



International Council of Associations for Science Education

ICASE International Bulletin for Science Education

Volume 3, Issue 1. March 2026

WELCOME

Dear ICASE colleagues,

Thank you for taking the time to read the March 2026 edition of the ICASE Bulletin. We hope the contents of this edition will be informative for you. We thank all our contributors who have provided such a diverse selection of articles. I would also like to thank Rory Geoghegan who is assisting me with the typesetting.

We would like to remind you of the upcoming ICASE World Conference that will be held in University College Cork, Ireland in June 2026. We hope that as many as possible of the ICASE community can travel to Ireland or this event, we look forward to giving those who arrive a "céad míle fáilte" - a hundred thousand welcomes! Details can be found in the flyer at the end of this edition.

If you wish to submit an article for the next edition of the ICASE Bulletin, please email:

icasebulletineditor@gmail.com

Stephen Murphy (Editor)



University College Cork, Ireland,

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The extraction of metals from ores: A case study of extraction of nickel in Indonesia

Gilbert Rantung, Angel Nickel Industry, Weda Bay Industrial Park, North Maluku, Indonesia.

Introduction

The extraction of metals from their ores is one of the fundamental topics studied in high-school chemistry courses all over the world. Chemistry students learn that an ore is a naturally occurring rock that contains enough of a metal (usually in the form of a compound) to make it worthwhile to extract that metal. When students first meet this topic, the most com-

mon example studied is the extraction of iron from iron ore in the blast furnace, Figure 1.

The main oxidation-reduction reactions that take place in the blast furnace are summarised in Figure 1. When introducing the concepts of oxidation and reduction to students, teachers may find it helpful to give some practical examples from industrial processes.

In this article we will look at the

extraction of the metal nickel. This metal is becoming more and more important because of its use in the manufacture of rechargeable batteries – especially for electric vehicles. Indonesia is now one of the world's leading producers of nickel and one of the most important industrial centres is PT Indonesia Weda Bay Industrial Park (IWIP) on Halmahera Island in North Maluku. By studying how nickel is extracted there, we can connect school chemistry ideas (such as physical and chemical changes, oxidation-reduction reactions and electrochemistry) to real industrial processes that affect our everyday lives.

The importance of nickel in our lives

About two-thirds of the world's nickel is used to make stainless steel. In a common type of stainless steel, nickel (usually about 8–10%) and chromium (about 18%) are added to iron to create an alloy that is tough, shiny and very resistant to rust.

Nickel is used in heat-resistant alloys for jet engines, gas turbines and chemical plant equipment. These alloys keep their strength at very high temperatures.

The uses of nickel in our everyday lives may be summarised as follows:

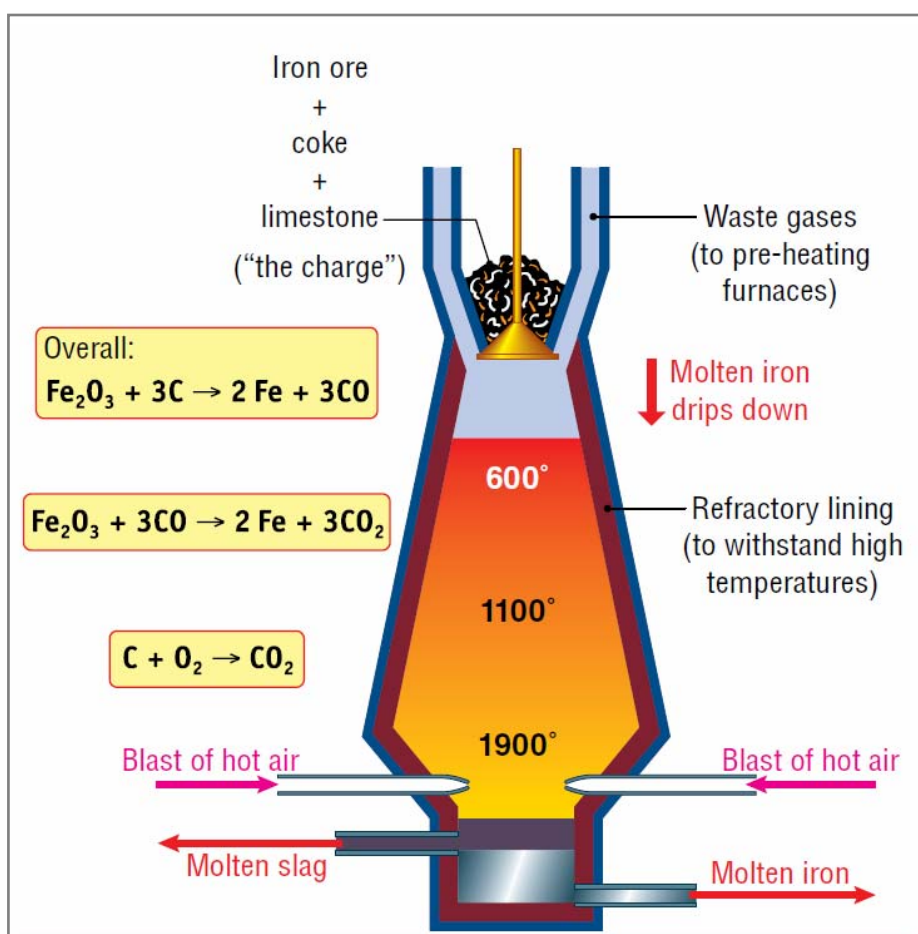


Figure 1. In the blast furnace, iron metal is extracted from the ore haematite, Fe_2O_3 .

- **Plating and coatings:** Thin layers of nickel are electroplated onto other metals to protect them from corrosion and to give a bright, attractive finish (for example on taps, door handles and some car parts).
- **Coins:** Many coins around the world are made of nickel-copper alloys or are plated with nickel because it is hard, corrosion-resistant and has an attractive silvery appearance.
- **Catalysts and chemicals:** Nickel compounds are used as catalysts in some chemical reactions and in hydrogenation of oils.
- **Batteries:** Nickel is a vital component in several types of rechargeable batteries, especially modern lithium-ion batteries used in electric vehicles.

Global demand for nickel has increased sharply in recent years, particularly for stainless steel and electric vehicle batteries. This has driven rapid growth in nickel mining and processing in Indonesia.

Nickel ore in Indonesia

Indonesia lies on the equator and has a hot, wet, tropical climate. These conditions are ideal for the formation of a special type of nickel ore called a laterite. Laterite ores form when rocks rich in iron and magnesium are slowly weathered over millions of years. As rainwater and oxygen react with the rock, some elements such as magnesium and calcium are washed out, while iron and nickel are left behind.

Laterite ores are usually divided into layers with different minerals. For example, the lower layer (closer to the original rock) is called the saprolite layer and it is rich in nickel and magnesium. A photograph of laterite ore is shown in Figure 2.



