GREENLIGHT: Generating Renewable Energy Education Network - Leading Initiatives for Green & Harmonious Tomorrows

Renewable Energy Resource Database

December 2024

23-2-TR01-KA220-SCH-000180691

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1.1 OVERVIEW OF EXISTING RESOURCES

Our study aimed to compile existing educational methodologies and resources that aim to increase energy literacy, especially for students between the ages of 15-18. In this context, global and national projects and educational materials related to energy saving, renewable energy and sustainability practices were examined. The outputs of previously developed resources and projects were evaluated and how they could be integrated into our project methodology was analyzed. The study was based on creating an-up-to-date and effective energy literacy model with the experiences gained from successful past applications. In this direction, innovative and applicable methods that will increase the effectiveness of projects for students were determined.

INTERNATIONAL / EU LEVEL

TURKIYE

1. Student Energy:

https://studentenergy.org/influencer/sdg/?psafe_param=1&gad_source=1&gclid=CjwKC AiAgoq7BhBxEiwAVcW0LD-Cni3-jNzNp1ZDYIaSPcBeoBIKOkfvTcKpdo7PGPvhoKu5pNk_hoCp4sQAvD_BwE

2. UNESCO - Education for sustainable development: a roadmap
https://unesdoc.unesco.org/ark:/48223/pf0000374802

3. EU Energy Platform

https://energy.ec.europa.eu/topics/energy-security/eu-energy-platform_en

4. Energy Education Platform:

https://energyeducation.ca/encyclopedia/Main_Page

5. International Energy Agency (IEA) Reports:

https://www.iea.org/reports/energy-efficiency 2023

PORTUGAL

6. U.S. Department of Energy Please

https://www.energy.gov/eere/education/articles/energy-literacy-framework-50-march 2017-english

https://www.energy.gov/energysaver/articles/energy-education-resources-spanish
https://www.energy.gov/energysaver/articles/energy-education-resources-spanish
https://www.energy.gov/eere/education/articles/7-energy-literacy-principles
https://www.energy.gov/energysaver/energy-literacy-essential-principles-energy-education

7. YOUTUBE

https://www.youtube.com/watch?v=h4RmNNve3lc

8. The United Nations Environment Programme (UNEP)

https://www.unep.org/topics/energy

9. Teach Engineering

https://www.teachengineering.org/activities/view/duk_solaroven_tech_act

10. National Energy Education Development Program

https://www.need.org/annual-report-page/student-outreach-23/

11. SAVE ENERGY & WATER.now

https://www.energie-wasser-sparen.jetzt/en/

GREECE

12. Strategic Energy Technology (SET) Plan Roadmap on Education and Training

file:///C:/Users/hp/Downloads/set%20plan%20roadmap%20on%20education%20and%2 0training_final.pdf

13. Clean Energy for EU Islands Initiative – "Education and Training Materials for Energy Transition"

https://clean-energy-islands.ec.europa.eu/

14. ENTSO-E Research, Development, and Innovation (RDI) Roadmap 2024–2034

https://eepublicdownloads.entsoe.eu/cleandocuments/Publications/RDC%20publications /entso-e_RDI_roadmap_2024-2034_240710.pdf

15. BP Statistical Review of World Energy(accessed on 2 October 2022):

https://www.energyinst.org/statistical-review

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16. UNESCO Global Action Programme on Education for Sustainable Development (ESD)

https://www.unesco.org/en/sustainable-development/education

17. Energy Literacy Training by Energy Swaraj Foundation

https://energyswaraj.org/energy-literacy-training/

18. Energy Literacy Quick Start Guide

https://www.energy.gov/eere/education/articles/energy-literacy-quick-start-guide

19. Strategic Energy Technology (SET) Plan

https://ec.europa.eu/energy/sites/ener/files/documents/setplan_education_training_roadmap_2015.pdf

20. European Climate Pact – Education and Awareness Programs

https://climate-pact.europa.eu/index_en

21. Horizon Europe Projects on Energy Literacy

https://ec.europa.eu/programmes/horizon2020/

22. Energy@EDU Initiative

https://millenniumedu.org/energyedu/

NATIONAL / LOCAL LEVEL

Materials promoting energy education in schools in our countries/regions:

TURKIYE

1. (TÜBİTAK)

TÜBİTAK offers teacher and student resources on renewable energy concepts and practices, including workshops, guides, and school project ideas.

https://www.tubitak.gov.tr

2. National Energy Efficiency Action Plan (NEEAP)

Provides energy education resources for schools, focusing on energy-saving behaviors and sustainability. Includes materials tailored for high school students.

https://www.enerjiverimliligi.gov.tr

3. Energy Efficiency Teacher Guide

Prepared by the Ministry of Energy and Natural Resources, this guide helps teachers promote energy efficiency in schools.

