomena?

Race Stage 4 Communication Skills

Based on your findings, can you make a prediction on weather patterns for your local environment and the V4 region? Do you expect a low or a high-pressure area in the coming 2 weeks? How would your forecast affect possible school activities, such as outdoor sports, excursions or recess?

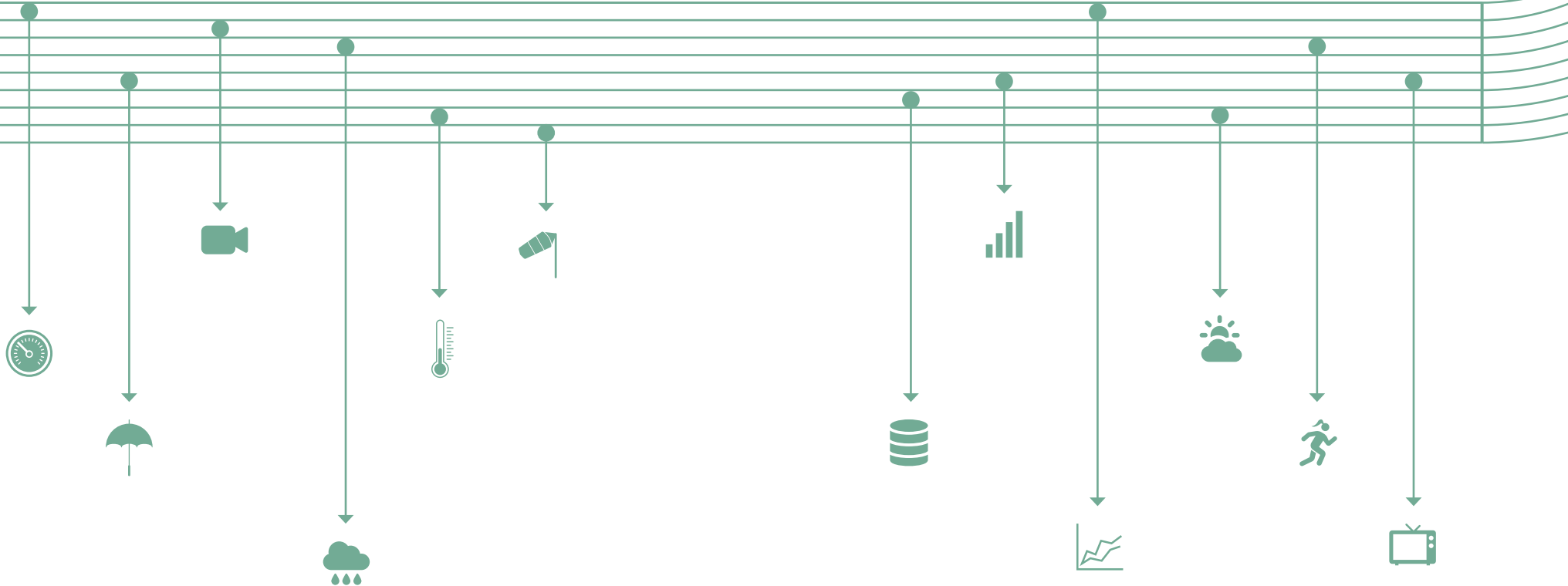
Develop with your team a short 2 min V4IoT weather forecast for the next week that you present live in class! Ensure that you have your data, stats and appealing visuals ready.

Don't forget to watch the real weather forecast in the news and find out what the professional meteorologist predicts!

4

Start

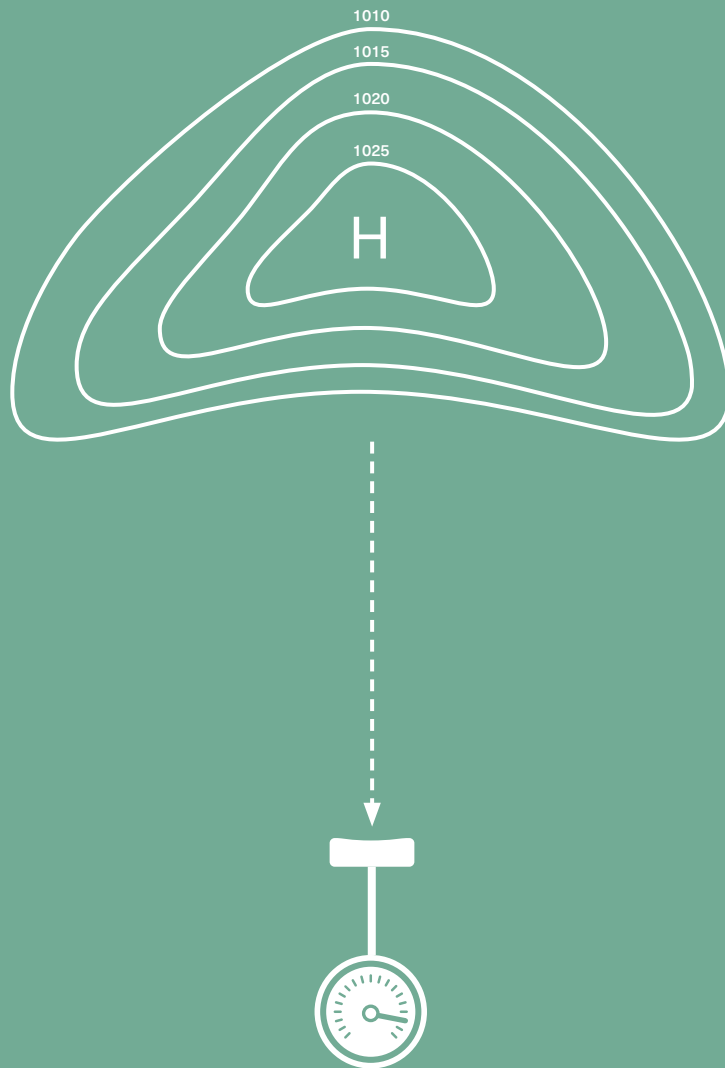
Finish



2.6 Teaching Module 5

Air Pressure

Examples of the Project Work and Results



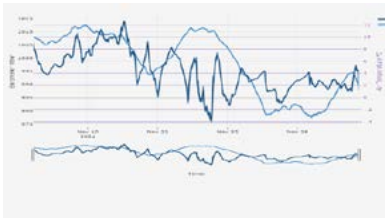
2.6 Examples of set up of IoT device on the school campuses and group photos



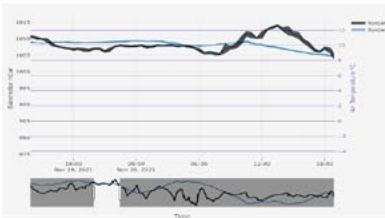
Weather station installed on the rooftop of Szent Piroska Greek Catholic Primary School, Hungary



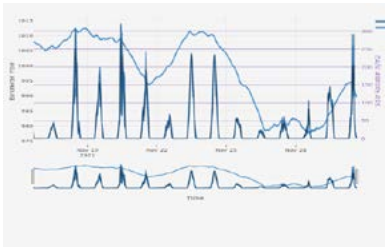
Teacher Pavol Trubac with students from Spojena Skola in Slovakia on school campus



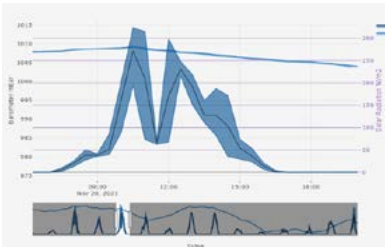
Example of data collection of barometric pressure and air temperature with IoT device



Example of data collection of correlation between barometric pressure and air temperature with IoT device



Example of data collection of barometric pressure and air temperature with IoT device



Example of data collection of barometric pressure and solar radiation with IoT device



Students in front of the weather station right after installation. SOS Bernolákovo, Slovakia



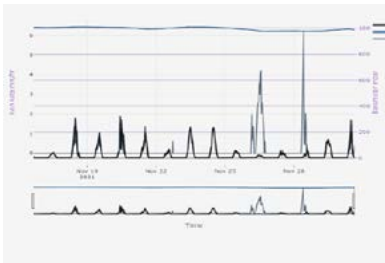
Students of SOS Bernolákovo, Slovakia, working on data comparison



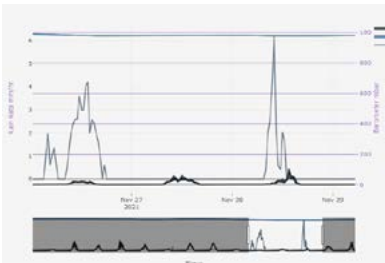
Students of SOS Bernolákovo, Slovakia, analysing weather data



Students of Szent Piroska Greek Catholic Primary School, Hungary, looking at the data collected from the IoT device



Example of data collection of barometric pressure and rainfall with IoT device



Example of data collection of correlation between barometric pressure and rainfall with IoT device

2.7 Conclusion and Recommendations



2.7 Conclusion and Recommendations

Preparing today's learners with interdisciplinary knowledge & skills to thrive in a constantly evolving world characterised by digitalisation and global, socio-economic and environmental challenges is a big task. It requires the delivery of thoughtful and timely relevant education. As highlighted throughout this project, pre-requisites to provide quality education, that is inclusive, innovative and impactful are teacher training and teacher professionalisation opportunities. Teachers at all levels, especially in primary and secondary education, need adequate and continued support to achieve the contemporary education goals.

The V4IoT project aimed to train and empower teachers through a variety of formal, non-formal and informal activities, working methods and tools. These included experts' trainings, peer-to-peer discussions, individual and group assignments, where participants had to meaningfully apply technology and co-create intellectual & creative products and outputs, or hands-on and practical tasks linked to Climate Action and Sustainable Development. All of these led to the joint development of Teaching Modules and this Handbook for teachers on 'STEM & ESD: Innovative Teaching and Learning through IoT, Big Data & AI'.

We hope that this Handbook will not only serve as a reference and inspirational tool for our project participants to integrate climate change education and ESD learning objectives in their STEM, as well as non-STEM classes, but also create a ripple effect in the larger educator community – in the Visegrad region and beyond. In this regard, we, the project partners and participating teachers of the V4IoT project, encourage all educators who read this Handbook to:

Level up your pedagogical competencies!

Deepen your thematic knowledge on ESD, 21st Century Skills and Climate Change Education, as well as on IoT, Big Data and AI: get insights into these topics from the respective chapters written by experts in this Handbook and also take a look at the reading recommendations for self-study. Be open-minded towards employing new technological equipment and tools in your classroom to strengthen your and your students' digital skills. This V4IoT project used an IoT device – the weather station – to innovate teaching & learning practices and the school environment of over 100 participants. This is however only one example of the plenty exciting and meaningful technological options available that can be explored.

2.7 Conclusion and Recommendations

Think out of the classroom-box!

Reflect on the importance of interdisciplinary STEM teaching & learning. Build up on the ideas from the Teaching Modules, adopt or adjust them for your lessons and stimulate your students' curiosity in STEM subjects! Bring in real-life scenarios into the classroom by collecting and analysing live data and show your students the significance of scientific and environmental monitoring for daily life and sustainable development! This might guide them to future professional STEM career paths.

Build a community of ESD educators!

Engage your peers and the larger education community and jointly promote and reinforce the role of education in driving sustainable development: Share this Handbook with your colleagues at school, teachers in your network and relevant education stakeholders from different sectors. Leverage on the lessons learnt by our project participants, explore possibilities to continue or enlarge this collaboration and look for fellow educators who are interested in similar peer-to-peer activities.

Advocate for more training opportunities!

Refer to the V4IoT project and Teacher Handbook as an example to innovate secondary school education: Be confident and advocate for more and relevant training opportunities with stakeholders at the relevant decision-making levels: your School Leadership and/or Ministry of Education!



Annexes



Translations of Foreword, Executive Summary and Introduction:

**Czech
Hungarian
Polish
Slovak**

**Coordinators and Partners
Participants
Recommended Reading List and Resources
Overview of Project Activities**

Translations/Czech

Foreword

Executive Summary

Introduction



Jsme velmi rádi, že jsme se jako ČR mohli zapojit do projektu společně se zeměmi V4, který bude v tomto roce ukončen. Problematika udržitelného rozvoje (UR) a role inovativní výuky a učení STEM (Science, Technology, Engineering and Mathematics) na školách při řešení místních a globálních výzev je důležité téma i pro ČR v kontextu Environmentální výchovy, vzdělávání a osvěty (EVVO), na kterém spolupracuje Ministerstvo školství, mládeže a tělovýchovy (MŠMT) s dalšími resorty zejména Ministerstvem životního prostředí. Téma je ukotveno v koncepčních materiálech resortu MŠMT, je naplňováno i formou plnění úkolů ze strategických a akčních dokumentů v oblasti udržitelného rozvoje ve spolupráci resortů s MŠMT, je akcentováno v Programovém prohlášení vlády 2022.

Základní i střední školy se v naší republice zapojují dlouhodobě do nejrůznějších aktivit a projektů na podporu environmentálního vzdělávání, vytváří za tímto účelem sítě škol a partnerské prostředí s firmami i s ohledem na nové technologie a materiály. Projekty jsou tematicky zaměřené např. na obnovitelné zdroje energie, snižování emisí v dopravě, klimatické změny spojené s nedostatkem vody, šetření a hospodaření s vodou, recyklace, odpadové hospodářství, nakládání s odpady např. při praktické přípravě, atd.