Figure 2. A sample of laterite ore from which nickel metal will be extracted.

Extraction of nickel metal

Extraction of nickel metal at Indonesia Weda Bay Industrial Park (IWIP) is an integrated industrial zone located in North Maluku, Indonesia. In this area, large laterite deposits are mined and processed. The park includes:

- Open-pit nickel mines.
- Rotary Kiln-Electric Furnace (RKEF) smelters that produce ferronickel and related products.

- High-pressure acid leach (HPAL) plants that produce intermediate product used to make battery materials.
- Supporting facilities such as power plants, port facilities and workshops.

Different companies operate within the park, but together they form a chain that transforms the ore into nickel products for battery industries and stainless steel products. The main stages may be summarised as follows:

Stage 1. Exploration and drilling. Geologists map the laterite deposits and drill boreholes to measure the thickness and composition of the ore in terms of average nickel content.

Stage 2. Open-pit mining. In this stage the soil and non-ore rock are removed and excavators remove the ore and load it on to trucks.

Stage 3. Crushing, screening and blending. In this stage the ore is crushed into smaller particles. Screening separates fine and coarse material. This stage does not involve chemical changes - it is mainly physical processing. This could be used by science teachers as an example of a physical change.

Stage 4. Drying of ore. The ore contains water in two forms - liquid water in the pores between particles and chemically-bound water in the crystal structure of minerals. Before smelting, the ore is dried in rotary kilns and drying kilns, Figure 3. In general, rotary kilns operate at a higher temperature than drying kilns.



Figure 3 This photograph shows a drying kiln used to remove moisture from the ore.

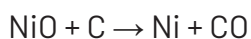
The result is a hot, dry ore that will be fed into the electric furnace in the next stage.

Stage 5. Smelting of ore.

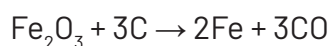
Smelting is a high-temperature process used to extract a metal from its ore. It involves heating the ore strongly in a furnace, usually with a reducing agent to convert metal compounds into pure metal.

In the Rotary Kiln-Electric Furnace process, the dry ore is mixed with a reducing agent (coke or coal) and smelted at high temperature in an electric furnace, Figure 4.

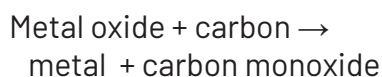
The reduction of the nickel ore to nickel metal may be represented in simplified form as:



The ore also contains iron(III) oxide, Fe_2O_3 . The reduction of the iron(III) oxide may be represented as:



In reality, the furnace contains a mixture of many oxides (such as MgO , SiO_2 and Al_2O_3) as well as iron and nickel compounds. The general word equation of:



is a good generalisation to help students to remember the key process that takes place in the furnace. Studying the chemical reactions that take place in the furnace is a good way to help students distinguish between the physical process of preparing the ore and the chemical process of extracting the metal from the ore. .

As the furnace operates, two liquid layers form:

- A dense, molten iron-nickel alloy called ferronickel.
- A lighter, molten slag containing oxides such as SiO_2 , MgO and Al_2O_3 .

Because ferronickel is denser, it sinks to the bottom of the furnace and can be tapped off separately from the slag.

A sample of ferronickel is shown in Figure 5. The slag is cooled and used as aggregate in construction material.



Figure 4. This photograph shows the electric furnace in operation.



Figure 5. This photograph shows a sample of ferronickel obtained from the furnace

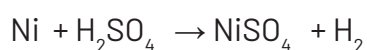
The molten ferronickel tapped from the furnace usually contains between 10% - 30% nickel, the rest being mainly iron, with small quantities of other elements. It is then:

- Further refined to adjust its composition and remove certain impurities such as sulfur.
- Cast into ingots or granulated into small pieces for easier handling.

This ferronickel is sold to stainless steel producers, where it is re-melted with iron and chromium to make stainless steel.

To be used in lithium ion batteries, the nickel must be chemically extracted, purified and converted into nickel sulfate. This is one of the precursors for nickel-manganese-cobalt cathodes in lithium ion batteries.

To extract the nickel, the ferronickel is crushed and dissolved in sulfuric acid solution. Nickel dissolves to form the nickel sulfate required in the manufacture of lithium ion batteries:



The iron in the ferronickel forms FeSO_4 which is further oxidised to $\text{Fe}(\text{OH})_3$ and removed as impurities. The purified solution of NiSO_4 is then crystallised as $\text{NiSO}_4 \cdot 6\text{H}_2\text{O}$ for use in lithium ion batteries. The operation of lithium ion batteries is commonly covered as a topic in electrochemistry in many science syllabi around the world.

Nickel makes it possible to build batteries that are:

- High in energy density (good range for electric vehicles).
- Reasonably affordable (especially when cobalt content is reduced).
- Suitable for large-scale energy storage, for example storing energy from solar and wind power.

5. Summary and Conclusions

In this article we have seen how the topic of the extraction of metals from their ores applies to one of today's most important industrial metals: nickel. Just as iron is extracted from hematite (Fe_2O_3) in the blast furnace by a redox reaction with carbon, nickel is extracted from laterite ores in Indonesia by a combination of physical processing, high-temperature reduction-smelting and chemical processing to extract nickel as nickel sulfate.

For high school chemistry students, nickel extraction in Indonesia offers an excellent modern case study of how chemical principles such as physical and chemical changes, redox reactions, reactions of metals with acids and electrochemistry are applied on a large industrial scale. It also shows how the same nickel that begins as part of an ore can end up in the stainless steel of a kitchen sink or in the battery pack of an electric car driving on our roads.

Activities of ICASE Science and Technology Education Centres

Janchai Yingprayoon

The first ICASE Science and Technology Education Centre was established at the Research Institute of Science Education (RISE), Guangxi Normal University, Guilin, China in 2007.



ICASE Center-China organized an ICASE Asian Symposium 2009 on Bridging the Gap between Formal and Informal Science Education, Nov. 1-3, 2009, Guilin, China

Web address:

<https://www.icaseonline.net/newsletter/ICASE%20Newsletter%2004.09.pdf>



ICASE Center, Suan Sunandha Rajabhat University organized an International Conference on Teaching Science and Mathematics using Toys and Hands-On Activities, July 4-7, 2011, Pattaya, Thailand



Seminar at ICASE Center, Suan Sunandha Rajabhat University, December 2012, Inauguration of ICASE Eureka Centre – University College Cork, Ireland.



Inauguration of the ICASE Centre in 2015, Visakhapatnam, India



The 6th ICASE World Conference on Science and Technology Education, December 2-6, 2019, Pattaya, Thailand



International ICASE Workshop on Teaching Science Using Toys and Hands-on Activities, in 2022 at Thaksin University, Pathalung, Thailand.