https://evcedruzgar.enerji.gov.tr/verimlilik/document/ogretmen_rehberi.pdf

4. Energy Efficiency Education Book

Comprehensive educational material on energy efficiency for schools. https://enerjiverimliligi.enerji.gov.tr/Home/egitim

5. Energy Efficiency Projects in Schools

A national project promoting energy-saving practices and awareness in schools, supported by the Ministry of National Education.

https://istanbul.meb.gov.tr/www/aydinlik-bir-gelecek-icin-okullarda-enerji-verimliligi/icerik/1643

6. Green Flag Program

A program for certifying eco-friendly schools that prioritize energy efficiency, resource conservation, and environmental education.

https://www.meb.gov.tr/cevreci-okullara-yesil-bayrak/haber/34581/tr

7. Energy Efficiency Training Programs

Training materials provided by the Ministry of Energy and Natural Resources for promoting energy management and energy literacy.

https://enerji.gov.tr/bilgi-merkezi-enerji-verimliligi-egitimler

8. Eco-Schools Program (TÜRÇEV)

Managed by the Turkish Environmental Education Foundation (TÜRÇEV), this program teaches students about energy saving, recycling, and sustainability.

https://www.turcev.org.tr/V2/Default.aspx

PORTUGAL

9. APREN – Portuguese Renewable Energy

This association has launched a pilot program on energy literacy for students aged 6 to 10, with the aim of promoting energy education and arousing their curiosity in the sector.
https://www.apren.pt/en/

10. AREAM

Agência Regional da Energia e Ambiente da Região Autónoma da Madeira- This guide helps teachers promote energy efficiency in schools.

https://aream.pt/files/2016/05/guia-escolas.pdf

11. ECOESCOLAS

The Eco-Schools program encourages schools and particularly students to improve their environmental performance through various activities. This international program, in Portugal, is coordinated by the European Blue Flag Association (ABAE), the Portuguese section of FEE." https://ecoescolas.abaae.pt/

12. REDE DE CENTROS CIÊNCIA VIVA

This network includes 21 science dissemination centres, some with energy themes and exhibitions.

https://www.cienciaviva.pt/centroscv/rede/

13. MISSÃO UP

Schools are invited to participate in the Positive Brigades Contest. This initiative involves student groups, guided by teachers, developing and carrying out missions related to energy efficiency and sustainable mobility, both inside and outside the school. Each school is responsible for creating their own "brigades" and defining their tasks.

https://www.bcsdportugal.org/wp-content/uploads/2013/10/2014-CS-GalpEnergia-MissaoUP.pdf

14. ABAAE - Educação Ambiental para a Sustentabilidade

The "Energy Eco-Reporter" challenge empowers students to become energy journalists, exploring local energy challenges and solutions.

https://ecoreporter.abaae.pt/

15. ENERKIDS

This contest based on everyday situations and practical rules that are easy to internalise, aims to sensitise primary school pupils to promote more efficient energy consumption.

http://www.enerkids.pt/?cix=1260&curr=1259&curr3=1259&ixf=seccao&lang=1

16. PROJETO ECOCHALLANGE

The Eco Challenge project aims to raise awareness among the educational community about the importance of energy efficiency, with a focus on sustainable development. This project provides a system for monitoring electricity consumption in schools.

https://www.dge.mec.pt/projeto-ecochallenge

GREECE

17. "Energy on the Go" Educational Program by Principia

This program aims to raise awareness among young people about sustainable development and the circular economy. It offers educational activities designed to engage students in understanding energy concepts and their practical applications.

https://principia-energy.com/en/target/quality-education

18. Renewable Energy Sources Educational Scenario

Developed within the Greek educational framework, this scenario introduces students to renewable energy concepts. It emphasizes hands-on learning and encourages students to explore various renewable energy technologies.

https://www.researchgate.net/publication/376613240_Renewable_Energy_Sources_An_educational_approach_in_Greek_Schools

19. Eunice Energy Group's Educational Equipment Donation

Eunice Energy Group (EEG) has donated educational equipment packages dedicated to Renewable Energy Sources (RES) to several Greek high schools. These packages are designed to enhance students' understanding of renewable energy technologies through practical engagement. https://eunice-group.com/

20. Environmental Education Programs by "In Action for a Better World"

Offers experiential programs on environmental education and sustainability, designed for various educational levels, including high school students. https://inactionforabetterworld.com/en/in-action/

21. Sustainable Greek School Program (Hellenic Society for the Environment and Culture - ELLINIKI ETAIRIA)

The program follows a holistic approach, including actions on energy efficiency, renewable energy, waste reduction, and sustainability. It empowers students, teachers, and communities to reduce their environmental footprint.

https://www.ellet.gr/en/project-category/environment/

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22. ComAct Project Educational Materials

Provides educational factsheets and practical guides on energy efficiency, designed to inform students about energy conservation and efficiency in an accessible manner.