Oblast EVVO je nedílnou součástí počátečního vzdělávání na základních i středních školách vč. odborných, je tematicky zahrnuto v rámcových vzdělávacích programech pro jednotlivé obory vzdělání.

Cílem EVVO a vzdělávání pro udržitelný rozvoj (VUR) je vést žáky k chování respektující zásady UR, tedy k zajištění potřeb současných generací, aniž by bylo ohroženo potřeby budoucích generací, vytváření úcty k živé i neživé přírodě, k ochraně a zlepšování přírodního a kulturního dědictví, životního prostředí a chápání globálních problémů světa. Vede žáky k pochopení souvislostí mezi různými přírodními jevy a lidskými aktivitami, mezi lokálními, regionálními a globálními environmentálními problémy; k porozumění souvislostí mezi environmentálními, ekonomickými a sociálními aspekty v rámci principů udržitelného rozvoje, osvojení základních principů šetrného a odpovědného přístupu k životnímu prostředí v osobním a profesním jednání. Výuka směřuje k propojování teoretických znalostí s praktickým využitím a rozvoji dovedností v širším kontextu a v závislosti na studovaném oboru vzdělání.

EVVO a v širším pojetí i VUR svým interdisciplinárním charakterem vytvářejí předpoklady pro využívání řady nástrojů řízení vyučovacího procesu, ať jsou tradičního typu (vyučovací hodina, exkurze, praktické cvičení) nebo inovativního typu (např. projektová výuka, školní konference, spolupráce s centry ekologické výchovy, vzájemná výměna zkušeností mezi školami či dalšími vzdělávacími institucemi).

Tématika EVVO a VUR je v rámci konceptu STEM vnímána jako integrační proces ve vazbě na předměty, které tento koncept naplňují (zejména předměty fyzika, přírodopis, chemie, matematika, ICT). Pro české vzdělávací prostředí znamená tento koncept změnu v pojetí vzdělávání, která by měla vést ke komplexnějšímu přístupu, provázanosti jednotlivých témat a tím i kvalitnější přípravě žáků.

Tento projekt s označením V4IoT umožnil zúčastněným partnerům zapojit se do řešení úkolů s tématy udržitelného rozvoje – identifikovat, zkoumat, analyzovat a diskutovat zadané úkoly; vyhodnocovat data a porovnávat je s daty z různých míst světa. Projekt přispěl i k rozvoji digitálních kompetencí žáků a rozvoji inovativních metod výuky na základě výměny zkušeností. Může být inspirací pro další školy a přispět k využívání nových forem a metod výuky z širšího pohledu. Vytvořená příručka je přínosným dokumentem věcného a hlavně metodického charakteru.

Poděkování patří všem zapojeným institucím a partnerům projektu včetně základní školy v ČR (Seč), která získala vybavení nadstandardní technikou a přispěla zejména k řešení otázek týkajících se slunečního svitu, solární energie, UV záření, teplotních změn získávaných v určitém časovém období. Získala tak cennou mezinárodní zkušenost pro realizaci těchto témat ve vzdělávání, které může dále šířit.

Ministerstvo školství, mládeže a tělovýchovy (MŠMT)
Česká republika

Příručka "STEM a ESD: Inovativní výuka a učení skrze IoT, Big Data a AI" je výsledkem středoškolského projektu "IoT, Big Data a AI: Inovace výuky STEM prostřednictvím posílení profesionality učitelů", zkráceně V4IoT. Projekt probíhal virtuálně od dubna 2021 do března 2022. Zúčastnilo se ho přibližně 35 učitelů a jejich studentů ze čtyř zemí Visegrádské skupiny (V4) – České republiky, Maďarska, Polska a Slovenska v programu peer-to-peer učení a budování kapacit, který přispěl k posílení pedagogických kompetencí zapojených učitelů.

Příručka představuje souhrn klíčových aktivit a studijních výsledků projektu a obsahuje příspěvky středoškolských učitelů, akademiků a tvůrců vzdělávací politiky. Slouží jako inspirativní nástroj pro učitele středních škol v zemích V4 i mimo ně v oblasti inovativních metod výuky a učení STEM v kontextu změny klimatu a udržitelného rozvoje. Skládá se ze dvou částí:

První část stanovuje tematický a technický základ znalostí, který byl navržen odborníky na vzdělávání, EdTech a tematickými experty. Druhá část představuje pět modulů výuky STEM, které zúčastnění učitelé ze zemí V4 vytvořili ve spolupráci s týmem ASEF Classroom Network absolvování tematických a technických školení.

První část

První část vymezuje koncepci projektu a nabízí přehled tematických a technických školení i peer-to-peer setkání, která byla součástí programu.

Tematická školení byla zaměřena na vzdělávání pro udržitelný rozvoj (ESD) s důrazem na vzdělávání v oblasti životního prostředí a klimatické změny a také rozvoj dovedností pro 21. století. Tato témata zdůraznila význam interdisciplinárních přístupů při řešení příležitostí a výzev týkajících se udržitelného rozvoje. Účastníci se touto cestou dozvěděli o relevanci konceptů ESD a dovedností pro 21. století pro inovaci výuky STEM na podporu pozitivních klimatických opatření.

Technická školení zajišťovala přehled o základech IoT, Big Data a AI. Experti se podělili o současné trendy a diskutovali o možných použití IoT, Big Data a AI a jejich dopadu na běžný život v oblasti vzdělávání i celé společnosti. Učitelé také získali praktický trénink ve způsobech používání a integrace vybavení IoT do tříd pro vzdělávání o změně klimatu.

Jednotlivé kapitoly první části shrnují klíčový obsah těchto témat. Autory jsou Leonie Nagarajan a Jyoti Rahaman z odboru vzdělávání ASEF a profesorka Aleksandra Przegalińska z Kozminského Univerzity v Polsku.

Druhá část

Druhá část představuje pět výukových modulů V4IoT STEM, které zapojení učitelé ze zemí V4 v průběhu projektu vytvořili ve spolupráci s týmem ASEF Classroom Network. Učitelé pracovali v malých skupinách a navrhovali výukové moduly na základě znalostí získaných z tematických a technických školení i dat shromážděných přes zařízení IoT.

Každý výukový modul V4IoT STEM je uveden v jedné kapitole. Ilustrace, datové grafy, grafika a jednoduché informační tabulky vysvětlují výukový modul krok za krokem a zdůrazňují jeho vzdělávací cíle v následujících pěti oblastech: 1) Změna klimatu, 2) Monitorování životního prostředí, 3) Dovednosti pro 21. století, 4) Vzdělávání o globálním občanství a 5) Cíle udržitelného rozvoje (SDG). Kapitoly o výukových modulech také obsahují část o tipech, tricích a doporučených digitálních nástrojích.

Zahrnutím výpovědí učitelů a studentů příručka zdůrazňuje význam vzájemného učení a sdílení osvědčených postupů výuky a učení na středních školách. Výukové moduly záměrně odkazují na místní případové studie a scénáře ze zemí V4, tyto příklady však lze snadno převzít a přenést do jiných regionů a globálního kontextu.

Výukový modul V4IoT 1: Vítr

První výukový modul V4IoT Vítr se zabývá meteorologickým jevem větru, jeho dopadem na kvalitu ovzduší a tím, jak lze vítr využít jako alternativní zdroj energie. Modul vede studenty ke shromažďování údajů souvisejících s různými vlastnostmi větru, včetně rychlosti, síly a směru větru, jakož i jeho vztahu k barometrickému tlaku. Dále zkoumá dopad větru na další meteorologické jevy, životní prostředí lidí a zdraví. Pro propojení tématu se svým lokálním prostředím musí studenti prozkoumat větrné podmínky na různých geografických místech ve Visegrádském regionu a posoudit proveditelnost vytvoření větrného parku ve svém regionu. Musí také předpovědět oblasti s rizikem znečištění vzduchu ve svém městě v závislosti na sezónních větrech. Modul vytvořili Adam Stepinski ze školy Liceum Ogólnokształcące im. Mikołaja Kopernika v Tarnobřehu v Polsku,

Adrienn Kortvelyesi a Dr. Heider Naszer ze školy Bugat Pal Secondary Technical School v Maďarsku a Mark Daniels z gymnázia BESST na Slovensku.

Výukový modul V4IoT 2: Déšť

Druhý výukový modul V4IoT Déšť vrhá světlo na změnu klimatu a její vliv na intenzitu a frekvenci srážek. Učitelé a studenti zkoumají význam deště pro životní prostředí a lidský život a diskutují o příkladech extrémních povětrnostních a srážkových podmínek, ať už jde o silné deště či sucho. Studenti se také učí o vodě jako o vzácném přírodním zdroji a o tom, jak ji hospodárně a zodpovědněji využívat ve škole, doma i v jiných oblastech života. Modul zaujímá interdisciplinární přístup, přičemž lekce STEM probíhá formou hraní rolí a pořádání soudního procesu. Studenti zaujmou role obviněného, žalobce, obhajoby, svědků a soudce v právním případě ohledně člověkem způsobených přestupků a zločinů proti vodě: jejího znečišťování, plýtvání a změn vodního cyklu. Modul vytvořily Agnieszka Kowal, Magdalena Kosacka a Tamara Szwajca ze školy Zespół Szkół Informatycznych v Kielcích v Polsku.

Výukový modul V4IoT 3: Teplota

Třetí výukový modul V4IoT Teplota 2 zkoumá vliv stoupajících teplot na lidské zdraví. Studenti pozorují a analyzují, jak mají vysoké a nízké teploty vzduchu různé dopady na lidské tělo a pohodu, a dozvídají se o potenciálních život ohrožujících stavech způsobených extrémním horkem či chladem. Prvky lekce také zkoumají, jak teplota působí na pohyb vzduchu a jak to ovlivňuje znečištění ovzduší. V hlavním cvičení mají studenti shromáždit data a provést výzkum pro vytvoření politik a opatření založených na důkazech. Cíl: udržet jejich místní komunity informované, zdravé a v bezpečí! Modul je výsledkem spolupráce mezi Agnieszkou Jadwiszczak, Ewou Rębowskou, Alicjou Łaskou, Joannou Kamock a Jowitou Królikowskou ze školy I Liceum Ogólnokształcące im. Kazimierza Jagiellończyka v Sieradzu v Polsku a Janou Vidovou a Romanem Jakobejem z Obchodné akademie Rožňava na Slovensku.

Výukový modul V4IoT 4: Sluneční záření

Čtvrtý výukový modul V4IoT Sluneční záření a UV index (UVI) se zabývá významem slunečního záření pro život na Zemi a zkoumá různé formy a

typy slunečního záření. Modul se zaměřuje zejména na výhody a nevýhody solární energie pro výrobu elektřiny. Studenti se potýkají s výzvou, jak udělat ze své školy průkopníka v zelené energii. Vyhodnocují možnost zřízení solárních panelů v kampusu a analyzují, zda se jejich školy mohou pro běžný provoz spolehnout výlučně na obnovitelnou solární energii. Na konci musí vytvořit návrh pro vedení své školy. Modul vytvořili Aneta Bednarek a Marcin Bernaś ze školy Liceum Akademickie Da Vinci v Poznani v Polsku, Milan Chalupník ze Základní školy, Seč, okres Chrudim v České republice a Sándor Ujvári ze školy Lánczos Kornél Gimnázium v Maďarsku,

Výukový modul V4IoT 5: Barometrický tlak

Pátý výukový model V4IoT Barometrický tlak cílí na základy různých typů meteorologických podmínek a zkoumá, jak atmosférický tlak vzduchu ovlivňuje teplotu, srážky a vítr. Sledováním a čtením barometrického tlaku pomocí zařízení IoT se studenti seznámí s jeho kolísáním a způsoby, jak předpovídat krátkodobé změny počasí. Získají také vhled do vlivu barometrického tlaku na naše zdraví a dýchání, každodenní aktivity a dokonce i vědecké experimenty. Modul představuje studentům různorodou pracovní náplň meteorologa a vyzývá je k připojení k závodu v kompetencích, aby otestovali svoji připravenost ve skutečném světě. Kdo má znalosti a dovednosti na to stát se školním meteorologem? Tento modul vytvořili Pavol Trubač ze Spojené školy, Peter Trubač z SOS Bernolákovo, Peter Korman z Gymnázia Mikuláša Kováča na Slovensku a Gabriella Iles a Patricia Nanansi ze školy Szent Pirooska Gorogkatolikus Altalanos Iskola v Maďarsku.

Další zdroje o projektu V4IoT lze najít na [webových stránkách projektu](#).

Naše společnost čelí digitální revoluci, kde technologie jako Internet věcí (IoT), Big Data a umělá inteligence (AI) poskytují řešení globálních výzev, jako jsou klimatická změna, potravinová bezpečnost a vznik pandemií (Yoon, 2020). Přestože STEM dovednosti (přírodní vědy, technologie, technika a matematika) jsou na pracovním trhu velmi žádané a pro rozvoj inovací nezbytné, příprava inovativních STEM profesionálů je stále výzvou (European Commission, 2015). Pro stimulaci zvědavosti studentů v těchto předmětech, návod ohledně možné budoucí profesionální kariéry a zdůraznění role vědy ve společenském pokroku tak musí být výuka a učení STEM zabudovány v reálných životních situacích a začínat již od rané úrovně vzdělání.