ICASE STEM Training Workshop in Vientiane 2023, Laos

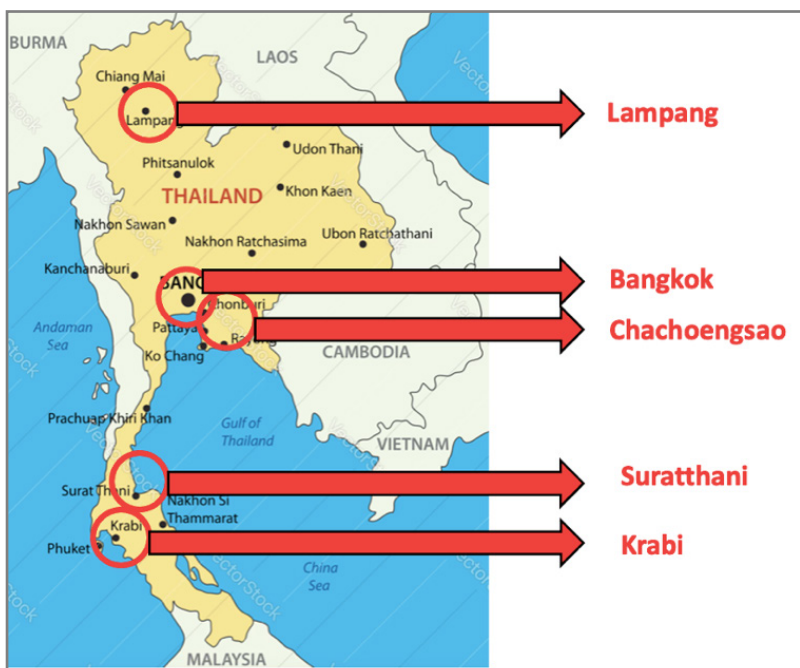


International ICASE STEM Education Contest, February 2024, in Vientiane, Laos.



There are 5 new small ICASE members (As local ICASE Centers) in 5 provinces in Thailand. They had applied for membership.

1. ICASE STEM center-Krabi province
2. ICASE: EEC SUJIPULI STEM Center, Chachoengsao Province
3. ICASE: PSU STEM Center-Suratthani Province
4. ICASE SRI-EAM STEM Center
5. ICASE UBB STEM Center-Lampang Province



ICASE Center-Krabi-Surathani-Thailand and ICASE Center-China organised China-Thailand Students STEM Project Seminar, Guilin, China, April 2024.



ICASE Center-Krabi-Thailand and ICASE Center-China organized China-Thailand Students Medical and Health Sciences Project Seminar, Guilin, China, March 2025.



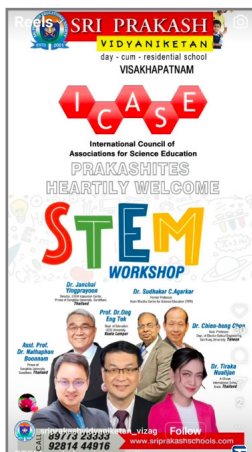
ICASE Center-Krabi-Thailand and ICASE Center-China organized China-Thailand Students Chemistry, Physics, Engineering, Computer Information Technology Project Seminar, Guilin, China, March 2025.



ICASE Sri-Eam STEM Center- Bangkok organized a STEM Education Training for Teachers, July 19, 2025, Bangkok, Thailand.



ICASE Centers – Krabi and Suratthani – Thailand and ICASE Center – India organized a STEM Workshop March 2025, Vasakhapatnam, India



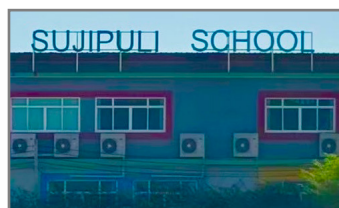
ICASE Center-Krabi-Thailand and ICASE Center-China organized a Seminar and Exchange Meeting for Chinese and Thai Teachers, April 2025



ICASE Center – Krabi – Thailand organized an Education Trip to attend ConNASTA 72 in Perth, Australia in July 5-15, 2025.



ICASE STEM Center- EEC Sujipuli-Thailand organised a STEM Education Workshops for Students, August 5-6, 2025, Chachoengsao, Thailand.



ICASE Centers – Krabi and Suratthani – Thailand organized a ICASE International Marine STEM Education Workshop, August 29-31, 2025, Suratthani, Thailand.

<https://sites.google.com/view/marine-stem>



Association for Science Education Conference 2026

Declan Kennedy, President of ICASE

The Association for Science Education (ASE) is among the most important professional bodies for science educators in the world. I have been attending the ASE Annual Conference in England for over forty years and it is always one of the great highlights of the year for me. It is a wonderful opportunity to promote ICASE and, particularly this year, to promote the 2026 ICASE World Conference in Cork. It is also a great opportunity to meet up with colleagues in the science education community.



Above: Staff at the ASE Stand at the conference were (left to right) Alastair Gittner, Will Hoole, Lynn Ladbrook, Chief Executive ASE and Vicki Parry.

The ASE supports science teachers, those involved in training science teachers, laboratory technicians, researchers and others involved in science education through professional development, publications, curriculum support, conferences and networking. ASE focuses not only on subject knowledge, but also with international issues related to science teaching and learning. Its work therefore spans classroom practice, practical work, assessment, curriculum development, inclusion, sustainability, research-informed teaching and leadership

in science education. For secondary school teachers of science in particular, ASE provides a valuable forum in which current ideas can be examined, resources shared and professional issues discussed by colleagues from across the science education community.



Above: Pictured at the ASE conference promoting the ICASE World Conference were (left to right) Marianne Cutler, Sue Dale Tunnicliffe, Declan Kennedy and Liliane Bouma.

The ASE Annual Conference 2026 took place from 8 to 10 January 2026 at the University of Nottingham UK. The conference included more than 220 sessions over the three days, together with keynote speakers, workshops, panel discussions, networking opportunities and a substantial exhibition of publishers, exam boards, professional organisations and laboratory resource suppliers. The event brought together teachers, technicians, researchers, educational organisations and subject specialists and it provided a very valuable programme of continuing professional development for everyone involved in science education. Although my own main interest was in the secondary science programme, it is worth noting that the overall conference also incorporated dedicated strands for Primary Science teachers and also for laboratory technicians.

One of the most impressive features of the conference was the sheer breadth of topics relevant to secondary school science teaching. The conference programme addressed themes such as curriculum development, assessment, inclusion and diversity, subject knowledge and pedagogy, practical work, teacher recruitment and retention, research, leadership, sustainability and climate change, and the use of technology in teaching and learning. This meant that delegates could move from sessions dealing with overarching educational questions to workshops focused on very practical classroom strategies. For a secondary science teacher, this range was particularly valuable because it reflected the real complexity of the profession: teaching science well involves not only secure scientific knowledge, but also knowledge of topics such as assessment, literacy, inclusive practice, laboratory practical work, curriculum reform and the ability to respond to new technological developments such as artificial intelligence.