https://comact-project.eu/pilot_content/educational-materials-for-energy-advisors/

23. Energy Efficiency and Renewable Energy Curriculum in Schools

Vocational curriculums developed by the Ministry of Education, tailored for schools across North Macedonia, that integrates lessons on energy efficiency, renewable energy sources, and sustainable practices.

https://csoo.edu.mk/pocetna/struki/

24. OXO NGO Environmental Education

Supports the integration of environmental topics into school curricula and promotes hands-on projects related to energy management.

https://oxongroup.org.mk/

25. School Energy Saving Campaign

Supports the integration of environmental topics into school curricula and promotes hands-on projects related to energy management.

https://www.energy.gov.mk/

26. Institute for Research in Environment, Civil Engineering, and Energy (IECE)

Conducts research and develops educational programs that focus on sustainable development, including energy solutions for schools.

https://iege.edu.mk/

27. Energy Efficiency Guide for Schools

A practical guide developed by the Ministry of Environment to help schools implement energy efficiency measures through practical projects and step-by-step recommendations.

https://www.energy.gov.mk/

28. EON Reality's XR and AI Initiative

Provides immersive learning experiences using spatial AI and interactive courses related to energy and sustainability, tailored for students in schools.

https://eonreality.com/eon-reality-launches-comprehensive-educational-program-with-spatial-ai-and-10000-custom-courses-in-north-macedonia/

29. Earth Energy Education School Projects

Offers tools and resources for schools to engage students with renewable energy technologies through small-scale solar and wind energy projects.

https://earthenergyeducation.com/school-projects

30. Swiss Cooperation Office Environmental Education Projects

Collaborates with educational institutions to integrate environmental sustainability topics into school education, focusing on energy literacy.

https://www.eda.admin.ch/dam/countries/countries-content/north-macedonia/en/swiss_cooperation_programme_north_macedonia_2021_24_EN.pdf

31. ARISE North Macedonia

A project aimed at promoting sustainable energy practices through stakeholder collaboration, including initiatives targeted at schools.

https://www.ariseproject.eu/north-macedonia/

1.2 INTERACTIVE ELEMENTS AND MULTI-MEDIA RESOURCES

Our study aimed to comprehensively investigate interactive tools and multimedia resources in order to increase the energy literacy of young people between the ages of 15-18. In this context, various resources such as videos and animations explaining energy concepts, games and simulations raising awareness about energy consumption and saving strategies, and practical activities were examined. The study aims to create an innovative and effective energy education model with the experiences gained from successful applications in the past.

TURKIYE

1. **Energy Audit Toolkit for Classrooms - A guide for students to measure energy use in schools and suggest improvements.**

https://www.energystar.gov/buildings/tools-and-resources/k-12-energy-efficiency-student-toolkit?utm_source

2. **Videos and animations explaining energy concepts such as renewable energy, energy conservation, and climate impacts.**

Energy 101: Renewable Energy Explained:

https://www.youtube.com/watch?v=1kUE0BZtTRc

3. **Practical activities such as DIY experiments, energy audits, or school energy-saving challenges.**

Example: Practical Classroom Activity - Renewable Energy Projects: https://www.need.org/renewable

4. **Energy Forms and Changes Simulation**

Explore how heating, cooling, and energy sources work through an interactive simulation.

https://phet.colorado.edu/en/simulation/energy-forms-and-changes

5. **NASA Climate Kids Games**

Fun games and activities to learn about energy, climate change, and sustainability.

https://climatekids.nasa.gov/menu/play/

6. Energy Lab Simulator

Design renewable energy systems for cities using real-world data. https://www.climate.gov/teaching/resources/energy-lab-29435

7. Science Buddies Energy Projects

Hands-on science projects and DIY experiments on energy types and conservation. https://www.sciencebuddies.org/blog/teach-types-of-energy

8. Power Discovery Zone

Videos, games, and activities about electricity, its sources, and smart energy use. https://powerdiscoveryzone.nationalgrid.co.uk/teacher-zone

PORTUGAL

9. PORTAL DA ENERGIA

Animated adventures that use imagination, humor, and magic to educate children about energy issues. These engaging stories provide children with practical information, inspiring them to adopt energy-efficient habits and contribute to a healthier environment.
https://portaldaenergia.azores.gov.pt/portal/Eficiencia-Energetica/Escolas?portalid=0

10. Ambiente Energia

Video on how to save energy for young people
https://www.youtube.com/watch?v=yebUsJv95oc&t=87s

11. NegaWATT

Nelson Martins' one-minute animated short teaches us how choosing energy-efficient appliances and making simple lifestyle changes can lower our energy costs
https://www.negawatt.pt/noticias/181-primeiro-video-sobre-o-que-e-a-eficiencia-energetica

12. PROJETO PEDAGÓGICO "POUPAR É GANHAR

Learn, Sing, and Save": A unique project that combines learning and fun to teach kids about environmental responsibility. Through a book and original songs, students discover the importance of conserving water, paper, and energy.
https://www.youtube.com/watch?v=8OOqBlVngmg