Školení učitelů a jejich profesionalizace jsou v tomto procesu nezbytné. Jen při zajištění kvalitního vzdělání a užití různých formálních i neformálních inovativních vzdělávacích nástrojů budou učitelé schopni nabízet studentům relevantní příležitosti pro budování Dovedností pro 21. století a digitální kompetence. Umožní jim to také smysluplně využívat své získané znalosti v běžném životě a v širším kontextu reálného světa.

Projekt "IoT, Big Data a AI: Inovace výuky STEM prostřednictvím posílení profesionality učitelů" (zkráceně V4IoT) byl zaměřen na budování pedagogické způsobilosti a digitální kompetence ve čtyřech Visegrádských zemích – České republice, Maďarsku, Polsku a Slovensku. Projekt se konal virtuálně od dubna 2021 do března 2022. Školám zapojených učitelů bylo poskytnuto průlomové technologické vybavení, které jim umožnilo sledovat a analyzovat klimatickou změnu a vzorce počasí skrze společný sběr dat o rychlosti větru, teplotě vzduchu, srážkách, vlhkosti, sluneční a UV radiaci a dalších faktorech. Všechny školy propojila společná technická platforma poskytující interaktivní prostředí k výuce a učení, které přesahovalo hranice a umožnilo učitelům a studentům diskutovat, společně zkoumat a identifikovat oblasti pro spolupráci.

Zhruba 35 středoškolských učitelů a jejich studentů se zúčastnilo tohoto kolaborativního on-line programu, který obsahoval tematická školení na výchovu k udržitelnému rozvoji (ESD), Dovednosti pro 21. století a změnu klimatu i technická školení o tom, jak lze IoT, Big Data a AI uplatnit v kontextu výuky a studia. Pro sdílení svých znalostí a podporu peer-to-peer výměny pracovali učitelé v malých skupinkách a vytvořili Výukové moduly STEM, které kombinují pět studijních cílů:

1. Získat hlubší vhled do příčin a dopadů klimatické změny, zejména specifických vzorců počasí a toho, jak ovlivňují běžný život v zemích V4 a dalších
2. Pochopit význam monitoringu životního prostředí pro vědecké účely a příklady toho, jak lze použít IoT, Big Data a AI pro monitoring ekosystémů, a to i ve školním prostředí
3. Posílit Dovednosti pro 21. století v oblastech jako informační gramotnost, digitální gramotnost, kreativita, týmová práce a kritické myšlení
4. Vybudovat si smysl pro globální občanství prostřednictvím mezikulturní spolupráce a interaktivních příležitostí pro výuku a učení, které přesahují hranice
5. Ocenit nejrůznější iniciativy vlád a občanské společnosti ohledně Agendy 2030 OSN a stát se zastáncem cílů udržitelného rozvoje (SDGs)

Projekt byl zakončen tvorbou této příručky, která kompiluje poučení z různých školení a pěti Výukových modulů STEM, které učitelé vytvořili. Cílem příručky je inspirovat zájemce pracující ve středoškolském vzdělávání v zemích V4 a celém regionu inovativními metodami pro výuku a učení STEM.

Projekt V4IoT koordinovalo Liceum Ogólnokształcące im. Mikołaja Kopernika v Tarnobřehu v Polsku a Asia-Europe Foundation (ASEF) v Singapuru v partnerství se Základní školou Seč, okres Chrudim v České republice; Základní a střední školou Mártona Bálinta v Maďarsku; Obchodnou akadémiou Rožňava a Spojenou školou na Slovensku a EdTech podporovatelem ScienceScope Ltd ze Spojeného království. Projekt byl kofinancován vládami České republiky, Maďarska, Polska a Slovenska prostřednictvím Visegrádských grantů z Mezinárodního visegrádského fondu. Mísí fondu je prosazovat myšlenky udržitelné regionální spolupráce ve střední Evropě.

Translations/Hungarian

Foreword

Executive Summary

Introduction



Napjaink helyi és globális kihívásai nem egyes országok külön problémái, hanem – annak ellenére, hogy a helyi kezdeményezések fontosak – a megoldás a közös erőfeszítésekben és az együttműködésen alapuló tevékenységekben rejlik.

A tudományköziséget mint kulcsszót használjuk a fenntarthatósággal kapcsolatban. Ez azt jelenti, hogy mindannyiunknak meg kell osztanunk a tudásunkat, ki kell cserélnünk nézeteinket és együtt kell dolgoznunk annak érdekében, hogy elmozduljunk a pusztá növekedéstől egy tisztességes és kivitelezhető fejlődés irányába. A regionális együttműködés adja meg a célt a helyi kezdeményezéseknek és jelentőségteljes tevékenységet támogató tudásépítő hálózatoknak.

A fiatalokat széleskörű természettudományos tudással rendelkező állampolgárokká kell nevelnünk annak érdekében, hogy az iskolapadból kilépve képesek legyenek eligazodni a körülöttük lévő világban és értelmezni tudják annak változásait. Fontos felkészíteni őket arra is, hogy legyenek tisztában a maguk szerepével és jelentőségével a természeti erőforrások hasznosítása, a környezet átalakítása terén.

A gazdaság fejlődése és az országok versenyképességének növelése érdekében elengedhetetlen, hogy minél több fiatal figyelmét irányítsuk rá a természettudományos és műszaki pályákra.

A fenntarthatóságra nevelés pedagógiája és gyakorlata a környezeti nevelésből szervesen, ahhoz szorosan kapcsolódva fejlődött. Nagyon fontosnak tartjuk a fenntarthatóságra nevelés korai életkorban való megkezdését, az iskolafokok közötti folytonosság biztosítását és az egészintézményes megközelítést. A teljes köznevelési vertikumon keresztül jelentős hangsúlyt fektetünk a STEM területek témájára és a fenntarthatóságra, igazodva a célcsoport életkorához és előzetes tudásához.

Az iskolák és a gazdasági szereplők közötti együttműködés hozzájárulhat a térség geopolitikai és oktatási jellegzetességeinek jobb kihasználásához. Az együttműködés spektrumának bővítése, a közös projekteken és kampányokon keresztüli kölcsönös tanulás előtérbe helyezése további fejlődési lehetőségeket kínál a természettudományos oktatás számára. Fontos cél, hogy minél több fiatal figyelmét irányítsuk rá a STEM pályákra. Ez a pályaaorientáció elképzelhetetlen anélkül, hogy a tanulók,

hallgatók megfelelő digitális kompetenciákkal rendelkezzenek, mivel a fenntarthatóság elérését célzó termékek, módszerek fejlesztése és alkalmazása nem nélkülözheti a robotika, a mesterséges intelligencia és egyéb informatikai megoldások felhasználását.

A tapasztalataink szerint a pedagógusok mindig örömmel fogadják a számukra érdekes információt, az új ötleteket és a támogatást. Ezért reméljük, hogy ezt a képzést és kézikönyvet örömmel fogadják.

Köznevelésért Felelős Államtitkár
Emberi Erőforrások Minisztériuma

A "STEM és ESD: Innovatív tanítás és tanulás az IoT-n, nagy adathalmazokon és AI-n keresztül" című kézikönyv a "IoT, Big Data and AI: Innovating STEM Teaching Through Strengthening Teacher Professionalisation" (magyarul: A dolgok internete, nagy adathalmazok és mesterséges intelligencia: a STEM tanítás innoválása a tanári szakszerű hivatásgyakorlás erősítésén keresztül), röviden V4IoT, című középiskolai projekt eredménye. A projekt virtuálisan 2021 áprilisa és 2022 márciusa között zajlott, és a négy visegrádi (V4) országból -- Csehországból, Magyarországról, Lengyelországból és Szlovákiából -- mintegy 35 tanár diákjaikkal együtt vett részt a társak közötti tanulási (peer-to-peer learning) és kapacitásépítési programban, amely hozzájárult a résztvevő tanárok pedagógiai kompetenciáinak fejlesztéséhez.

A Kézikönyv összefoglalja a projekt kulcsfontosságú tevékenységeit és tanulási eredményeit, és tartalmazza középiskolai tanárok, oktatók és oktatáspolitikai döntéshozók közreműködéseit. Inspiráló eszközként szolgál a V4-országokbeli és azon túli középiskolai tanárok számára az innovatív STEM tanítási és tanulási módszerek területén az éghajlatváltozás és a fenntartható fejlődés összefüggéseiben. A Kézikönyv két részből áll:

Az első rész megalapozza a tematikus és technikai tudást, amelyet oktatás-, az oktatási-technológiai- és a tematikus szakértők alakítottak ki.

A második rész öt STEM-oktatási modult mutat be, amelyeket a V4-országok programban résztvevő tanárai fejlesztettek ki az ASEF Classroom Network csapatával partnerségben, a program tematikus és technikai képzéseit követően.

Első rész

Az első rész felvázolja a projekt koncepcióját, és áttekintést ad a program részét képező tematikus és műszaki képzésekről, valamint a társas tanulási (peer-to-peer learning) alkalmakról.

A tematikus képzés, valamint az Oktatás a Fenntartható Fejlődésért (ESD) koncepcióra, ezen belül a környezeti ismeretkerek, a klímaváltozásra és helyezve a hangsúlyt, valamint a 21. századi készségekre fókuszált. A képzés kiemelte az interdiszciplináris megközelítések fontosságát a fenntartható fejlődés lehetőségeinek és kihívásainak kezelésekor. A résztvevők így a két fenti koncepció – ESD és 21. századi készségek

– relevanciájáról tanultak a a STEM oktatás esetében, illetve az éghajlatváltozás elleni fellépés esetében.

A műszaki képzés egy áttekintést adott a dolgok internete (IoT), a nagy adathalmazok és a mesterséges intelligencia (AI) technológiákról. Szakértők osztották meg tudásukat az aktuális trendekről, és a három technológia hétköznapi felhasználásáról és hatásáról, valamint az oktatási szektorban és a társadalomban általában. A programban résztvevő tanárok praktikus tréninget kaptak arról is, hogyan alkalmazzák klímaváltozás oktatásához szükséges IoT eszközöket a tantermekben.

Az első rész egyes fejezetei összefoglalják a fenti tartalmakat. A szerzők Leonie Nagarajan és Jyoti Rahaman az Ázsia-Európa Alapítvány (ASEF) Oktatási Osztályától, valamint Aleksandra Przeglasińska, a Kozminski Egyetemről.

Második rész

A második rész bemutatja az öt V4IoT STEM tanítási modult, amelyeket a V4 országok résztvevő tanárai fejlesztettek ki a projekt során az ASEF Classroom Network csapatával együtt. A tanárok kis csoportokban dolgoztak, és a tematikus és technikai képzések során szerzett ismeretek, valamint az IoT-eszközön keresztül gyűjtött adatok alapján tervezték meg az oktatási modulokat.

Minden V4IoT STEM tanítási modul egy fejezetben kerül bemutatásra. Illusztrációk, adattáblázatok, grafikák és egyszerű információs táblázatok lépésről lépésre elmagyarázzák a tanítási modult, és kiemelik annak tanulási céljait a következő öt területen: 1. éghajlatváltozás, 2. környezetfigyelés, 3. 21. századi készségek, 4. globális állampolgárságra való nevelés és 5. a Fenntartható Fejlődési Célok (SDG). A Tanítási modul fejezetek tartalmaznak tippeket és trükköket, valamint digitális eszközöket ajánlanak.

A tanárok és diákok hozzászólásaival a Kézikönyv hangsúlyozza a társak közötti tanulás és a jó tanítási és tanulási gyakorlatok megosztásának fontosságát a középiskolákban. A tanítási modulok szándékosan hivatkoznak a V4 országok helyi esettanulmányaira és eseteire. Ezek a példák azonban könnyen átvehetők és átvihetők más régiókba és a globális kontextusba.

Hungarian

Vezetői összefoglaló

V4IoT 1. tanítási modul: Szél

Az első V4IoT tanítási modul, -- Szél -- a szél időjárási jelenségeivel, a levegőminőségre gyakorolt hatásával és a szél alternatív energiaforrásként való felhasználásával foglalkozik. A modul arra ösztönzi a diákokat, hogy adatokat gyűjtsenek a szél különböző tulajdonságairól, beleértve a szél sebességét, erősségét és irányát, valamint a légnyomáshoz való viszonyát, és feltárja a szél hatását más időjárási jelenségekre, az emberek környezetére és egészségére. Ebben a tanítási modulban a diákok a helyi szélviszonyokat tanulmányozzák a különböző visegrádi országokban, és egy szélerőmű létrehozásának lehetőségét vizsgálják meg a saját régiójukban, ennek segítségével kötik a témát a saját környezetükhöz. A diákok előrejelzéseket is készítenek a légszennyezés kockázatáról az adott városban, az évszaknak megfelelő széljárási viszonyokból kiindulva. A modult Adam Stepinski (lengyelországi tarnobrzei Kopernikusz Középiskola), Körtvélyesi Adrienn és Dr. Naszer Heider (magyarországi Bugát Pál Technikum), és Mark Daniels (szlovákiai Besst Gymnázium) fejlesztette ki.