Above: Some staff members of CLEAPSS pictured at the CLEAPSS stand. Matt Endean (far right) will be participating in the ICASE World Conference in Cork.

A particularly memorable part of the conference for me was my visit to the CLEAPSS laboratory workshops. These sessions were most helpful and reminded delegates that high-quality science teaching depends on well-designed, safe and educationally purposeful practical work.

During my visit to the CLEAPSS workshop, Bob Worley introduced me to a wide range of really interesting microscale chemistry practical work. I was delighted to receive a copy of the book *Understanding Chemistry through Microscale Practical Work*, written by Bob Worley, David Paterson and Sarah Longshaw. The book is an excellent guide to the microscale technique and explains how microscale practical work can be used to support students' understanding of chemistry through a wide range of simple and effective experiments.



Above: Bob Worley demonstrating the microscale Hofman voltameter that he has constructed at the CLEAPSS workshop.

Another outstanding session was the "International Sustainability and Climate Change", seminar chaired by Marianne Cutler. This seminar brought together international expertise in science teaching and learning on the topic of sustainability. This is an increasingly important dimension of science education, and this session stood out because it connected science teaching with wider environmental responsibility and curriculum thinking. It also demonstrated that sustainability is not an optional extra but an important lens through which many areas of secondary science can now be viewed, from climate science and ecosystems to materials, energy and citizenship.

The wide range of exhibition was another major strength of the conference. The ASE exhibition area consisted of publishers, exam boards, professional organisations and laboratory resource suppliers. This area gave delegates an

opportunity to examine textbooks, laboratory equipment, practical resources, assessment materials and it also created informal spaces for discussion with exhibitors and colleagues. In many ways, the exhibition complemented the formal sessions by allowing teachers to see how ideas presented in talks and workshops might be supported by concrete classroom resources. I was delighted to meet so many exhibitors who will be coming to the ICASE World Conference in University College Cork in June 2026.



Above: Pictured at the Molymod stand were (left to right) Janet Howe, Philip Spiring and Leonardo Spiring. Molymod was invented by James Spiring, father of Janet and Philip and grandfather of Leonardo.

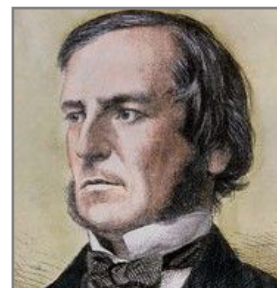
Overall, the ASE Conference 2026 at the University of Nottingham was an excellent professional experience. It showcased the vitality of the science education community and offered a very rich balance of educational debate and practical classroom support. The conference provided us with an opportunity to reflect on current challenges in science education, to learn from leading speakers and practitioners, and to return from the conference with new ideas about important topics such as curriculum, teaching and learning, assessment, sustainability and laboratory practical work. We are very fortunate to have ASE represented by Marianne Cutler on the ICASE Executive. I congratulate the ASE on another excellent conference which reflected ASE's reputation as a key organisation in the advancement of science education at international level.

ICASE World Conference 2026: the Boole Connection

Declan Kennedy, President of ICASE

The ICASE World Conference on Science Education in June 2026 will be based in the Boole lecture theatres of University College Cork.

These lecture theatres are named after George Boole, a famous secondary school teacher of mathematics and science who became the first Professor of Mathematics when University College Cork (then called Queen's College Cork) was founded in 1845.



George Boole
(1815 - 1864)

George Boole was born in 1815 in Lincoln, England, His father, John Boole, was a shoemaker who enjoyed applying mathematics to the construction of optical instruments such as telescopes, microscopes, cameras and kaleidoscopes. He passed this enthusiasm for science to his son.

His ability was widely recognised and in 1844 he was awarded the Gold Medal of the Royal Society for a paper on differential equations. In 1849 he was appointed the first Professor of Mathematics at Queen's College Cork

While in Cork, Boole wrote his most famous book, 'An Investigation of the Laws of Thought on which are founded the Mathematical Theories of Logic and Probabilities'. In this work he showed how logical reasoning could be expressed using algebra. This idea, now known as Boolean algebra which later became fundamental to the operation of modern computers. In 1937 Claude Shannon demonstrated in his MIT master's thesis, 'A Symbolic Analysis of Relay and Switching Circuits', that Boolean algebra could be used to design electronic switching circuits. Shannon's thesis has often been described as the most important master's thesis ever written.

George Boole died in Cork in 1864 at the age of only forty nine from pneumonia and is buried in St. Michael's Church graveyard in Blackrock, Cork. His legacy lives on today not only in mathematics and computing but also in modern artificial intelligence. George Boole transformed logic into mathematics, and that mathematics ultimately became the language of computers.



Australasian Science Education Research Association

2026 Conference (ASERA57)

Image: Tourism and Events Queensland

Tuesday 30 June – Friday 3 July 2026

Brisbane City (Southbank), Queensland, Australia

As one of the longest-standing and most respected science education research communities worldwide, ASERA is proud to bring together researchers and educators from Australia, New Zealand, the Asia-Pacific region, and beyond. Each year, our annual conference offers a vibrant forum for sharing ideas, building collaborations, and shaping the future of science education.

Join us in Brisbane for ASERA57, hosted by the [Queensland University of Technology](https://www.qut.edu.au), for four days of inspiring presentations, engaging discussions, and networking with colleagues from around the globe!

Key Dates

- **Call for Abstracts Opens:** November 2025
- **Abstract Deadline:** Early March 2026
- **Registrations Open:** March 2026
- **Early Bird & Presenter Registrations Close:** Late April 2026
- **Standard Registrations Close:** Early June 2026

Key Events

- **30 June 2026:** HDR/ECR Day, Welcome Reception
- **1 July 2026:** Conference Presentations, HDR/ECR Fireside Chat
- **2 July 2026:** Conference Presentations, ASERA AGM, Conference Dinner
- **3 July 2026:** Conference Presentations



Please see the [ASERA57 website](https://www.asera57.org) for more information

News from the Australasian Science Education Research Association (ASERA)

Dr Carol Aldous , ICASE Australia Pacific Regional Representative

About ASERA

The Australasian Science Education Research Association (ASERA) was established in 1970 by the internationally respected science educator and reformer, the late Professor Peter Fensham. The association aims to promote science education and science education research in order to better understand and improve the learning and teaching of science across a wide range of educational levels, science disciplines, and contexts.

ASERA brings together researchers and educators from across Australia, New Zealand, the Asia-Pacific region, and the wider educational community.