13. DECO

Short animation on easy ways to save resources and energy
https://www.youtube.com/watch?v=ZSeGr9ovSXM

14. INTITUTO EUROFARMA

Rap Energia, about energy saving
https://www.facebook.com/watch/?v=784666602157613

15. AZORES NATURE PARKS

This animated film showcases the abundant renewable energy sources in the Azores, including solar, wind, hydro, and geothermal power. These resources are virtually

inexhaustible, providing a sustainable energy future for the islands.
https://www.youtube.com/watch?v=rgS3-WPnCIA

16. UA "UAU - Ciência sem limites

This is an episode of the UA series "UAU - Science without limits" and addresses the topic of renewable energies. Aveiro University.
https://www.youtube.com/watch?v=uxzcKkWDrj4

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17. Energy Challenge Game by Project Learning Tree

An interactive game where students make decisions to improve energy efficiency in various scenarios, enhancing their understanding of energy conservation. https://www.plt.org/activity/energy-society-activity-6-energy-challenge-game/

18. Green Energy Games by Science Trek

A collection of online games and puzzles that teach students about renewable energy sources and their benefits in a fun, interactive way.
https://sciencetrek.org/topics/green-energy/games

19. Energy Games by Let's Talk Energy

Interactive games that allow students to explore electricity generation, avoid electric shocks, and produce renewable power, promoting hands-on learning about energy. https://energy.techno-science.ca/

20. Interactive Games by THINK! ENERGY Program

A suite of games including word searches, crosswords, and quizzes focused on energy efficiency and conservation, suitable for classroom activities. https://thinkenergy.org/consumers/families/interactive-games/

21. Energy Games & Activities by EIA Energy Kids

Interactive games and activities that educate students about energy sources, consumption, and the importance of energy efficiency in daily life.
https://www.eia.gov/kids/games-and-activities/

22. Kinetic Energy Science Games by Legends of Learning

Curriculum-based games that teach students about kinetic energy, its dependence on mass and velocity, and its role in energy systems.
https://www.legendsoflearning.com/learning-objectives/kinetic-energy/

23. Videos that delve into various aspects of renewable energy

https://www.youtube.com/watch?v=UkNMVFTa3bo
https://www.youtube.com/watch?v=7wN4fI9iJH4

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24. Energy Lab Simulator

An online simulation that allows students to create a portfolio of different energy sources to meet the rising energy demands due to increasing populations. It provides insights into the balance between energy production and environmental impact.

https://cleanet.org/resources/49451.html

25. The Game of Energy Choices

A board game that teaches students about various energy generation choices, and the considerations and costs involved in each. Players take on the role of utility company executives tasked with providing electricity to customers under various scenarios, balancing factors like cost and carbon emissions.

https://www.climate.gov/teaching/resources/generate-the-game-of-energy-choices-36329

26. Energy System Map

An interactive tool developed by Student Energy that allows users to explore the entire energy system, from various energy sources to their end uses. The map features an interactive view, a searchable energy topics index, and accompanying educational videos.

https://studentenergy.org/map/

27. RECxploration: Discover Renewable Energy Communities Through a Game

An educational game developed by the Joint Research Centre of the European Commission that demonstrates how energy choices impact consumption and how individuals can engage with Renewable Energy Communities (RECs). Players make decisions that influence energy consumption patterns and learn about the benefits of participating in RECs.

https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/recxploration-discover-renewable-energy-communities-through-game-2024-04-29_en

28. Balancing the Grid – Interactive Game

Developed by the National Energy System Operator, this game provides insight into the challenges of maintaining grid stability. Players attempt to keep the energy grid balanced while facing scenarios similar to those encountered by real-world control room operators.

https://www.neso.energy/energy-101/balancing-grid-interactive-game

29. Energy Farm

An interactive game by Siemens Education where players step into the role of an energy manager tasked with powering a farm using innovative energy solutions. The game challenges players to design and implement systems that meet the farm's energy needs while minimizing costs and environmental impact.

https://energyfarmgame.co.uk/

30. Be Green My Friend – Online Energy Games

A compilation of educational energy-related games aimed at teachers, students, and parents. The platform provides links to various games that cover topics such as energy conservation, renewable energy, and sustainable living.

https://begreenmyfriend.weebly.com/online-energy-games.html

31. Videos that delve into various aspects of renewable energy

https://www.youtube.com/supported_browsers?next_url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3Des3jzBsXDDs

https://www.youtube.com/watch?v=itd5kg7GsfA&ab_channel=Morrow

https://www.youtube.com/watch?v=44Wp3WE1AHs&ab_channel=EcoMasteryProject

https://www.youtube.com/watch?v=K0YAouAKhjk&ab_channel=BioTechWhisperer

https://www.youtube.com/watch?v=VfowJHJz6-s&ab_channel=TheIndependent

1.3 GUIDES / MATERIALS FOR TEACHERS AND EDUCATORS

Our study aimed to identify teacher guides and teaching materials adapted to high school students that could support educators in teaching energy literacy. In this context, accessible and comprehensive resources at both national and international levels were examined.