V4IoT 2. tanítási modul: Csapadék

A második V4IoT tanítási modul -- Csapadék -- rávilágít az éghajlatváltozásra és arra, hogy ez hogyan befolyásolja a csapadék intenzitását és gyakoriságát. A tanárok és a diákok megvizsgálják az eső jelentőségét a környezet és az emberi élet szempontjából, és megvitatják a szélsőséges időjárási és csapadékviszonyok példáit, mint például a heves esőzéseket vagy aszályokat. A tanulók megismerik a vizet, mint szűkös természeti erőforrást, valamint a víz gazdaságos és felelősségteljes felhasználását az iskolában, otthon és az élet más területein. A modul interdiszciplináris megközelítést alkalmaz, a STEM oktatást szerepjáték és bírósági tárgyalás formájában tartja. A diákok a vádlott, az ügyész, a bíró, a védőügyvédek, a tanúk szerepeit veszik fel egy képzeletbeli jogi ügyben, mely az ember okozta vízügyi jogsértésekre és büntetésekre fókuszál, mint például a vízszennyezés, víz pazarlás, vízkörforgással kapcsolatos változásokról. A modult Agnieszka Kowal, Magdalena Kosacka és Tamara Szwajca fejlesztette ki a lengyelországi kielcei Zespót Szkół Informatycznych középiskolából.

V4IoT 3. tanítási modul: Hőmérséklet

A harmadik V4IoT tanítási modul – Hőmérséklet – az emelkedőhőmérséklet emberi egészségre gyakorolt hatását vizsgálja. A diákok megfigyelik és elemzik, hogy a magas és alacsony levegőhőmérséklet milyen eltérő hatással van az ember szervezetére és jólétére, valamint megismerik a szélsőséges hőség vagy hideg lehetséges életet veszélyeztető kondícióit. Az óra részeként azt is megvizsgálják, hogy a hőmérséklet hogyan befolyásolja a levegő mozgását, és ez hogyan befolyásolja a légszennyezést. Az egyik fő feladat ebben a modulban, hogy a diákok adatot gyűjtsenek és kutatást végeznek, és ezek alapján tényekkel alátámasztott szakpolitikai döntéseket és cselekvési terveket készítenek elő. A cél: biztosítani a helyi közösség tájékoztatását, egészségét és biztonságát! Ez a modul Agnieszka Jadwiszczak, Ewa Rębowska, Alicja Łaska, Joanna Kamock és Jowita Królikowska (lengyelországi sieradzi Általános Középiskola, I Liceum Ogólnokształcące im. Kazimierza Jagiellończyka w Sieradzu), valamint Jana Vidová and Roman Jakobej (szlovákiai Business Academy Rožňava, Obchodná Akadémia v Rožňave) együttműködésében jött létre.

V4IoT 4. oktatási modul: Napsugárzás

A negyedik V4IoT tanítási modul -- Napsugárzás -- a napsugárzás fontosságával foglalkozik a földi élet szempontjából, és megvizsgálja a napsugárzás különböző formáit és típusait. A modul különösen a napenergia előnyeire és hátrányaira fókuszál. A diákok ebben a modulban azon dolgoznak, hogy az iskolájuk úttörővé váljon a zöld energia területén. Megvizsgálják a napelemek használatának lehetőségét az iskolában, és elemzik, hogy az iskolájuk mennyiben tudna a megújuló napenergia forrásokra támaszkodni a mindennapi energia szükséglet kielégítésben. A modul egy diákok által készített javaslattal zárul, melyet az iskola vezetése elé terjesztenek.

A modult Aneta Bednarek és Marcin Bernas (lengyelországi poznańi Liceum Akademickie Da Vinci), Milan Chalupník, (csehországi Zákładní Škola Seč, okres Chrudim), valamint Ujvári Sándor (magyarországi Lánccos Kornél Gimnázium), fejlesztette ki.

V4IoT 5. tanítási modul: Légnyomás

Az ötödik V4IoT tanítási modul – Légnyomás – azt vizsgálja, hogy a különböző időjárási kondíciók hogyan befolyásolják a légnyomást és ezen keresztül a hőmérsékletet, a csapadékot és a szelet. A légköri nyomás IoT-eszközzel történő nyomonkövetésével és leolvasásával a diákok megismerkedhetnek a légköri nyomás változásaival és a rövid távú időjárási változások előrejelzésével. Betekintést nyernek a légköri nyomás egészségünkre és légzésünkre, mindennapi tevékenységeinkre, sőt tudományos kísérleteinkre gyakorolt hatásaiba is. A modul során a diákok megismerkednek a meteorológus munkakörrel, és egy kompetencia alapú versenyben méri fel a mennyire állnak készen a való élet kihívásaira. Vajon kinek vannak a legjobb készségei és tudása, hogy az iskola házi meteorológusa legyen? Ezt a modult Peter Trubač, a szlovákai Spojena Skola, Pavol Trubač a szlovákiai SOS Bernolákovo, Peter Korman a szlovákiai Gymnázium Mikulasa Kovaca, valamint Iles Gabriella és Nánási Patrícia a magyarországi Szent Piroska Görögkatolikus Általános Iskola munkatársai fejlesztették ki.

A V4IoT projekttel kapcsolatos további források a [projekt weboldalon](#) találhatóak.

Társadalmaink egy digitális forradalom előtt állnak, ahol a különböző technológiák, mint például a dolgok internete (IoT), a nagy adathalmazok és a mesterséges intelligencia (AI), olyan megoldásokat kínálnak, amelyek megbirkóznak a globális kihívásokkal, beleértve az éghajlatváltozást, az élelmezésbiztonságot és a járványkitöréseket (Yoon, 2020). Bár a STEM (tudományos, technológiai, mérnöki és matematikai) készségekre nagy az igény a munkaerőpiacon, és elengedhetetlenek az innováció ösztönzéséhez, az innovatív STEM-szakemberek felkészítése továbbra is kihívás marad (European Commission, 2015). Az életszerű szituációkba ágyazott STEM tanításának és tanulásának ezért a korai oktatási szinten kell elkezdődnie, hogy felkeltse a tanulók kíváncsiságát a tantárgyak iránt, iránymutatást adjon a lehetséges jövőbeni szakmai karrierlehetőségekhez, és kiemelve a tudomány szerepét a társadalmi fejlődésben.

A tanárképzés és a tanárok szakszerű hivatásgyakorlása nélkülözhetetlen ebben a folyamatban: csak a minőségi oktatás biztosításával, valamint a formális és nem formális innovatív oktatási eszközök széles skálájával tudnak a tanárok megfelelő lehetőségeket biztosítani a tanulóknak a 21. századi készségek és digitális kompetenciák fejlesztésére, és megszerzett tudásuk jelentékeny alkalmazására a mindennapi életben és nagyobb valóságos kontextusokban.

Az "IoT, Big Data and AI: Innovating STEM Teaching Through Strengthening Teacher Professionalisation" (magyarul: A dolgok internete, nagy adathalmazok és mesterséges intelligencia: a STEM tanítás innoválása a tanári szakszerű hivatásgyakorlás erősítésén keresztül) című projekt, röviden V4IoT, a tanárok pedagógiai kapacitásának és digitális kompetenciájának fejlesztésére összpontosított a négy visegrádi országban: Csehországban, Magyarországon, Lengyelországban és Szlovákiában. A projekt virtuálisan 2021 áprilisa és 2022 márciusa között zajlott. A résztvevő tanárok iskoláit csúcstechnológiás berendezésekkel látták el, amelyek lehetővé tették számukra, hogy közös adatgyűjtéssel nyomon kövessék és elemezzék az éghajlatváltozást és az időjárási mintákat, mint például a szélsébséget, a levegő hőmérsékletét, az eső sebességét, a páratartalmat, a nap- és UV-sugárzást stb. Egy közös technikai platform határon túlmutatva minden iskolát összekapcsolt, és interaktív tanítási és tanulási környezetet teremtett, lehetővé téve a tanárok és a diákok számára, hogy megvitassák, közösen felfedezzék és azonosítsák az együttműködési területeket.

Közel 35 középiskolai tanár diákjaikkal együtt vett részt ebben az együttműködésen alapuló online programban, amely tematikus tréningeket szervezett a tanároknak az Oktatás a Fenntartható Fejlődésért (ESD) témakörben, a 21. századi készségekről és az éghajlatváltozásról; valamint technikai tréningeket arról, hogyan lehet a dolgok internetét, a nagy adathalmazokat és a mesterséges intelligenciát tanítási és tanulási kontextusba ágyazni. A tudásmegosztás és párbeszéd ösztönzése érdekében a tanárok kis csoportokban dolgoztak a különböző STEM tanítási modulokon. A modulok a következő öt tanulási célt ötvözik, melyek eredménye képpen a diákok:

1. Mélyebb betekintés szereznek az éghajlatváltozás okaiba és hatásaiba, különös tekintettel a konkrét időjárási mintákra, valamint arra, hogy ezek hogyan befolyásolják a mindennapi életet a V4-országokban és azon túl.
2. Megismerik a környezeti megfigyelés tudományos célú jelentőségét, valamint példákat arra vonatkozóan, hogyan lehet az IoT-t, a nagy adathalmazokat és az AI-t használni az ökoszisztémák megfigyelésére, akár iskolai környezetben is.
3. Fejlesztik a 21. századi készségeik olyan területeken, mint az információs írástudás, a digitális írástudás, a kreativitás, a csapatmunka és a kritikai gondolkodás.
4. Globális állampolgárság tudatuk növekszik, az interkulturális együttműködés és interaktív tanítási és tanulási lehetőségek révén, amelyek túlmutatnak a határokon.
5. Elismerik a kormányok és a civil társadalom hozzájárulását az ENSZ Agenda 2030 céljaihoz, valamint a Fenntartható Fejlődési Célok (SDG) szószólójává válnak.

A projekt ennek a Kézikönyvnek az elkészítésével zárult, amely összegyűjti a különböző képzési összejevelemek tanulságait és a tanárok által létrehozott öt STEM tanítási modult. A Kézikönyv célja, hogy innovatív STEM tanítási és tanulási módszerekkel inspirálja a középfokú oktatás iránt érdeklődőket és az abban dolgozókat a V4 országokban és szerte a régióban.

A V4IoT projektet a lengyelországi tarnobrzei Kopernikusz Középiskola és a szingapúri Ázsia-Európa Alapítvány (ASEF) koordinálta a csehországi Základní Škola Seč, okres Chrudim-mal; a magyarországi Bálint Márton Általános Iskola és Középiskolával; a szlovákiai Obchodná akadémia Roznava-val és Spojena Skola-val és az egyesült királyságbeli oktatási-technológiát támogató ScienceScope Ltd-vel. Csehország, Magyarország, Lengyelország és Szlovákia Kormányai társfinanszírozták a projektet a Nemzetközi Visegrádi Alap Visegrád Támogatásán keresztül. A támogatás missziója a fenntartható regionális együttműködés ötleteinek előmozdítása Közép-Európában.

Translations/Polish

Foreword

Executive Summary

Introduction



Rozwój praktycznie doniosłych umiejętności uczniów, które pozwolą im w przyszłości aktywnie funkcjonować na rynku pracy, jest wyzwaniem dotyczącym wszystkie systemy oświaty na całym globie. Dynamicznie zmieniająca się sytuacja gospodarcza, polityczna, prawno-międzynarodowa wymusza zapewnienie jak najbardziej wszechstronnego wykształcenia jego końcowym beneficjentom.

Proces kształcenia z jednej strony powinien zapewnić jego uczestnikom możliwość elastycznego reagowania na zmieniającą się sytuację, a z drugiej strony wyposażyć ich w specjalistyczną wiedzę w wybranych dziedzinach, dzięki której staną się ekspertami.

W ramach działań podejmowanych przez Ministerstwo Edukacji i Nauki zdefiniowaliśmy pięć umiejętności, które naszym zdaniem odegrają w przyszłości kluczową rolę i na ich rozwoju należy skupić naszą uwagę. Są to: samodzielność myślenia, rozwiązywanie problemów, liderowanie, współpraca, zarządzanie sobą.

Niniejsza publikacja, jak i projekt, którego jest efektem, doskonale wpisuje się w realizowane przez resort Edukacji i Nauki działania kierunkowe. Należy zauważyć również, że w ramach projektu, oprócz wykorzystywania Internetu rzeczy, dużych baz danych i sztucznej inteligencji, poruszane są kwestie związane ze zrównoważonym rozwojem, a opisane przedsięwzięcia uwzględniają metodykę STEM.

Warto dodać, iż edukacja dotycząca zrównoważonego rozwoju jest stałym elementem nauczania zarówno w przedszkolu, szkole podstawowej, a także ponadpodstawowej. Niezwykle istotne jest również to, że tematyka ochrony klimatu włączana jest od ponad 10 lat do zajęć realizowanych w polskich szkołach, a Ministerstwo Edukacji i Nauki uważnie obserwuje wzrastającą rolę i znaczenie kształtowania właściwych postaw dzieci i młodzieży wobec zmieniającej się rzeczywistości klimatycznej, czemu nadaje bardzo wysoki priorytet operacyjny.

Wsparcie dla szkół i nauczycieli w realizacji treści z wykorzystaniem metodyki STEM stanowi realizowany obecnie w szkołach program „Laboratoria przyszłości” - największy digitalizacyjny projekt w historii polskiej edukacji. Działania projektowe angażują szkoły, nauczycieli i uczniów, a także dostarczają im innowacyjnych narzędzi i materiałów

dydaktycznych. Wspieranie nauczycieli w doskonaleniu zawodowym i poszerzaniu wiedzy na temat zjawisk klimatycznych jest jednym z naszych priorytetów.