ASERA 57 2026 Conference

Since its establishment more than fifty years ago, ASERA has hosted an annual conference at which the latest research in science education is presented and discussed. The conference provides a leading forum for the exchange of ideas, research findings and professional collaboration.

This year ASERA 57 conference will be held at the Queensland University of Technology, South Bank, Brisbane, Australia from 30th June to 3rd July. Further information is provided in the flyer that follows. We warmly invite you to join us.

ASERA Position Paper: “Science Education: Fit for the Future”

The national launch of the ASERA position paper entitled “Science Education: Fit for the Future”, is to take place on 11th May at Deakin University in Melbourne Australia.



This landmark publication brings together leading researchers and educators to outline a research-informed vision for strengthening science and STEM education across Australia. The paper outlines key findings, priorities, and recommendations to inform national policy, research, and practice.

The recommendations attend to five pillars of science education:

- (1) Science Education as a Community Endeavour,
- (2) Curriculum and Valued Knowledge,
- (3) Science Education for Future Thinking,
- (4) Respect for Evidence, and
- (5) Science Identity and Citizenship.

ICASE World Conference

A presentation on the development of the ASERA position paper to guide science education policy framings in Australia and New Zealand will be given at the 8th ICASE World Conference on Science and Technology Education in Cork, Ireland from 22-25th June.

UNESCO News, March 2026



Information compiled by Teresa J. Kennedy, PhD
ICASE Representative to UNESCO

What's happening at UNESCO?

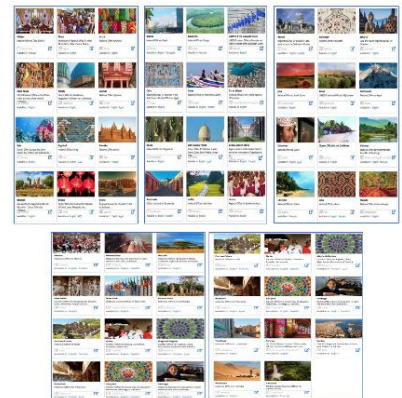
For information about key priorities occurring at UNESCO see: <https://www.unesco.org/en>

Keep up to date with UNESCO events at: <https://www.unesco.org/en/events>

The page is updated every day with events sorted by date, type, and theme.

UNESCO Field Offices

[UNESCO House in Paris](#), through its field offices, develops strategies, programs, and activities in consultation with national authorities and other partners. UNESCO also operates specialized institutes and centers. Check the list below to see the location of the UNESCO Field Offices.



For UNESCO Offices by Region

see: <https://www.unesco.org/en/fieldoffice>

For Publications produced by UNESCO Field Offices see:

<https://unesdoc.unesco.org/explore/by-field-office-institute-or-center>

United Nations Decades

United Nations [International Decades](#) are ten-year global initiatives proclaimed by the United Nations General Assembly to focus international attention and coordinated action on major global challenges. These Decades are part of a broader system of international observances, including designated days, weeks, and years, established by the United Nations to raise awareness and promote action on issues aligned with the Organization's priorities.



United Nations Decades encourage collaboration among governments, scientific institutions, civil society, and the private sector to advance knowledge, mobilize resources, and accelerate progress toward shared global goals. **Currently, [16 United Nations Decades](#) are underway worldwide.** Many United Nations Decades support networks of endorsed initiatives, projects, and partnerships that translate global goals into practical actions at local, national, and international levels.

These Decades often contribute to advancing the United Nations 2030 Agenda for Sustainable Development and its Sustainable Development Goals by mobilizing coordinated international action.

Featured ICASE UN Decade Activities follow.

UN Decade of Ocean Science for Sustainable Development (2021-2030)

The [Ocean Decade](#) seeks to stimulate scientific research, partnerships, and innovation to better understand the Ocean system, reverse the decline of Ocean health, and support the sustainable management of marine resources. Its vision, “**the science we need for the Ocean we want**” promotes the generation of transformative Ocean science solutions for sustainable development while connecting people and the Ocean. **Understanding the Ocean requires the integration of many scientific disciplines, including physics, chemistry, biology, geology, atmospheric science, engineering, and emerging data sciences.**

Coordinated by the Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific and Cultural Organization (UNESCO-IOC), the Ocean Decade provides a global framework that brings together governments, scientists, industry, civil society, and other stakeholders to co-design and implement science-based solutions to Ocean challenges.

Through networks of **endorsed [Decade Actions](#)** and **[Activities](#)**, the Ocean Decade mobilizes international collaboration and advances research, data sharing, and capacity development to support the conservation and sustainable use of the Ocean. These efforts contribute directly to achieving the 2030 Agenda for Sustainable Development, particularly Sustainable Development Goal 14: Life Below Water, while also strengthening connections between science, policy, and society.

Since the launch of the Ocean Decade, ICASE and its member organizations have been actively engaged in advancing its goals within the global science education community. Working with the **UNESCO-IOC**, **ICASE co-chaired the Ocean Decade NGO Task Group** that developed the **[Ocean Decade Guide for NGOs](#)**, aimed at supporting support civil society organizations in understanding and engaging with Ocean Decade initiatives.

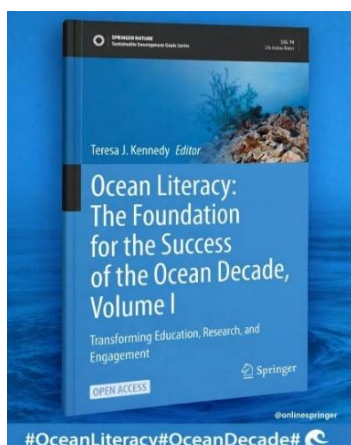


ICASE also supported the advancement of Ocean Literacy through the development of the **three-volume book series, [Ocean Literacy: The Foundation for the Success of the Ocean Decade](#)**, which



was awarded endorsement as an official **Ocean Decade Action**. This series brings together international perspectives on education, communication, and collaboration aimed at strengthening society’s relationship with the Ocean. The series consists of **65 chapters** by **250 authors** from **42 countries/regions** and

was double-blind peer reviewed by **80+ expert reviewers** in the field as well as **Springer Nature**.



[Volume I: Transforming Education, Research, and Engagement](#) is available Open Access. Check out [Chapter 17](#) as a sample! 

Volumes II & III will be available soon on the Springer Nature website:

Volume II: [Fostering Community, the Sustainable Blue Economy, and the Arts](#)

Volume III: [Accelerating Communication, Technology, and Global Initiatives](#)



ICASE President Declan Kennedy's statement included in the [Foreword of Volume I](#):

“As the Lead Institution for this officially Endorsed Ocean Decade Activity, the International Council of Associations for Science Education (ICASE) is proud to support this transformative contribution to the global Ocean Literacy movement. This series exemplifies the power of international collaboration in advancing science education that is equitable, inclusive, and responsive to the sustainability challenges of our time. It reflects what is possible when educators, scientists, and civil society come together in pursuit of shared goals.