TURKIYE

1. **Energy Literacy: Essential Principles and Fundamental Concepts for Energy Education**

https://www.energy.gov/eere/education/articles/download-copy-energy-literacy-framework

2. **A Quick Start Guide for Educators**

https://www.energy.gov/sites/prod/files/2015/03/f20/EnergyLiteracy_QuickStartGu ide.pdf

3. **Renewable Energy Lesson Plans & Teaching Materials (CREATE)**

https://createenergy.org/teaching-materials/

4. **GENERATE: The Game of Energy Choices (Teacher's Guide)**

https://www.epa.gov/sites/default/files/2017-08/documents/generate_teachersguide_highschool.pdf

5. **Bringing Energy Topics Into Your Classroom**

https://cleanet.org/clean/literacy/energy/index.html

6. **Geothermal Energy: Teacher Guide for Grades 9-12**

https://www1.eere.energy.gov/education/pdfs/doe_teacher_guide.pdf

7. **School Energy Managers - Secondary (NEED Project)**

https://www.rkc.edu/catalogue

8. **Exploring Solar Energy Teacher Guide**

https://eere.energy.gov/education/pdfs/solar_exploringsolarenergyteacher.pdf

PORTUGAL

9. **A energia viva na Terra –Manual do professor (The living energy on earth – teacher's gook)**

https://www.apren.pt/contents/documents/manual-do-professor-apren--versao-net.pdf

10. **Guia para a eficiência energética e a qualidade do ar no interior da escola (guide for energetic efficency and air quality inside the School)**

https://aream.pt/files/2016/05/guia-escolas.pdf

11. **Renewable Energy Lesson Plans for High School**

https://subjecttoclimate.org/teacher-guides/renewable-energy-lesson-plans-for-high-school#Reading

12. **Five Ways to Learn About Energy**

https://www.neefusa.org/story/environmental-education/five-ways-learn-about-energy

13. **Energy In Action | Post Primary School**

https://www.seai.ie/plan-your-energy-journey/schools/post-primary-school/energy-in-action

14. **Renewable electricity in the Portuguese energy system until 2050**

https://www.apren.pt/contents/documents/apren-en-2050-ing-v4.pdf

15. **Teaching and Learning of Energy in K – 12 Education**

https://link.springer.com/book/10.1007/978-3-319-05017-1

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16. **CLEAN (Climate Literacy and Energy Awareness Network):**

https://cleanet.org/index.html

17. **European Union Learning Corner**

https://learning-corner.learning.europa.eu/learning-materials_en?f%5B0%5D=topics_topics%3A11

18. **A Systemic Framework of Energy Efficiency in Schools**

https://link.springer.com/article/10.1007/s12053-023-10099-4

19. **Experiences from Using Gamification and IoT-based Educational Tools in High Schools towards Energy Savings**

https://arxiv.org/pdf/1909.00699

20. **National Renewable Energy Laboratory (NREL) - Energy Education Resources**

https://www.eia.gov/kids/for-teachers/related-links/energy-literacy/us-doe-nrel?utm_

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21. **Alternative Energy / Green Energy – Solar & Wind Energy Learning**

https://amatrol.com/product-categories/alternative-energy-green-energy/

22. Destination Renewable Energy: Pioneering the Future of Clean Energy with HYREF
https://destination-earth.eu/news/dre-pioneering-the-future/
23. What is Green Energy? (Definition, Types, and Examples)
https://www.twi-global.com/technical-knowledge/faqs/what-is-green-energy
24. 7 Energy Literacy Principles – EERE STEM and Education
https://www.energy.gov/eere/education/eere-stem-and-education
25. Energy Literacy Framework - A Quick Start Guide for Educators
https://www.energy.gov/sites/default/files/2015/03/f20/EnergyLiteracy_QuickStartGuide.pdf
26. National Energy Education Development (NEED) Project
https://www.need.org/educators/curriculum-resources/
27. ECO AWARENESS - Energy and Energy Sources for Grades 4, 5, and 6
https://ekosvest.com.mk/wp-content/uploads/2021/03/energija-mali.pdf
28. Renewable Energy Sources Textbook for Technical Students in Computerized Control and Mechanical Engineering
https://www.e-ucebnici.mon.gov.mk/pdf/obnovlivi_izv_na_energija_3_mak_izb.pdf
29. Infothek – Solar Systems
http://www.sm.mk20.com/infoteka.pdf
30. Green Learning - Tools for Teaching Sustainability and Energy Literacy
https://greenlearning.ca/
31. Renewable Energy Sources – Power for a Sustainable Future
https://1000knigi.mon.gov.mk/book.php?id=1810
32. Energy and the Environment
https://www.1000knigi.mon.gov.mk/book.php?id=1769
33. Alternative Energy Systems and Applications
https://1000knigi.mon.gov.mk/book.php?id=1545

1.4 ERASMUS / EU PROJECTS

Our study aimed to identify Erasmus+ and European Union supported projects focusing on energy education, energy literacy and sustainability goals and to examine the main outputs of these projects. In this context, the materials and applications of projects aiming to increase energy literacy among young people were evaluated.