W obszarze edukacji STEM oraz edukacji o zrównoważonym rozwoju współpracujemy

z innymi instytucjami publicznymi m.in. Centrum GovTech Polska (KPRM), Ministerstwem Spraw Zagranicznych, czy Ministerstwem Klimatu i Środowiska. Na poziomie krajowym i międzynarodowym bierzemy udział w inicjatywach promujących finansowanie innowacyjnych działań edukacyjnych.

Kończąc pragniemy złożyć wyrazy uznania Fundacji Azja-Europa (ASEF) za podjęcie bardzo istotnego i potrzebnego przedsięwzięcia. Niniejsza pozycja zawiera bardzo interesujące treści, które mogą być przydatnym kierunkowskazem w pracy technicznego nauczyciela. Wierzymy, że jego zawartość okaże się owocna w Państwa pracy.

Z wyrazami szacunku

Zespół Transformacji Cyfrowej Ministerstwa Edukacji i Nauki
Polska

Podręcznik "STEM & ESD: innowacyjne nauczanie przy użyciu internetu rzeczy, dużych baz danych i sztucznej inteligencji" jest wynikiem projektu szkół średnich "Internet rzeczy, wielkie bazy danych i sztuczna inteligencja: innowacyjne nauczanie metodą STEM przez wzmocnienie profesjonalizacji nauczyciela", w skrócie V4IoT. Projekt odbywał się wirtualnie pomiędzy kwietniem 2021 roku, a marcem 2022 roku, a jego uczestnikami było około 35 nauczycieli oraz ich uczniowie z czterech krajów grupy wyszehradzkiej: (V4) Czech, Węgier, Polski i Słowacji w ramach programu budującego współpracę i wzmacniającego pedagogiczne kompetencje jego uczestników.

Podręcznik prezentuje podsumowanie kluczowych działań i wyników nauki, a zawiera materiały stworzone przez nauczycieli szkół średnich, nauczycieli akademickich, a także polityków zajmujących się edukacją. Służy on za inspirujące narzędzie dla nauczycieli szkół średnich z grupy V4 w temacie innowacyjnego nauczania metodą STEM w kontekście zmian klimatycznych i zrównoważonego rozwoju, a składa się z dwóch części:

Część pierwsza daje tematyczną i techniczną wiedzę, przekazaną przez ekspertów z dziedziny edukacji i technologii. Część druga to wprowadzenie pięciu modułów nauczania STEM, które uczestniczący nauczyciele z grupy krajów V4 rozwijali wspólnie z zespołem ASEF Classroom Network po przejściu odpowiednich szkoleń tematycznych.

Część pierwsza

Część pierwsza zarysowuje koncepcję projektu i dostarcza podsumowanie tematycznych i technicznych sesji treningowych, ale również sesji dwustronnych, które były częścią programu. Poszczególne rozdziały podsumowują metodologię, zawartość trzech różnych części sesji i zawierają użyte tam materiały naukowe, odnośniki i pomoce do dalszej nauki.

Tematyczne sesje treningowe skupiały się na Edukacji dla Zrównoważonego Rozwoju, ze szczególnym zwróceniem uwagi na edukację o zmianach środowiskowych i klimatycznych, jak również umiejętnościach XXI wieku. Podkreślały one wagę podejścia interdyscyplinarnego uwzględniającego szanse, jak i wyzwania, zrównoważonego rozwoju. Dzięki tym sesjom uczestnicy dowiedzieli się o adekwatności i wadze zrównoważonego rozwoju i umiejętności XXI

wieku w kontekście innowacyjnego nauczania STEM, które ma wspierać działania pro-klimatyczne.

Techniczne sesje treningowe dostarczyły informacji na temat internetu rzeczy, dużych zbiorów danych i sztucznej inteligencji. Specjaliści podzielili się z uczestnikami aktualnymi trendami i przedyskutowali z uczestnikami potencjał aplikacji internetu rzeczy, dużych zbiorów danych i sztucznej inteligencji oraz ich wpływ na życie codzienne, edukację i całe społeczeństwo. Nauczyciele wzięli także udział w szkoleniu na temat wykorzystania sprzętu internetu rzeczy w edukacji klimatycznej. Pojedyncze rozdziały w części pierwszej podsumowują kluczowe zagadnienia z tej tematyki. Ich autorami są Leonie Nagarajan i Jyoti Rahaman z wydziału edukacji ASEF oraz prof. Aleksandra Przeglasińska z Uniwersytetu Koźmińskiego w Polsce.

Część druga

Część druga to wprowadzenie do pięciu modułów V4IoT STEM, jakie uczestniczący nauczyciele z krajów grupy V4 rozwijali w ramach projektu we współpracy z zespołem ASEF Classroom Network. Nauczyciele pracowali w małych grupach, projektując moduły nauczania oparte na wiedzy zyskanej podczas technicznych sesji treningowych i danych zebranych przez stacje pogodowe.

Każdy moduł V4IoT STEM prezentowany jest w jednym rozdziale. Ilustracje, grafiki z danymi, a także proste grafiki informacyjne wyjaśniają na czym polega każdy moduł i wskazują na jego główne cele w czterech obszarach: 1. zmiany klimatyczne, 2. monitorowanie środowiska, 3. umiejętności XXI wieku, 4. edukacja nakierowana na globalne obywatelstwo, 5. cele zrównoważonego rozwoju (SDG). Rozdziały zawierające wspomniane moduły zawierają też sekcję dotyczącą podpowiedzi użytkownika rekomendowanych narzędzi cyfrowych.

Podręcznik zawiera świadectwa składane przez nauczycieli i uczniów, dlatego stanowi podkreślenie wagi dzielenia się dobrymi praktykami w edukacji szkół średnich. Moduły odnoszą się celowo do badań lokalnych i scenariuszy z krajów grupy V4. Te przykłady mogą jednak być z łatwością zaadoptowane w innych regionach świata.

Moduł nauczania V4IoT 1: Wiatr

Pierwszy moduł nauczania V4IoT Wiatr zajmuje się zjawiskiem pogodowym, jakim jest wiatr, jego wpływem na jakość powietrza i sposobem w jaki wiatr może być używany jako alternatywne źródło energii. Moduł prowadzi uczniów przez zbiór danych związanych z różnymi właściwościami wiatru takimi jak siła, moc i kierunek, a także jego związek z ciśnieniem atmosferycznym. Moduł bada wpływ wiatru na inne zjawiska pogodowe, środowisko człowieka i jego zdrowie. Aby połączyć temat ze środowiskiem lokalnym uczniowie musieli zbadać warunki wiatrowe w różnych miejscach w krajach grupy wyszehradzkiej i oszacować możliwości zakładania elektrowni wiatrowych w regionie. Musieli oni również przewidzieć obszary w ich mieście, gdzie istnieje zagrożenie zanieczyszczenia powietrza w zależności od sezonowych wiatrów. Moduł prowadzony był przez pana Adama Stępińskiego z Liceum Ogólnokształcącego im. Mikołaja Kopernika w Tarnobrzegu, Adrienn Kortvelyesi i dr. Heider Naszer z Bugat Pal Secondary Technical School na Węgrzech i pana Marka Daniela z Besst Gimnazjum w Słowacji.

Moduł nauczania V4IoT 2: Deszcz

Drugi moduł V4IoT Deszcz rzuca światło na zmiany klimatyczne i ich wpływ na intensywność i częstotliwość opadów. Nauczyciele i uczniowie badają znaczenie deszczu dla środowiska i życia ludzkiego, a także omawiają przykłady ekstremalnych warunków pogodowych, takich jak nadmierne opady, czy susza. Uczniowie dowiadują się o wodzie jako ograniczonym zasobie naturalnym i tym, w jaki sposób używać wodę ekonomicznie we wszystkich obszarach życia. Moduł charakteryzuje podejście interdyscyplinarne, w którym lekcja STEM prowadzona jest w formie dramy. Uczniowie przejęli role oskarżonych, oskarżycieli, obrońców w sprawie kryzysu i przestępstw człowieka przeciwko wodzie. Oskarżenie dotyczy zanieczyszczenia, odpadów i zmian w cyklu krążenia wody. Moduł opracowany został przez panią Agnieszkę Kowal, Magdalenę Kosacką i Tamarę Szvajca z Zespołu Szkół Informatycznych w Kielcach.

Moduł nauczania V4IoT 3: Temperatura

Trzeci moduł V4IoT Temperatura bada wpływ temperatury zewnętrznej na zdrowie człowieka. Uczniowie obserwują i analizują jak wysokie i niskie temperatury wpływają na ciało człowieka i jego zdrowie, a także dowiadują

się o potencjalnie zagrażających życiu warunkach powodowanych ekstremalnym chłodem, bądź gorącem. Elementy lekcji zawierają również informacje o tym, jak temperatura wpływa na ruch powietrza i jak to z kolei wpływa na zanieczyszczenie powietrza. W głównym zadaniu tego modułu uczniowie mieli zebrać i przeprowadzić badanie, aby opracować wskazania do działań podejmowanych przez rządzących. Celem było uświadomienie lokalnych społeczności w kwestii zdrowia i bezpieczeństwa. Moduł jest owocem współpracy pomiędzy Agnieszką Jadwiszczak, Ewą Rębowską, Alicją Łaska, Joanną Kamock i Jowitą Królikowską ze szkoły średniej w Sieradzu (I Liceum Ogólnokształcące im. Kazimierza Jagiellończyka w Sieradzu) z Polski i Janą Vidovą, Romanem Jakobej, Dianą Mešťanová i Jurajem Valko Krišťák z the Business Academy Rožňava (Obchodná akadémia vRožňave) w Słowacji.

Moduł nauczania V4IoT 4: Promieniowanie słoneczne

Czwarty moduł V4IoT Promieniowanie słoneczne zajmuje się znaczeniem promieniowania słonecznego dla życia na Ziemi i bada różne formy i typy promieniowania słonecznego. W szczególności skupia się na wadach i zaletach energii słonecznej w generowaniu prądu. Uczniowie pracowali nad wyzwaniem, aby uczynić ich szkołę pionierem w pozyskiwaniu tzw. "zielonej energii". Uczestnicy dokonali oceny umieszczenia paneli słonecznych na terenie szkoły oraz dokonali analizy, czy ich placówka może całkowicie polegać na energii odnawialnej. Na koniec stworzyli oni propozycję do przedstawienia lokalnym władzom. Moduł został opracowany przez następujących nauczycieli: Aneta Bednarek i Marcin Bernas z Liceum Akademickiego Da Vinci w Poznaniu; Milana Chalupníka z Základní Škola Seč, okres Chrudim w Czechach oraz Sándora Ujvári, Borsányi Zoltán, Bordács Lajos z the Lánchos Kornél Gimnázium na Węgrzech.

Moduł nauczania V4IoT 5: Ciśnienie atmosferyczne

Piąty moduł V4IoT Ciśnienie atmosferyczne odnosi się do elementów różnych typów warunków pogodowych, bada wpływ ciśnienia powietrza na temperaturę, opady i wiatr. Śledząc i odczytując pomiary ciśnienia atmosferycznego uczniowie dowiadują się o różnicach w ciśnieniu oraz o tym jak przewidywać zmiany pogodowe. Rozumieją również wpływ ciśnienia atmosferycznego na zdrowie i oddychanie człowieka, jego codzienne działania, a nawet eksperymenty naukowe. Ta część wprowadza

Polish Streszczenie

uczniów do zakresu prac meteorologa. Moduł ten został opracowany przez nauczycieli: Pavol Trubac z Spojena Skola, Peter Trubac z SOS Bornolakovo, Peter Korman z Gymnazium Mikulasa Kovaca w Słowacji oraz Gabriella Illes i Patricia Nanansi z Szent Pirooska Gorogkatolikus Altalanos Iskola na Węgrzech.

Więcej materiałów na temat projektu V4IoT znajduje się na [stronie internetowej projektu](#).

Polish Wstęp

Nasze społeczeństwa stoją obecnie w obliczu rewolucji cyfrowej, w której technologie takie jak internet rzeczy (IoT), duże zestawy danych i sztuczna inteligencja (AI) dają nam rozwiązania globalnych problemów, między innymi zmian klimatycznych, zabezpieczenia pożywienia, czy wybuchów pandemii (Yoon, 2020). Pomimo, że umiejętności STEM (nauki ścisłe, technologia, inżynieria i matematyka) są obecnie bardzo cenione wśród pracowników, a jednocześnie niezbędne do wprowadzania innowacji, wyzwaniem pozostaje przygotowanie profesjonalnie wykształconych pod kątem STEM pracowników (Komisja Europejska, 2015). Nauczanie i uczenie się opartych na STEM scenariuszy musi więc odbywać się w jak najwcześniejszej fazie edukacji, tak by stymulowało ciekawość uczniów, będąc równocześnie załącznikiem ich przyszłych karier.

Niezbędne jest przy tym odpowiednie szkolenie nauczycieli i ich profesjonalizacja: tylko w przypadku wysokiej jakości edukacji i użyciu różnorodnych nieformalnych i innowacyjnych narzędzi edukacyjnych, nauczyciele będą w stanie wyposażyć uczniów w niezbędne w XXI wieku umiejętności i kompetencje cyfrowe, a także wdrażać ich wiedzę w kontekście codziennego życia.