As an organization dedicated to strengthening science education worldwide, ICASE is honored to have played a role in supporting this project as it will inspire educators and learners across generations and geographies. The success of the Ocean Decade depends on more than just data and discovery, it depends on education that connects people to the Ocean in meaningful ways. This three-volume series represents a significant step in that direction and aligns with the mission of ICASE to promote quality science education that supports sustainable futures.”

—Declan Kennedy, PhD, President, International Council of Associations for Science Education (ICASE) University College Cork, Ireland (Reflections from the Ocean and Science Education Community, *Ocean Literacy: The Foundation for the Success of the Ocean Decade, Volume I: Transforming Education, Research, and Engagement*, p. xi).

The poster below was displayed at the [American Geophysical Union \(AGU\) Ocean Sciences Meeting](#) in Glasgow, Scotland (February 2026) to announce the series. Teresa also served on a Town Hall panel organized by Woods Hole Oceanographic Institution entitled *Leveraging Oceanographic Data Repositories as Educational Partners*.

ONE OCEAN, MANY VOICES
Ocean Literacy: The Foundation for the Success of the Ocean Decade

OVERVIEW
Ocean Literacy: The Foundation for the Success of the Ocean Decade is a three-volume, 65 chapter peer-reviewed book series. The series advances global understanding of the Ocean and strengthens the role of Ocean Literacy in achieving the societal and sustainable outcomes of the United Nations Decade of Ocean Science for Sustainable Development.

Officially endorsed by the UNESCO-IOC as an Ocean Decade Activity, this series integrates education, community engagement, the arts, technology, and global collaboration to bridge scientific knowledge with meaningful action.

Vol. I: Transforming Education, Research, and Engagement

- Foundations of Ocean Literacy across formal and informal education
- Frameworks supporting governance, outreach, and innovation
- Links between research, policy, and public engagement

Vol. II: Fostering Community, the Sustainable Blue Economy, and the Arts

- Community-led and Indigenous-informed approaches
- Ocean Literacy in economic pathways and workforce development
- Arts, storytelling, and culture as drivers of Ocean connection

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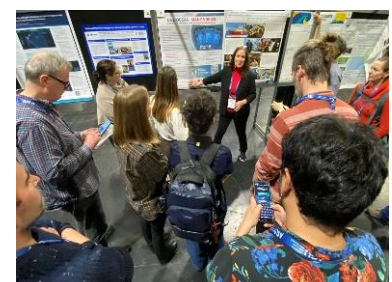
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Teresa Kennedy with Dina Eparkhina, author of [Chapter 20](#) from the European Global Ocean Observing System (EuroGOOS), Belgium.





2021 United Nations Decade
2030 of Ocean Science
for Sustainable Development

Continuing this momentum, the **Marine Science Education (MSE) Strand** of the upcoming [ICASE 2026 World Conference on Science and Technology Education](#) in Cork, Ireland has received **endorsement as an official Ocean Decade Activity** by the **UNESCO Intergovernmental Oceanographic Commission (UNESCO-IOC)**.

The **MSE Strand** will highlight the role of science education in advancing Ocean Literacy and supporting the broader goals of the Ocean Decade.

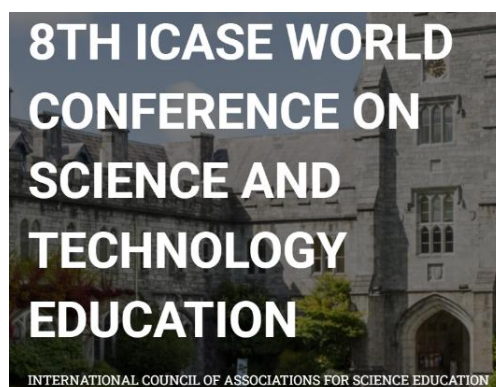
ICASE is honoured to collaborate with the [Irish Ocean Literacy Network \(IOLN\)](#) in coordinating this important component of the conference.

[Keynote Speakers](#) presenting during the **MSE Strand** include (listed in order their presentations occur throughout the conference strand):

- **Nóirín Burke, PhD** and **Catherine McCann** —The Irish Ocean Literacy Network (IOLN);
- **Pierre-Yves Cousteau** — Marine conservationist, Ocean filmmaker, and Goodwill Ambassador for the International Union for Conservation of Nature (France—connecting from his research ship);
- **Diz Glithero, PhD** — Executive Director, Centre for Ocean Literacy Collaboration (COLC), and lead author of the Ocean Decade Vision 2030 White Papers—Challenge 10: Restoring Society’s Relationship with the Ocean (Canada);
- **Francesca Santoro, PhD** — Senior Programme Officer for Ocean Literacy, UNESCO Intergovernmental Oceanographic Commission (Italy);
- **Tami Lunsford** — President, National Marine Educators Association (NMEA) (USA);
- **Orla Doherty** — Producer with the BBC Studios Natural History Unit and producer of *The Deep* and *Our Blue Planet* from Sir David Attenborough’s series *Blue Planet II* (England—connecting from her filming location); and
- **Jan Seys, PhD** — Head of Science Communication at the Flanders Marine Institute (VLIZ) and member of the IOC Group of Experts on Ocean Literacy (Belgium).



The Marine Science Education Strand will highlight Ocean Literacy frameworks and practices, marine science education, interdisciplinary and transdisciplinary approaches, teacher preparation and professional learning, participatory and community-engaged marine science, and innovative practices across formal and informal settings. Submissions are encouraged from educators, researchers, NGOs, community organizations, and institutions working at local, regional, and global scales. **Your participation in this event is most welcome!**

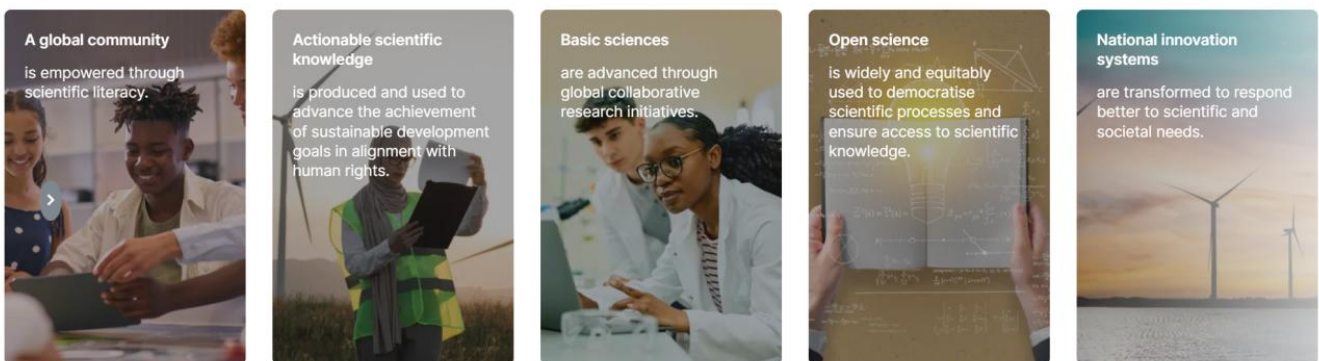


The International Decade of Sciences for Sustainable Development (2024–2033)