TURKIYE

1. **SAVE AND GAME – Escape Game for Energy Sustainability**
https://erasmus-plus.ec.europa.eu/projects/search/details/2022-3-HR01-KA210-YOU-000097125
https://saveandgame.eu/

2. **No Time to Waste - A project to actively deal with sustainability**

https://erasmus-plus.ec.europa.eu/projects/search/details/2020-1-DE03-KA229- 077518
https://sites.google.com/view/no-time-to-waste/startseite

3. **Innovative educational pathways to the new Energy Landscape. - a small scale transnational study of how and if innovative educational pathways gain knowledge and acceptance that can facilitate the transition to a sustainable society.**

https://erasmus-plus.ec.europa.eu/projects/search/details/2021-1-SE01-KA210- VET-000029938

PORTUGAL

4. **Secove - Sustainable Energy Centres of Vocational Excellency:** aims at fostering collaboration, communication, and knowledge exchange among Centers of Vocational Excellence (CoVEs) across Europe.

https://secove-project.eu/about/

5. **EDDIE - Education-Energy-Digitalization-EU-Erasmus:** a collaborative project to create a Sector Skill Alliance to develop a Blueprint for the digitalization of the Energy

https://eddie-erasmus.eu/

6. **SEED - Sustainable Energy Education:** aims at promoting innovative vocational education and training, providing solutions for preventing global climate change and for Europe to become a fossil free energy continent.

https://coveseed.eu/

7. **T-SHORE - Technical Skills for Offshore Renewable Energy:** create innovative approaches for skills provision in the offshore renewable energy sector by linking offshore-energy-hotspots spread across Europe and stimulate innovation and collaboration between VET providers, industry and research institutes.

https://t-shore.eu/

8. **Energy Helps Strong Economy**: provide participants with more knowledge, expertise and expertise in the European perspective on sustainable energy sources (solar power, wind power, hydro energy, geothermal power and biofuels) and to build eco-friendly ways of solving the energy crisis; to encourage future consumers to be conscientious citizens and to generate work options in science.

https://www.erasmusly.com/energy-helps-strong-economy-erasmus-project-17165.html

9. **Energy Literacy (El-Practice):** aims to support young adults in enhancing their knowledge, skills, and abilities in sustainable energy use.

http://www.el-practice.eu/en/#About_Energy_Literacy

GREECE

10. **IoE-EQ (Internet of Energy - Education and Qualification)** The IoE-EQ project aims to create vocational education and training qualifications for professionals, training them to adopt and manage IoT devices in the energy sector, thereby supporting the digital transformation of energy systems.

https://www.ioe-edu.eu/en/default.aspx

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11. **EL-Practice -** Enhances the energy literacy of young adults by promoting sustainable

https://www.el-practice.eu/en/

12. **Bogdanci Wind Park Phase I Pilot Project** - The first wind farm in North Macedonia, aiming to demonstrate wind energy viability, encourage private investment, and showcase renewable energy technology.

https://www.wbif.eu/project/PRJ-MKD-ENE-001

13. **Albania–North Macedonia Power Interconnection Grid.** A European Commission-supported project for a 400kV transmission system linking Bitola, Ohrid, and Albania to create an East-West electricity transmission corridor.

https://www.wbif.eu/project/PRJ-MKD-ENE-005

14. **Renewable Energy Sources for Safe Future -** An Erasmus+ KA2 project promoting renewable energy and sustainability education for adults in North Macedonia and other partner countries.

https://www.eko-zivot.org.mk/renewable-energy-sources-for-safe-future/

15. **Wind Park Bogoslovec** - Operational wind farm contributing 87,000 tons of CO_2 emission reduction annually.

https://wpbogoslovec.com/mk/pocetna/

16. **E-LIT: Energy Literacy for Adults** - Focuses on reducing energy poverty by improving energy literacy among adults, equipping them to make informed energy decisions.

https://en.ktu.edu/projects/energy-literacy-for-adults-an-innovative-approach-to-reducing-energy-poverty-e-lit/

17. **Destination Renewable Energy (HYREF**) - Hybrid Renewable Energy Forecasting System (HYREF), integrating climate and weather data for precise energy forecasts.