Projekt "Internet rzeczy, duże bazy danych i sztuczna inteligencja: Innowacyjne uczenie metodą STEM przez wzmocnienie profesjonalizacji nauczycieli", w skrócie V4IoT, skupiał się na tworzeniu możliwości edukacyjnych nauczycieli i ich kompetencji cyfrowych z czterech krajów Wspólnoty Wyszehradzkiej: Czech, Węgier, Polski i Słowacji. Projekt odbywał się wirtualnie pomiędzy kwietniem 2021, a marcem 2022. Szkoły i uczestniczący nauczyciele otrzymali zaawansowany sprzęt techniczny, który pozwolił im na monitorowanie i analizę zmian klimatycznych i wzorów pogodowych, a wszystko to dzięki wspólnej analizie danych takich jak pomiary prędkości wiatru, temperatury powietrza, opadów atmosferycznych, wilgotności, promieniowania UV itp. Wspólna platforma techniczna połączyła te szkoły i wspomagała interaktywne uczenie się, co umożliwiło nauczycielom i uczniom podjęcie dyskusji celem dogłębnego badania obszarów zainteresowania.

W projekcie uczestniczyło około 35 nauczycieli szkół średnich i ich uczniowie, a wśród omawianych zagadnień znalazły się edukacja dla zrównoważonego rozwoju, umiejętności XXI wieku, zmiany klimatyczne, a także szkolenia techniczne dotyczące sposobów w jakie internet rzeczy, duże bazy danych i sztuczna inteligencja mogą być wprowadzane do

procesu nauczania. Celem dzielenia się własną wiedzą i zachęcania do współpracy, nauczyciele pracowali w niewielkich grupach rozwijając moduły nauczania STEM, łączące ze sobą pięć celów edukacyjnych:

1. większa wiedza o przyczynach i wpływie zmian klimatycznych i wzorów pogodowych, a także ich wpływ na codzienne życie w krajach V4 i poza nimi,
2. zrozumienie wagi monitorowania środowiska naturalnego, a także przykłady w jaki sposób internet rzeczy, duże zbiory danych i sztuczna inteligencja, mogą być wykorzystywane do monitorowania ekosystemów, nawet na poziomie szkolnym,
3. wzmocnienie umiejętności XXI wieku w obszarach takich, jak umiejętność pozyskiwania informacji, kompetencje cyfrowe, twórczość, praca grupowa i krytyczne myślenie,
4. budowanie poczucia globalnego obywatelstwa przez współpracę interkulturową i nauczanie interaktywne ,
5. docenianie różnorodnych wysiłków dokonywanych przez rządy i społeczeństwa w kierunku Agendy ONZ 2030 oraz uzyskanie postawy wspierającej cele zrównoważonego rozwoju (SDGs).

Projekt zakończył się stworzeniem własnego podręcznika, zawierającego lekcje omówione na poszczególnych sesjach treningowych w ramach pięciu modułów STEM stworzonych przez nauczycieli. Podręcznik ma inspirować osoby zainteresowane pracą w szkołach średnich – w krajach grupy V4 i innych w regionie, za pomocą innowacyjnych metod nauczania STEM.

Projekt był koordynowany przez Liceum Ogólnokształcące imienia Mikołaja Kopernika w Tarnobrzegu oraz Fundację Europa-Azja (ASEF) w Singapurze, w ramach partnerstwa z Základní Škola Seč, okres Chrudim w Czechach; Szkołą Podstawową i Średnią Márton Bálint na Węgrzech; Obchodná akadémia Roznava and Spojena škola w Słowacji oraz partnerem EdTech ScienceScope Ltd z Wielkiej Brytanii. Projekt był współfinansowany przez rządy Czech, Węgier, Polski i Słowacji przez międzynarodowy Fundusz Wyszehradzki. Misją Funduszu jest rozwój idei zrównoważonej współpracy regionalnej w Europie Centralnej.

Translations/Slovak

Foreword

Executive Summary

Introduction



Jedným z najpálčivejších problémov, ktorým v súčasnosti ľudstvo čelí je zabezpečenie spravodlivého a dôstojného života pre všetkých ľudí, regenerácia prírody a umožnenie biodiverzite prosperovať. Toto nebolo nikdy dôležitejšie, a preto si to vyžaduje odklon od neudržateľných praktík a uvedomenie si hodnoty životného prostredia, od ktorého závisí naša budúcnosť ako druhu a budúcnosť našej planéty. Túto systémovú zmenu nemožno dosiahnuť len prostredníctvom politických dohôd, finančných stimulov alebo technologických inovácií, hoci sú dôležité a potrebné, ale najmä z dlhodobého hľadiska je potrebná zmena vo vzdelávaní, zmena aj v celoživotnom vzdelávaní.

Ekologická kríza ovplyvňuje každého a všetky aspekty spoločnosti, a preto sa stalo kľúčovým pre súčasnosť a budúcnosť našej planéty vytváranie príležitostí na učenie sa pre environmentálnu udržateľnosť. Spoločné porozumenie môže byť katalyzátorom akcie a spoločnej stratégie učenia sa pre environmentálnu udržateľnosť, aby sme mohli túto krízu pochopiť, konať a spoločne ju vyriešiť. Včasné strategické opatrenia sú potrebné na to, aby pomohli Európanom plne sa zapojiť do ekologickej transformácie nášho hospodárstva a spoločnosti, a nie len na ňu reagovať. Súčasťou tejto strategickej akcie je vzdelávanie v oblasti environmentálnej udržateľnosti.

Vzdelávanie založené na kompetenciách, ktoré pomáha žiakom rozvíjať zručnosti udržateľnosti založené na vedomostiach a postojoch môžu pomôcť presadzovať zodpovedné konanie a stimulovať ochotu prijať alebo požadovať opatrenia na miestnej, národnej a globálnej úrovni. Stať sa kompetentnými v otázkach udržateľnosti umožní žiakom nielen vedieť o problémy, ale aj konať. Európska komisia sa zaviazala splniť ciele trvalo udržateľného rozvoja (SDG) a kvalitné vzdelávanie (SDG 4) je kľúčom k dosiahnutiu všetkých cieľov trvalo udržateľného rozvoja. V súlade s kľúčovou úlohou celoživotného vzdelávania sa rozvoj kompetencií v oblasti udržateľnosti prostredníctvom vzdelávania a odbornej prípravy stal cieľom politiky EÚ a jej členských štátov. Udržateľnosť je jednou z kľúčových priorít Európskej komisie v oblasti vzdelávania a odbornej prípravy na roky 2019 – 2024.

Existuje široký konsenzus, že témy trvalej udržateľnosti je potrebné začleniť do celoživotného vzdelávania. Udržateľnosť je však komplexný pojem, ktorý treba definovať a je veľmi nejednoznačný. Udržateľnosť znamená rôzne veci pre rôzne skupiny ľudí v rôznych obdobiach. Udržateľnosť a trvalo udržateľný rozvoj sa často používajú zameniteľne, napriek ich

koncepčným rozdielom. Ako tvrdí UNESCO, udržateľnosť je najlepšie opísaná ako dlhodobý cieľ, ako je dosiahnutie udržateľnejšieho sveta, zatiaľ čo trvalo udržateľný rozvoj, ako to slovo naznačuje, sa týka mnohých procesov a ciest používaných na stimuláciu rozvoja alebo dosiahnutie pokroku udržateľným spôsobom. Napríklad SDG sú globálne ciele, ktoré povzbudzujú všetky krajiny a sektory, aby spolupracovali s cieľom nakoniec dosiahnuť udržateľnosť riešením výziev súvisiacich s trvalo udržateľným rozvojom.

Kompetencia v oblasti udržateľnosti umožňuje žiakom stelesniť hodnoty udržateľnosti a osvojiť si komplexné systémy s cieľom prijať alebo požadovať opatrenia, ktoré obnovia a udržia zdravie ekosystémov a posilnia spravodlivosť, čím sa generujú vízie pre udržateľnú budúcnosť.

Vzdelávanie k trvalej udržateľnosti sa zameriava na rozvoj vedomostí, zručností a postojov žiakov k udržateľnosti, aby mohli myslieť, plánovať a konať s ohľadom na udržateľnosť, aby žili v súlade s planétou. Všetky typy učenia – formálne, neformálne a informálne – sa považujú za rozvoj tejto kompetencie v ranom detstve, a to prostredníctvom jej zhromažďovania od malých detí a tínedžerov, až po ich uvedenie do kontextu ako mladých dospelých a neustále ich rozvíjanie ako dospelých. Udržateľnosť ako kompetencia sa vzťahuje na všetky sféry života, na osobnej aj kolektívnej úrovni.

Department of Secondary School Education

Ministry of Education, Science, Research and Sports of the Slovak Republic

Príručka "STEM a ESD": "Inovatívne technológie výučby a štúdia pomocou internetu vecí, veľkých dát a umelej inteligencie" predstavuje výsledok stredoškolského projektu "Internet vecí, veľké data a umelá inteligencia: Inovácia STEM – vyučovanie prostredníctvom zvyšovania odbornosti vyučujúcich, v skratke V4IoT. Projekt prebiehal v online formáte od apríla 2021 do marca 2022 a zapojilo sa doň viac ako 25 učiteľov so svojimi žiakmi zo štyroch krajín Vyšehradskej štvorky: Českej republiky, Maďarska, Poľska a Slovenska. Prostredníctvom účasti v projekte sa utužovala a rozvíjala spolupráca medzi študentmi a vybudovali sa kapacity, ktoré prispeli k zvýšeniu pedagogickej odbornosti.

Príručka predstavuje súhrn kľúčových aktivít a vzdelávacích výstupov projektu, zahŕňa postrehy a znalosti stredoškolských učiteľov, akademikov a tvorcov vzdelávacích plánov. Príručka slúži ako inšpirácia pre stredoškolských učiteľov v krajinách V4 a mimo nich, v oblasti inovatívnych STEM vyučovacích a študijných metód v kontexte klimatických zmien a trvalo udržateľného rozvoja. Pozostáva z dvoch častí:

Prvá časť vymedzuje tematický a technický okruh vedomostí, ktorý bol navrhnutý pedagogickými a EdTech odborníkmi a taktiež odborníkmi daných oblastí. Druhá časť predstavuje šesť modulov STEM vyučovania, ktoré boli vytvorené učiteľmi po tom ako absolvovali odborné školenia.

Prvá časť

Prvá časť načrtáva koncepciu projektu a poskytuje prehľad tematických a technických školení, ako aj stretnutí žiakov, ktoré boli súčasťou projektu. Jednotlivé kapitoly sumarizujú metodológiu a obsah troch rôznych sekcií, obsahujú zoznam použitých učebných materiálov, zdrojov a odkazov pre ďalšie štúdium.

Tematické školenia boli zamerané na vzdelávanie o trvalo udržateľnom rozvoji (ESD) s dôrazom na vzdelávanie v oblasti životného prostredia a zmien klímy, ako aj na rozvoj zručností 21. storočia.

V rámci týchto školení sa zdôrazňovala dôležitosť interdisciplinárnych prístupov pri riešení príležitostí a výziev smerom k trvalo udržateľnému rozvoju a účastníci sa dozvedeli o význame konceptu vzdelávania ESD a zručností 21. storočia pre zavedenie nevyhnutnej inovácie vo výučbe STEM predmetov s cieľom podporiť pozitívny prístup ku realizácii klimatických aktivít.

Technické školenia poskytli prehľad o základoch internetu vecí, veľkých dát a AI. Odborníci odprezentovali súčasné trendy a diskutovali o potenciálnych aplikáciách internetu vecí, veľkých dát a AI a ich vplyve na každodenný život v oblasti vzdelávania a spoločnosti ako takej. Učitelia tiež absolvovali praktické školenia o tom, ako používať a integrovať internet vecí v triedach na dosiahnutie vzdelávacích cieľov v oblasti týkajúcej sa zmeny klímy.

Jednotlivé kapitoly prvej časti zhŕňajú kľúčový obsah týchto tém. Autormi sú Leonie Nagarajan & Jyoti Rahaman z oddelenia vzdelávania ASEF, ako aj profesorka Aleksandra Przeglasińska z Kozminského univerzity v Poľsku.

Druhá časť

Druhá časť predstavuje päť vyučovacích modelov V4IoT STEM, ktoré boli vytvorené participujúcimi učiteľmi z krajín V4 počas realizácie projektu. Učitelia pracovali v malých skupinách a navrhli vyučovacie modely na základe vedomostí získaných z tematických a technických školení, ako aj z údajov zozbieraných prostredníctvom technologického zariadenia internetu vecí.

Každý výučbový model V4IoT STEM je prezentovaný v samostatnej kapitole. Ilustrácie, dátové grafy, grafika a jednoduché informačné tabuľky vysvetľujú model krok za krokom a každý model sa zameriava na vzdelávacie ciele projektu v nasledujúcich piatich oblastiach: 1) zmena klímy, 2) monitorovanie životného prostredia, 3) zručnosti 21. storočia, 4) vzdelávanie o globálnom občianstve a 5) ciele trvalo udržateľného rozvoja. Kapitoly taktiež obsahujú časť o tipoch, trikoch a odporúčaných digitálnych nástrojoch.

Na základe zhrnutých vyjadrení učiteľov a študentov, príručka zdôrazňuje dôležitosť spoločného a vzájomného učenia sa, ako aj dôležitosť a potrebu vhodných vyučovacích a vzdelávacích postupov na stredných školách. Vyučovacie modely odkazujú na konkrétne lokálne príklady a scenáre z krajín V4. Tieto príklady sa však dajú ľahko osvojiť a pretransformovať do iných regiónov ako aj do globálneho kontextu.