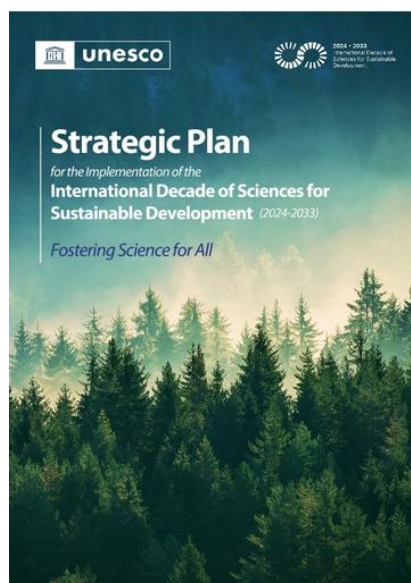
The [International Decade of Sciences for Sustainable Development \(IDSSD\) \(2024–2033\)](#) was proclaimed by the United Nations General Assembly to strengthen the role of science in addressing global challenges and advancing sustainable development. The Decade calls for stronger collaboration among governments, scientific institutions, civil society, and the private sector to ensure that scientific knowledge and innovation contribute effectively to solutions for humanity and the planet. UNESCO has been designated to lead and coordinate the implementation of the Decade, working with partners worldwide to promote the use of science as a common good that supports informed decision-making, sustainable development, and a prosperous future for all.

The Decade also promotes science as a global public good, encouraging open collaboration, knowledge sharing, and equitable access to scientific advances across all regions of the world.

The Decade's expected outcomes



The Science Decade supports endorsed initiatives that apply science and technology to address global challenges and advance the goals of the 2030 Agenda for Sustainable Development. Through these initiatives, the Decade promotes international collaboration and mobilizes the global scientific community to develop practical solutions that advance equity, protect the environment, and strengthen resilient and inclusive societies. View the [Endorsed Initiatives](#).



Now two years into its implementation, the **International Decade of Sciences for Sustainable Development (IDSSD)** will convene its [2026 Global Conference](#), bringing together stakeholders from around the world to review progress, highlight science-driven solutions, and help shape a resilient and inclusive post-2030 future. The conference will connect leaders from government,

academia, industry, civil society, and Indigenous knowledge communities to strengthen partnerships and advance the role of science in achieving sustainable development.

Held under the theme **“Science in Action: Charting a Sustainable and Equitable Future for All,”** the event will highlight the importance of transdisciplinary research, open science, and stronger connections between science, policy, and society.

The conference objectives include:

- Demonstrating the impact of IDSSD-endorsed initiatives addressing global challenges
- Accelerating progress and sharing good practices since the Decade’s launch
- Shaping priorities for the 2026–2029 implementation phase
- Forging partnerships across sectors and regions
- Building trust in science through stronger science–policy–society linkages
- Integrating multiple knowledge systems, including Indigenous and local knowledge
- Informing the post-2030 agenda on science for sustainable development

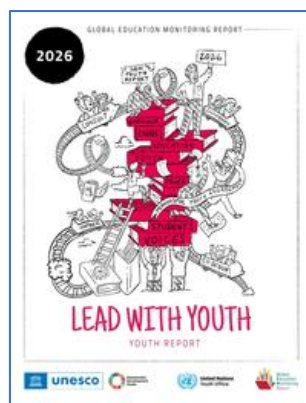
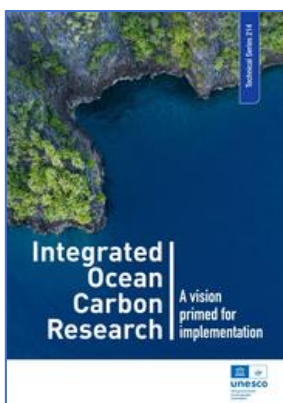
[Registration](#) for both **in-person and online participation** will open soon.

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Education and Artificial Intelligence in Ukraine: Prospects, Challenges and Strategic Directions

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Abstract. Artificial intelligence (AI) is increasingly heralded as a transformative force in education, enabling personalised learning, adaptive tutoring, predictive analytics and automation of administrative tasks. In Ukraine, where the educational system is undergoing deep structural reforms in the context of digitalisation, conflict and socio-economic shifts, the adoption of AI represents both a significant opportunity and a formidable challenge. Recent research demonstrates a growing awareness among Ukrainian higher education stakeholders of AI-tools, yet also flags concerns about content quality, equity and educator readiness. This article aims to synthesise current knowledge, chart the landscape of AI adoption in Ukraine's education system, identify key enablers and barriers, and propose strategic directions for integrating AI in a way that supports educational quality, equity and resilience.

Keywords. Artificial Intelligence, Digital Transformation, Adaptive Learning, Higher Education, Armed Conflict.

1. Introduction

Ukraine has committed to enhancing digital infrastructure in education and aligning with global "Education 4.0/5.0" paradigms. For instance, a study [1] shows Ukrainian educators framing the transition from Education 4.0 to Education 5.0 in the AI-era. Digital transformation is inherently complicated by the ongoing war, socio-economic instability and disparities in access. Yet these very challenges underscore the importance of resilient, adaptive educational systems. AI thus emerges not simply as an innovation option, but potentially as a capacity-booster for education in a crisis-affected environment [2-3]. Measures have already been taken to develop the infrastructure.

For example, the Ministry of Education and Science and the Ministry of Digital Transformation of Ukraine, together with experts, have developed recommendations for the responsible use of artificial intelligence in higher education institutions. The document (<https://bit.ly/44CiuHR>) contains advice for faculty, students, higher education institution administrators, and researchers on how to effectively integrate AI into the educational and scientific process. The recommendations pay special attention to the security component of integrating AI tools—the principles of human control, confidentiality, data management, transparency, and non-discrimination.