https://destination-earth.eu/news/dre-pioneering-the-future/

18. **EVIDENT Project -** Uses gamification and interactive tools to educate consumers about energy efficiency, promoting sustainable consumption behaviors.

https://cordis.europa.eu/article/id/442567-new-game-to-increase-energy-literacy-among-consumers

19. **Skills for Green Jobs in North Macedonia -** The project by the European Training Foundation (ETF) focuses on improving skills for green jobs, especially in renewable energy and sustainable practices. It aims to strengthen vocational education to match the needs of a greener economy.

https://www.etf.europa.eu/en/skills-green-jobs-north-macedonia

1.5 ERASMUS / EU PROJECTS SUMMARIES OF INTERNATIONAL RESEARCH ARTICLES ON ACADEMIC STUDIES ON ENERGY LITERACY

Our study aimed to examine national and internationally published academic studies on energy literacy and sustainability education. Research on energy literacy, renewable energy education and energy saving practices designed especially for young people and students was scanned. In this context, articles published in various academic journals and education databases were evaluated and the basic findings, methods and recommendations obtained from these studies were summarized.

NATIONAL / LOCAL LEVEL

TURKIYE

1. **"Contributions of Epistemological Beliefs on Energy Literacy in Lower-Secondary School Students in Turkiye."**

Ayata, S., Oylumluoglu, G., & Alpaslan, M. M. Contributions of Epistemological Beliefs on Energy Literacy in Lower-Secondary School Students in Turkey. *Journal of Baltic Science Education*, 2024; 23(3), 421-431. doi:10.33225/jbse/24.23.421

Objective: To investigate the impact of epistemological beliefs on the energy literacy of lower-secondary school students in Turkey.

Methodology: Data were collected from 656 lower-secondary school students in Turkey's Aegean Region using self-report questionnaires. The Energy Literacy Scale and the Scientific Epistemological Beliefs Scale were employed to assess students' energy literacy and their beliefs about knowledge, respectively. Statistical analyses, including Pearson correlation and multiple regression, were conducted to explore the relationships between variables.

Findings: Energy Literacy Levels: Students exhibited low mean scores in the knowledge dimension of energy literacy, while their scores in the behavioral and affective dimensions were moderate.

Epistemological Beliefs' Impact: The 'reasoning' dimension of epistemological beliefs positively predicted energy literacy in the knowledge dimension, whereas the 'authority and accuracy' dimension had a negative predictive effect.

Recommendations: Enhancing students' epistemological beliefs, particularly fostering sophisticated beliefs that value reasoning over reliance on authority, may improve their energy literacy levels. Educational interventions should focus on developing critical thinking

and independent reasoning skills to promote a deeper understanding of energy-related concepts.

2. **"Development of a Measurement Tool to Determine the Energy Literacy Levels of Fifth Grade Students"**

Urey, M., & Yıldız, M. Development of a Measurement Tool to Determine the Energy Literacy Levels of Fifth Grade Students. *E-International Journal of Educational Research*, 2024; 15(1), 19-46. doi.org/10.19160/e-ijer.1463544

Objective: To determine the energy literacy levels of fifth graders and to determine the capacity rates of energy education.

Methodology: Energy literacy design with quantitative method.

Findings: The analysis indicated that the developed measurement tool is both reliable and valid for assessing energy literacy among fifth-grade students. The instrument effectively captures multiple dimensions of energy literacy, providing educators and researchers with a comprehensive tool to evaluate students' understanding and attitudes toward energy-related concepts.

Recommendations: This measurement tool can be used in educational settings to identify areas where students may need further training or support in energy education. Additionally, the tool can serve as a valuable resource for assessing the effectiveness of energy education programs and curricula for young students.

3. **"Student Views on Sustainable Development and Sustainable Education"**

Yalçın K, Köybaşı Şemin F. Student Views on Sustainable Development and Sustainable Education. GEFAD. April 2024;44(1):171-207. doi:10.17152/gefad.1187974

Objective: To evaluate students' views on sustainable development and sustainable education concepts.

Methodology: In-depth interviews were conducted using qualitative research methods.

Findings: Students stated that sustainable education helps them understand social, economic and ecological systems and adapt these systems to their lives**.**

Recommendations: Practical activities should be increased in sustainability education. Projects should be developed in which students can take an active role in social and ecological issues.

4. **"Life Skills Framework for Sustainability Education"**

Uslu S, Özdemir O. Life Skills Framework for Sustainability Education. *The Journal of Buca Faculty of Educatio*n, 2023;(57):1996-2011. doi.org/10.53444/deubefd.1302801

Objective: To determine the life skills required for sustainability education at the secondary school level and to create a framework.

Methodology: 22 peer-reviewed articles were reviewed in the Scopus database and an analysis was conducted in line with expert opinions.

Findings: The life skills required for sustainability education were determined and an original framework that could be adapted to curriculum was created.