V4IoT Výučbový modul 1: Rýchlosť a smer vetra

Prvý modul V4IoT o rýchlosti a smere vetra sa zaoberá javmi vetra, jeho vplyvom na kvalitu ovzdušia a tým, ako možno vietor využiť ako alternatívny zdroj energie. Modul vedie študentov k zhromažďovaniu údajov spojených s rôznymi vlastnosťami vetra, vrátane rýchlosti, sily a smeru, ako aj jeho vzťahu k barometrickému tlaku, a skúma vplyv vetra na iné poveternostné javy, životné prostredie ľudí a na zdravie. Aby sa téma spojila s miestnym prostredím, študenti musia preskúmať veterné podmienky v rôznych geografických lokalitách vo Vyšehradskom regióne a posúdiť realizovateľnosť zariadenia veterného parku v ich regióne. Musia tiež predpovedať oblasti rizika znečistenia ovzdušia v ich meste v závislosti od sezónnych vetrov. Model vyvinuli Adam Stepinski, z Kopernikovej strednej školy v Tarnobrzegu, v Poľsku, Adrienn Kortvelyesi a Dr. Heider Naszer z Bugat Pal, strednej technickej školy v Maďarsku a Mark Daniels, z Besst Gymnázia na Slovensku.

V4IoT Výučbový modul 2: Celkové zrážky a miera zrážok

Druhý model V4IoT o úhrne zrážok rozoberá zmeny klímy a jej vplyv na intenzitu a frekvenciu zrážok. Učitelia a študenti skúmajú význam dažďa pre životné prostredie a život ako taký, diskutujú o príkladoch extrémnych poveternostných podmienok (napr. silných dažďoch alebo obdobiach extrémneho sucha). Študenti sa naučia, že voda je vzácny prírodný zdroj a učia sa o tom, ako hospodárne a zodpovedne nakladať s vodou v škole, doma a všade inde. Daný model má interdisciplinárny dosah s predmetmi STEM, a je vedený formou hier, funkčného hrania a súdneho procesu. Študenti sú v pozícii obvineného, prokurátora, obhajcu, svedkov a sudcu v právnom prípade, ktorý sa zameriava na "človekom spôsobené priestupky a zločiny" proti vode: znečistenie vody, plytvanie vodou a zmeny vo vodnom cykle. Model vyvinuli Agnieszka Kowal, Magdalena Kosacka a Tamara Sz wajca zo strednej školy Zespół Szkół Informatycznych v Kielce, v Poľsku.

V4IoT Výučbový modul 3: Teplota

Tretí model výučby V4IoT o teplote skúma vplyv vonkajšej teploty na ľudské zdravie. Študenti pozorujú a analyzujú aký vplyv majú vysoké a nízke teploty vzduchu na ľudské telo a pohodu človeka. Dozvedia sa o potenciálnych, život ohrozujúcich podmienkach spôsobených teplotnými zmenami, extrémnym teplom a chladom, diskutujú o tom ako teplota ovplyvňuje

pohyb vzduchu a ako to vplýva na znečistenie ovzdušia. Študenti zozbierali data a zrealizovali výskum zameraný na štúdium politík a aktivít v tejto oblasti. Cieľom je zabezpečiť informovanie miestnych komunít, aby tie boli zdravé a bezpečné. Model je výsledkom spolupráce Jany Vidovej, Romana Jakobeja z Obchodnej akadémie v Rožňave, na Slovensku a Agnieszka Jadwiszczak, Ewa Rębowska, Alicja Łaska, Joanna Kamocka a Jowita Królikowska z Kopernikovej strednej školy v Sieradzu (I Liceum Ogólnokształcące im. Kazimierza Jagiellończyka w Sieradzu), v Poľsku.

V4IoT Výučbový modul 4: Index slnečného a ultrafialového žiarenia (UVI)

Štvrtý model výučby V4IoT o Indexe slnečného a ultrafialového žiarenia (UVI) sa zaoberá významom slnečného žiarenia pre život na Zemi a skúma jeho rôzne formy a typy. Modul sa zameriava najmä na výhody a nevýhody solárnej energie na výrobu elektriny. Študenti pracujú na výzve, aby sa ich škola stala priekopníkom v oblasti zelenej energie. Posudzujú možnosť umiestnenia solárnych panelov na akademickú pôdu a analyzujú, či sa ich školy môžu úplne spoľahnúť na obnoviteľnú slnečnú energiu pri každodennej prevádzke a na konci musia vytvoriť návrh pre vedenie školy. Model vytvorili Sándor Ujvári, Borsányi Zoltán, Bordács Lajos, Lánczos Kornél z gymnázia v Maďarsku, Milan Chalupník, Taťána Holavová, Iva Korberová zo Základnej školy, v Seči, okres Chrudim v Českej republike a Aneta Bednarek a Marcin Bernaś z Liceum Akademickie Da Vinci v Poznani, v Poľsku.

V4IoT Výučbový modul 5: Barometrický tlak

Piaty modul o barometrickom tlaku sa zaoberá prvkami rôznych typov poveternostných podmienok a skúma, ako atmosférický tlak ovplyvňuje teplotu, zrážky a vietor. Sledovaním a čítaním barometrického tlaku pomocou zariadenia internet vecí sa študenti dozvedia o zmenách barometrického tlaku a ako predpovedať krátkodobé zmeny počasia. Získajú tiež prehľad o vplyve barometrického tlaku na naše zdravie a dýchanie, každodenné aktivity a dokonca aj na vedecké experimenty. Modul predstavuje študentom rôznorodú pracovnú náplň meteorológa a pozýva ich, aby sa pripojili k pretekem spôsobilosti, aby si otestovali svoju pripravenosť v reálnom svete. Kto má vedomosti a zručnosti na to, aby sa stal školským meteorológom? Tento model je vytvorený Petrom Trubačom zo Soš v Bernolákovo, Pavlom Trubačom zo Spojenej školy na Slovensku,

Petrom Kormanom z Gymnázia Mikukáša Kováča na Slovensku a Gabriella Iles a Patricia Nanansi Szent Piroska Gorogkatolikus Altalanos Iskola, Maďarsko.

Viac informácií o projekte V4IoT môžete nájsť na [stránke projektu](#).

Naše spoločnosti čelia technologickej revolúcii, kde internet vecí (IoT), veľké data (Big Data) a umelá inteligencia (AI) poskytujú riešenia, ktoré sú potrebné na zvládnutie globálnych výziev, vrátane zmeny klímy, potravinovej bezpečnosti alebo pri prepuknutí pandémie (Yoon, 2020). Hoci sú zručnosti v oblasti STEM (Veda, Technológia, Inžinierstvo a Matematika) nevyhnutné na podporu inovácií a sú vysoko žiadané v pracovnej sfére, príprava inovatívnych odborníkov v oblasti STEM zostáva výzvou (European Commission, 2015). Výučba a štúdium STEM sú zakomponované do reálneho života a s ich štúdiom sa musí začať už na nižších vzdelávacích stupňoch, aby sa podnietila zvedavosť študentov k predmetu a naviedla ich na možnú budúcu kariéru v danej oblasti a taktiež zdôraznila úlohu vedy pre spoločenský pokrok.

Školenia učiteľov a ich odbornosť sú v danom procese kľúčové. Len poskytnutím kvalitnej výučby a pri použití rôznych formálnych a neformálnych inovatívnych vyučovacích metód bude učiteľ schopný poskytnúť študentom relevantné príležitosti na budovanie zručností, digitálnych kompetencií pre 21. storočie a umožniť študentom využívať nadobudnuté vedomosti v každodennom živote alebo v širšom kontexte reálneho sveta.

Projekt "Internet vecí, veľké dáta a umelá inteligencia: Inovácia STEM – vyučovanie prostredníctvom zvyšovania odbornosti vyučujúcich (v skratke V4IoT), bol zameraný na budovanie pedagogickej kapacity digitálnych kompetencií učiteľov v štyroch krajinách Vyšehradskej štvorky: Českej republike, Maďarsku, Poľsku a Slovensku. Projekt prebiehal vo virtuálnej forme od apríla 2021 do marca 2022. Školy zapojených pedagógov dostali najmodernejšie technologické vybavenie, ktoré im umožnilo monitorovať a analyzovať klimatické zmeny a vzorce počasia prostredníctvom zberu údajov, ako napríklad: rýchlosť vetra, teplota vzduchu, úhrny zrážok, vlhkosť, slnečné a UV žiarenie, atď. Spoločná technická platforma prepájala všetky školy, umožnila interaktívne vyučovanie a vytvorila vzdelávacie prostredie, ktoré presiahlo hranice vzdialenosti a umožnilo učiteľom a študentom diskutovať, spoločne skúmať a identifikovať oblasti spolupráce.

Tohto online spoločného projektu sa zúčastnilo viac ako 25 učiteľov. Program projektu zahŕňal tematické školenia o vzdelávaní pre trvalo udržateľný rozvoj, školenia o zručnostiach 21. storočia, klimatických zmenách, ako aj technické školenia o tom, ako možno internet vecí, veľké dáta a umelú inteligenciu začleniť do kontextu vyučovania a štúdia. Pre

možnosť efektívneho zdieľania nadobudnutých znalostí medzi študentami, vyučujúci pracovali s malými skupinkami žiakov a vyvinuli vyučovacie modely STEM, ktoré kombinovali 5 študijných cieľov:

1. Získať väčší prehľad o príčinách a vplyve klimatických zmien, najmä o špecifických vzorcoch počasia a o tom, ako ovplyvňujú každodenný život v krajinách V4 a mimo nich
2. Porozumieť dôležitosti monitorovania životného prostredia pre vedecké účely a pochopiť ako internet vecí, veľké dáta a umelá inteligencia môžu byť použité na monitorovanie ekosystémov, hoci aj v školskom prostredí
3. Posilniť zručnosti 21. storočia v oblastiach ako sú: informačná gramotnosť, digitálna gramotnosť, kreativita, tímová práca a kritické myslenie
4. Budovať pochopenie globálneho občianstva prostredníctvom medzikultúrnej spolupráce, interaktívnej výučby a študijných možností, ktoré presahujú geografické hranice
5. Oceniť rozličné úsilie vlád a občianskych spoločností v súvislosti s agendou OSN 2030: stať sa zástancom cieľov trvalo udržateľného rozvoja (SDG)

Projekt sa zakončil vytvorením tejto príručky, ktorá obsahuje poznatky získané počas školenia a piatich výučbových modelov STEM vytvorených vyučujúcimi. Cieľom príručky je inšpirovať záujemcov a pracovníkov v oblasti stredoškolského vzdelávania v krajinách V4 a naprieč regiónmi v oblasti inovatívneho STEM vyučovania a inovatívnych študijných metód. Tento úvod, predslov, zhrnutie, a tematický úvod o internete vecí, veľkých dátach a umelej inteligencii bol preložený do češtiny, maďarčiny, poľštiny a slovenčiny. Zvyšné kapitoly tejto príručky sú dostupné výhradne v anglickom jazyku.

Projekt V4IoT koordinovala Kopernikova stredná škola v Tarnobrzeg v Poľsku a Ázijsko-európska nadácia (ASEF) v Singapure v spolupráci s týmito školami: Základní škola Seč, okres Chrudim v Českej republike; Márton Bálint základná a stredná škola v Maďarsku, Obchodná akadémia Rožňava a Spojená škola na Slovensku. V oblasti vzdelávacích technológií (EdTech) podporovateľom projektu je ScienceScope Ltd vo Veľkej Británii.

Projekt spolufinancovali vláda Českej republiky, Maďarska, Poľska a Slovenska, prostredníctvom vyšehradských grantov z Medzinárodného vyšehradského fondu. Úlohou fondu je podporovať myšlienky udržateľnej regionálnej spolupráce v strednej Európe.