A significant amount of statistical data has been accumulated. For example, according to the results of the international study "Education as a Tool for Developing Personal Resilience, Social Capital, and a Culture of Peace," 22% of students and 24% of teachers frequently use artificial intelligence in their teaching. Students, parents, and teachers surveyed for the aforementioned international study consider critical thinking and information evaluation to be the most useful skills acquired in future education (36% of students, 48% of teachers, and 41% of parents) (<https://summitflg.org/study/osvita-yak-instrument-formuvannya-osobistoyi-stijkosti-socialnogo-kapitalu-krayinita-kulturi-miru/>). Among Ukrainian respondents, this figure is 54%.

2. Opportunities of AI in Ukrainian Education

AI is integrated into education in Ukraine in different ways:

- Personalised and adaptive learning. AI-driven tools can tailor content, pacing and feedback to individual learners, supporting diverse needs (including inclusive education). Ukrainian research highlights positive attitudes among stakeholders toward AI-tools for personalised learning and real-time feedback.
- Automation and administrative efficiency. Routine tasks (scheduling, assessment, tutoring chatbots) can be streamlined, freeing educators for higher-order pedagogical work. For example, Ukrainian studies reflect on chatbot use in higher education institutions.

- Supporting inclusive education. AI has potential to support students with special educational needs via adaptive interfaces, immersive technologies and accessibility features. A Ukrainian inclusive-education study emphasises both promise and necessity of careful integration.
- Data-driven decision-making and institutional management. AI analytics can inform institutional strategies, monitor learning trajectories, predict drop-out risk and support quality assurance

3. Key Challenges and Risks

The integration of AI into education has revealed the following challenges:

- Infrastructure, connectivity and digital divide. Reliable internet, hardware, cloud services and institutional support remain uneven across Ukraine, especially in conflict-affected regions.
- Teacher readiness, motivation and professional development. Studies show that teacher motivation and self-development in AI technologies are critical yet under-addressed. Without targeted training and support, AI tools risk being under-utilised or mis-used.
- Data quality, bias and content accuracy. AI systems depend on high-quality data and pedagogically sound design. Ukrainian inclusive study warns of uncritical adoption of “radically new technologies” without age-appropriateness, cultural fit and methodical integration.
- Ethical, legal and governance issues. AI in education raises issues of privacy, algorithmic transparency, academic integrity (especially relevant in Ukrainian context with generative AI use), and regulatory frameworks are still evolving.
- Equity and inclusion risks. Uneven access may deepen existing educational inequalities; AI must be implemented with equity-awareness.
- Conflict and resilience context. Ukraine’s ongoing war amplifies the importance of resilient digital systems, yet also makes implementation more complex due to displacement, infrastructure damage and staff stress. AI deployment must be

aligned with crisis-sensitive educational strategies.

4. Strategic Directions for Ukraine

Drawing on the Ukrainian context and international best-practice, we propose three interlinked strategic pillars.

4.1. Infrastructural & environmental readiness

- Develop national AI-in-education infrastructure: connectivity, cloud platforms, secure data management, resilient systems in conflict zones.
- Establish partnerships between government, universities, EdTech firms and international donors to resource AI initiatives.
- Ensure open-platforms and interoperable systems facilitating scalability.

4.2. Pedagogy & human-centred AI integration

- Promote teacher professional development programmes focused on AI literacy, pedagogical adaptation and ethical use of AI.
- Embed learner-centred AI tools (adaptive tutoring, chatbots, VR/AR) aligned with Ukrainian curricula and language/cultural context.
- Foster inclusive AI design that involves students, teachers and communities in tool development (co-design).
- Maintain human-in-loop approaches: AI supports rather than replaces educators, particularly vital in contexts of trauma and disruption.

4.3. Governance, ethics & inclusion

- Develop national policy framework for AI in education: data governance, algorithm transparency, academic integrity guidelines, privacy protections.
- Monitor and evaluate AI implementation outcomes with a focus on equity: ensure that students in rural, displaced or conflict-affected areas receive access and benefit.

- Encourage research and feedback loops: universities to conduct evaluative studies of AI impact, adaptives to Ukrainian realities (e.g., war-affected learners).
- Align AI integration with resilience-oriented education: designing for continuity under disruption, leveraging AI to support remote/hybrid learning during crises.

5. Proposed Integrative Model for Ukraine

We offer a conceptual model — “AI-Enabled Resilient Education System (AI-RES)” for Ukraine. The model posits three layers: (a) foundational layer (infrastructure, policy, digital access); (b) operational layer (pedagogical practices, AI-tools, teacher training); and (c) outcome layer (learning quality, inclusion, resilience, well-being). Feedback loops link outcome data back to infrastructure refinement and practice improvement. The model emphasises that AI adoption must be systemic, not piecemeal, and must integrate with Ukraine’s specific socio-political context (including war, displacement, need for psychosocial support).

6. Discussion

While the potential of AI in Ukrainian education is compelling, the strategic focus must shift from technology-push to people-centred, context-aware implementation. The war-affected environment amplifies the need for educational systems that are adaptable, inclusive and emotionally supportive; AI can contribute but cannot substitute human connection, pedagogical sensitivity and institutional resilience. Ukrainian case studies suggest positive stakeholder attitudes toward AI but simultaneously highlight readiness gaps and ethical concerns. The success of AI in Ukrainian education will ultimately depend on aligning digital innovation with educator capacity, learner needs and systemic equity.

7. Conclusion

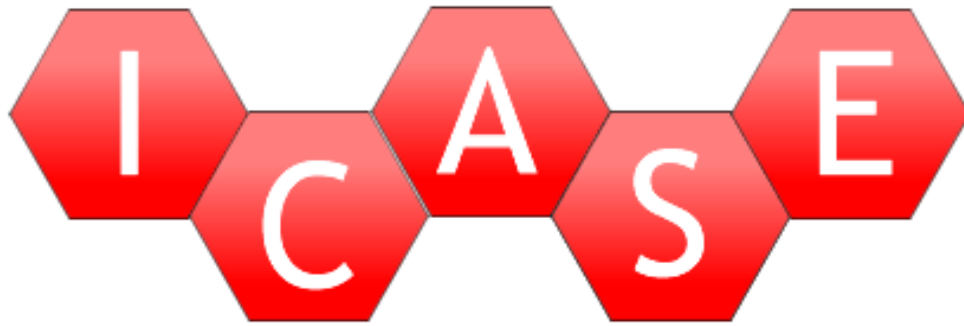
In Ukraine, integrating AI into education presents a pivotal moment: if done strategically, it can support personalised, inclusive and resilient learning systems; if done poorly, it risks amplifying inequality and undermining trust. The

transition to an “Education 5.0” paradigm — where AI, human pedagogy and resilient infrastructure converge — offers hope for a post-conflict recovery and future-oriented educational ecosystem [4-5]. The recommendations offered in this paper provide a roadmap for policymakers, educators and technologists alike. Further empirical research is needed on longitudinal impacts, equity outcomes and conflict-sensitive AI deployment in Ukrainian education.

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