Coordinators and Partners



Funding Partner

Visegrad Fund

The Visegrad Fund is an international donor organisation, established in 2000 by the governments of the Visegrad Group countries Czechia, Hungary, Poland and Slovakia to promote regional cooperation in the Visegrad region (V4) as well as between the V4 region and other countries, especially in the Western Balkans and Eastern Partnership regions. The Fund does so by awarding €8 million through grants, scholarships and artist residencies provided annually by equal contributions of all the V4 countries. Other donor countries (Canada, Germany, the Netherlands, South Korea, Sweden, Switzerland, the United States) have provided another €10 million through various grant schemes run by the Fund since 2012.

www.visegradfund.org



Coordinating School

Copernicus Upper-Secondary School in Tarnobrzeg, Poland

Copernicus-Upper Secondary School was established in 1909 and is the oldest education institution in the region. With the mission to help its students become conscious and active citizens, the school has been involved in numerous international projects which provide opportunities for international exposure and collaboration. In total, the school has conducted over 50 projects in Europe, Asia, and the Americas. The school received the “Silver School 2022” award by the “Perspektywy” Educational Foundation, as part of the PERSPECTIVE 2022 ranking of the 500 best general secondary schools in Poland.

www.lo.tarnobrzeg.pl



Partner Schools

Základní Škola Seč, Czech Republic

Located in the countryside (Seč, okres Chrudim) in a protected area near a large dam reservoir, environmental education plays an important role for Základní Škola Seč School. The school has a solid track record in national and international school co-operations, having been involved in a number of Erasmus+ projects and other projects funded under the European Social Fund.

zs-sec.cz



Márton Bálint Primary and Secondary School, Hungary

Márton Bálint Primary and Secondary School is located in Törökbálint. It is a pioneer school in competence-based teaching in Hungary, applying project based and peer learning methodologies to prepare its students for success in life. STEM education is one of the school's strategic areas, where modern digital facilities support experimental learning. 11 teaching practices at school were featured among the most innovative methodologies by the Hungarian National Education Agency. The school is highly engaged in international cooperation & participated in several Erasmus+ programmes. It has also set up an Eco-School in 2010.

balintsuli.hu



Partner Schools

Obchodná akadémia Rožnava, Slovakia

Obchodná akadémia Rožnava is a vocational school that provides comprehensive services for students, including accommodation. For the past 15 years, the school has been actively partnering with other educational institutions across Europe on international projects under the European Lifelong Learning Programmes (Comenius, Leonardo da Vinci and Erasmus plus).

www.oarv.sk



Spojena Skola, Slovakia

The vocational school Spojena skola is located in the Danubian Lowland. With a focus on agriculture & farming the school ensures continued learning pathways for students and supports post-secondary studies, for example in horse breeding. The school recently integrated new organisational units to include business & industry-related subjects. Spojena skola has been engaged for over 20 years in European Lifelong Learning Programmes, ranging from Erasmus+ to Comenius or Leonardo da Vinci projects.

www.spojsivanka.sk



Project Management Partner and Thematic Expert

Asia-Europe Foundation (ASEF)

The Asia-Europe Foundation (ASEF) is an intergovernmental not-for-profit organisation located in Singapore. Founded in 1997, it is the only institution of the Asia-Europe Meeting (ASEM). ASEF's mission is to promote understanding, strengthen relationships and facilitate cooperation among the people, institutions and organisations of Asia and Europe. ASEF enhances dialogue, enables exchanges and encourages collaboration across the thematic areas of culture, education, governance, sustainable development, economy, public health and media.

www.asef.org

The ASEF Classroom Network (ASEFClassNet)

The ASEF Classroom Network (#ASEFClassNet) connects high school students, teachers & school leaders, teacher trainers, researchers, policy makers and EdTech experts from the 51 ASEM Partner countries. The ASEF ClassNet provides opportunities for collaborative teaching & learning and focuses on Education for Sustainable Development and the potential of education technology in the secondary education sector. Activities of the network include, amongst others, conferences & capacity building programmes for school leaders & teachers, bi-regional school collaborations, research & studies for policy support as well as communication and outreach campaigns to advance knowledge and promote good practices within the secondary school sector.

classnet.asef.org



EdTech Partner and Technical Expert

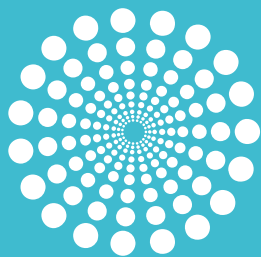
ScienceScope Ltd

ScienceScope Ltd is based at Downside School near Bath, in the South-West of the United Kingdom. With a focus on developing research projects on Education Technology, the company has been awarded grant funding to develop projects in multiple countries from around the world including the UK, Singapore and the UAE. ScienceScope Ltd has collaborated with a wide range of academic & government partners including the University of Bath and the University of Glasgow in the United Kingdom, the Singapore Infocom and Media Development Authority (IMDA) and the National Institute for Education Singapore.

www.sciencescope.uk



Participants



Participants Teachers

Czech Republic

Základní škola Seč, okres Chrudim

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Tatána Holavová, Teacher

Iva Korberová, Teacher

Hungary

Bugat Pal Secondary Technical School

Adrienn Körtvélyesi, Teacher

Heider Naszer, Teacher

Lánczos Kornél Gimnázium

Sándor Ujvári, Physics Teacher

Márton Bálint Primary and Secondary School

Andrea Molnarne Laszlo, Teacher

Szent Pirooska Greek Catholic Primary School

Gabriella Illés, Teacher

Patricia Nánási, Biology Teacher

Poland

Copernicus Upper-Secondary School in Tarnobrzeg

Boguslaw Lubanski, Teacher

Adam Stepinski, Teacher

I Liceum Ogólnokształcące Collegium Gostomianum

Andrzej Bryla, Teacher

I Liceum Ogólnokształcące im. Kazimierza Jagiellończyka w Sieradzu

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Joanna Kamocka, Teacher

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Ewa Rębowska, Teacher

Participants Teachers

Liceum Akademickie Da Vinci

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Marcin Bernaś, Geography Teacher
Marzena Tchórzewska, IT Teacher

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Magdalena Kosacka, Teacher
Agnieszka Kowal, Teacher
Tamara Szwajca, Teacher

Slovakia

Besst Gymnazium

Mark Daniels, Teacher

Grammar school Mikuláš Kováč in Banská Bystrica

Peter Korman, Teacher

Obchodná akadémia Rožnava

Roman Jakobej, Teacher
Juraj Valko Krišťák, Teacher
Diana Mešťanová, Teacher
Jana Vidová, Teacher

Secondary School of Electrical Engineering (SPŠE)

Martin Ambrozy, Teacher

Škola umeleckého priemyslu Košice

Zuzana Tkacova, Teacher & ICT Co-ordinator

SOS Bernolákovo

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Ján Vojtašák, Teacher

Participants Students

Hungary

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Emese Szűcs

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Szymon Skulski, Kamila Skwara, Patryk Słonina,
Katarzyna Stagraczyńska, Adam Świerk, Dominik Szczepan, Małgorzata
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Alexander Ślusarczyk

Zespół Szkół Informatycznych im. Gen. Józefa Hauke Boska w Kielcach

Daniel Fidor, Aleksander Grosicki, Kacper Krzysztof, Wiktor Markowski
Mateusz Sarbian, Anthony Siwiec, Mateusz Słowik, Karol Smuga

Slovakia

Gymnasium Mikuláš Kováč

Sára Goldbachová, Ján Hukel, Viktor Kandár, Kristián Koleno,
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Katarína Trnková, Lucia Volentierová

Participants

Students

Obchodná akadémia Roznava

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Juraj Szantó, Róbert Zakhar

Spojena Skola

Nela Brinzova, Jakub Cervený, Ema Dodokova, Samuel Gabriska, Viktoria
Hromadova, Alica Komzikova, Dominik Kubik, Jakub Molnar
Niccolo Richter, Richard Stiglic

Note

The list of teachers and students participants does not present all names
as some participants wished to not be displayed for privacy reasons.

Recommended Reading List



Recommended Reading List and Resources

Thematic Training Session #1

Understanding Education for Sustainable Development (ESD)

What is ESD? by UNESCO

<https://en.unesco.org/themes/education-sustainable-development/what-is-esd>

<https://en.unesco.org/themes/education-sustainable-development>

Education for Sustainable Development by UNESCO & OECD

<https://www.oecd.org/env/outreach/Presentation%20by%20Bernard%20Combes%20UNESCO.pdf>

Issues and Trends in Education for Sustainable Development (ESD) by UNESCO

<https://unesdoc.unesco.org/ark:/48223/pf0000261445>

A Decade of Progress on Education for Sustainable Development: Reflections from the UNESCO Chairs Programme by UNESCO

<https://unesdoc.unesco.org/ark:/48223/pf0000252319>

UNESCO Global Action Programme (GAP) on ESD by UNESCO <https://unesdoc.unesco.org/ark:/48223/pf0000246270>

Textbooks for Sustainable Development: A Guide to Embedding by UNESCO <https://unesdoc.unesco.org/ark:/48223/pf0000259932>

Integrating Education for Sustainable Development (ESD) in Teacher Education in South-East Asia: A Guide for Teacher Educators by UNESCO

<https://bangkok.unesco.org/sites/default/files/2018-10/265760E.pdf>

Thematic Training Session #2

The Implications of Climate Change, Global Warming, and the Future of STEM

IPFCC Report 2021

https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf

Causes and Consequences of Climate Change by European Union

https://ec.europa.eu/clima/change/causes_en

Recommended Reading List and Resources

Overview: Weather, Global Warming and Climate Change by NASA
<https://climate.nasa.gov/resources/global-warming-vs-climate-change/>

What's the difference between Climate Change and Global Warming?
by NASA
<https://climate.nasa.gov/faq/12/whats-the-difference-between-climatechange-and-global-warming/>

What is Action for Climate Empowerment? by UNFCCC
<https://unfccc.int/topics/education-youth/the-big-picture/what-is-actionfor-climate-empowerment>

Action for climate empowerment: guidelines for accelerating solutions through education, training and public awareness by UNESCO
<https://unesdoc.unesco.org/ark:/48223/pf0000246435>

Getting climate-ready: a guide for schools on climate action by UNESCO
<https://unesdoc.unesco.org/ark:/48223/pf0000246740>

Climate change in the classroom: UNESCO course for secondary teachers on climate change education for sustainable development by UNESCO
<https://unesdoc.unesco.org/ark:/48223/pf0000219752>

STEM resources on Climate Change
<https://www.stem.org.uk/climate-change-educational-partnership>

UNESCO Associate Schools 4 Climate Action: Documentary by UNESCO ASPnet
<https://www.youtube.com/watch?v=RkoXX4m9wR8&t=1554s>

Sustainable Development Goals in STEM Education by SCIENTIX
<https://blog.scientix.eu/2021/02/sustainable-development-goals-in-stemeducation/>

YouthXchange guidebook series: climate change and lifestyles by UNESCO
<https://unesdoc.unesco.org/ark:/48223/pf0000212876>

Climate Change, STEM, and the Next Generation
by Education Business UK
<https://educationbusinessuk.net/features/climate-change-stem-and-nextgeneration>

SDG13 UN Report
<https://unstats.un.org/sdgs/report/2021/goal-13/>

Visualising a Warming World by World Bank
<https://www.connect4climate.org/infographics/visualising-warming-world>

Gap minder – data visualisation
[https://www.gapminder.org/tools/#\\$chart-type=bubbles&url=v1](https://www.gapminder.org/tools/#$chart-type=bubbles&url=v1)

Data for Climate Action
The Data – Data For Climate Action
<http://www.dataforclimateaction.org/home/data/>

TED talk: Strategies to talk about Climate Change
By John Marshall
https://www.ted.com/talks/john_marshall_3_strategies_for_effectively_talking_about_climate_change?language=en

TED talk: How to green the world's dessert and reverse Climate Change
TED Talk
by Allan Savory
<https://www.youtube.com/watch?v=vpTHi7O66pI>

Thematic Training Session #3
Interactive Session on Building the Connection: STEM, ESD and 21st Century Skills

The Future of Education and Skills: Education 2030 by OECD
[https://www.oecd.org/education/2030/E2030%20Position%20Paper%20\(05.04.2018\).pdf](https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf)

Exploring STEM Competences for the 21st Century by UNESCO
<https://unesdoc.unesco.org/ark:/48223/pf0000368485>

Resources on Design Thinking in STEM by Siemens Stiftung
<https://www.siemens-stiftung.org/en/projects/design-thinking-in-stem/>

Recommended Reading List and Resources

Using Science to Do Social Good: STEM Education for Sustainable Development [Position paper developed in preparation for the second “International Dialogue on STEM Education” (IDoS) in Berlin, December 5-6, 2019]
<https://innovec.org.mx/home/images/positionpaper-idos2019-usingsciencetodosocialgood.pdf>

ESD Starts Where STEM Stops: Integrating the Social Sciences into STEM by Julie M. Davis, Queensland University of Technology, Brisbane
<https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.663.7578&rep=rep1&type=pdf>

Practical pedagogy for embedding ESD in science, technology, engineering, and mathematics curricula by the University of Bradford
<https://bradscholars.brad.ac.uk/handle/10454/4795>

21st Century Skills: Ancient, ubiquitous, enigmatic? By the University of Cambridge
<https://www.cambridgeassessment.org.uk/Images/130437-21st-century-skills-ancient-ubiquitous-enigmatic-.pdf>

Technical Training Session #1 What is the Internet of Things (IoT), How Does it Work?

What is the “Internet of Things?” by the World Economic Forum
<https://www.youtube.com/watch?v=NnB-iSrqbFY>

What is the Internet of Things (IoT)? By Oracle and IBM
<https://www.oracle.com/sg/internet-of-things/what-is-iot/>
<https://www.ibm.com/blogs/internet-of-things/what-is-the-iot/>

What is IoT? – a guide to IoT terminology
<https://www.telenorconnexion.com/iot-insights/what-is-iot-guide/>

Gartner Glossary on IoT Platforms
<https://www.gartner.com/en/information-technology/glossary/iotplatforms>

Technical Training Session #2 What is Big Data, What is Artificial Intelligence (AI)?

What are AI and Big Data? by World Economic Forum
<https://www.youtube.com/watch?v=uD8Dbozzod4>

What is Big Data? By Oracle
<https://www.oracle.com/sg/big-data/what-is-big-data/>

History of Big Data by SAS
https://www.sas.com/en_sg/insights/big-data/what-is-big-data.html

The 4 Vs of Big Data by Open Sistemas
<https://opensistemas.com/en/the-four-vs-of-big-data/>

Talking Big Data and Analytics with IBM by Forbes
<https://www.forbes.com/sites/chrisversace/2014/04/01/talking-big-data-and-analytics-with-ibm/?sh=b090e91a66e3>

Technical Training Session #3 Introduction to ScienceScope's IoT Devices, The Weather Station, and its Relevance to STEM Learning

Resetting the way we teach science is vital for all our futures by World Economic Forum
<https://www.weforum.org/agenda/2020/08/science-education-resetstem-technology/>