Recommendations: Sustainability education should be integrated into the secondary school curriculum. Students' problem-solving, critical thinking and social responsibility skills should be developed.

5. **" Investigation of Energy Literacy of Secondary School Students in Terms of Various Variables"**

Soğukpınar, R., & Yenice, N. Investigation of Energy Literacy of Secondary School Students in Terms of Various Variables. *Western Anatolia Journal of Educational Sciences*, (2022), 13 (2), 1352-1374. doi.org/10.51460/baebd.1120901

Objective: To examine the energy literacy levels of secondary school students in terms of variables such as gender, grade level and parental education level.

Methodology: The Energy Literacy Scale was applied to 643 secondary school students using the quantitative screening model.

Findings: No significant difference was observed in terms of grade level and parental education level. According to gender, energy literacy levels of female students were higher.

Recommendations: Programs should be developed to ensure gender equality in energy literacy education. Parental support should be provided by increasing families' energy awareness.

6. **“Investigation of the Relationship between Middle School Students' Energy Literacy and Demographic Variables”**

Ayata, S., Oylumluoğlu, G., & Alpaslan, M. M. Investigation of the Relationship between Middle School Students' Energy Literacy and Demographic Variables. *Science, Education, Art and Technology Journal (SEAT Journal)],*2022; 6(2), 115-129.doi.org/10.46328/bestdergi.83

Objective: To explore the relationship between middle school students' energy literacy and demographic variables such as gender, grade level, and socioeconomic status.

Methodology: The study employed a survey method to assess energy literacy among middle school students. The survey measured three dimensions of energy literacy: knowledge, attitudes, and behaviors. Demographic information was also collected to analyze correlations between these variables and energy literacy levels.

Findings: Gender Differences: The study found that female students exhibited higher energy literacy levels in the affective and behavioral dimensions compared to male students.

Grade Level: Energy literacy levels increased with grade level, indicating that older students possessed greater energy-related knowledge and more positive attitudes and behaviors towards energy conservation.

Socioeconomic Status: Students from higher socioeconomic backgrounds demonstrated higher energy literacy across all dimensions, suggesting that socioeconomic factors play a significant role in energy education.

Recommendations: The study suggests that energy education programs should be tailored to address demographic disparities. For instance, targeted interventions could be designed to engage male students more effectively in the affective and behavioral aspects of energy literacy. Additionally, providing additional support and resources to students from lower socioeconomic backgrounds may help bridge the energy literacy gap.

7. "Adaptation of the Energy Literacy Scale into Turkish: A Validity and Reliability Study"

Güven, G., Yakar, A., & Sülün, Y. Adaptation of the Energy Literacy Scale into Turkish: A Validity and Reliability Study. *Çukurova University Journal of Education Faculty*,2019; 48(1), 821-857. doi.org/10.14812/cuefd.489058

Objective: Adapting the energy literacy scale to Turkish and measuring students' energy literacy.

Methodology: The scale was adapted to Turkish and applied to 550 students, validity and reliability analyses were conducted.

Findings: Energy literacy levels were measured successfully and the scale was found to be reliable.

Recommendations: Reliable tools that measure energy literacy should be used more widely. Energy awareness training should be standardized at the national level.

PORTUGAL

8. "Accountability implications for intermediaries in upscaling: Energy community rollouts in Portugal"

Scharnigg, R. & Sareen, S. (2023). Accountability implications for intermediaries in upscaling: Energy community rollouts in Portugal. Technological Forecasting & Social Change, 197, 10 pages. DOI: 10.1016/j.techfore.2023.122911

Objectives: Analyses the roles of four types of organisations as intermediaries: non-profit institutions, municipalities, new entrant companies with innovative business models and the renewables arm of the incumbent.

Methodology: Based on three months of multi-sited fieldwork and 36 interviews, the authors analysed the emergent roles of intermediaries.

Findings: The accountability regime significantly impacts learning and shapes the actors and outcomes prioritized during diffusion. The incentives set by the accountability regime are major factors that determine outcomes, and intermediaries step in to fill gaps left by sectoral governance.

Recommendations: Households in poverty can hardly establish energy community projects where experienced, well-connected project managers often struggle unless given structural support and lowered barriers. Future research can investigate how and which policy changes can construct accountability regimes where incumbents participate in more disruptive pathways to develop more sustainable and equitably oriented sociotechnical models.

9. **"Energy literacy assessment among Portuguese university members: Knowledge, attitude, and behavior"**

Martins, A., Madaleno, M. & Dias, M. (2020a). Energy literacy assessment among Portuguese university members: Knowledge, attitude, and behavior. *Energy Reports*, 6, 243–249. DOI: 10.1016/j.egyr.2020.11.117

Objectives: To create an energy literacy scale, as well as the indices for each of the energy literacy dimensions and to determine which factors influence energy literacy levels.

Methodology: 409 valid answers to a questionnaire targeted to university community (students, teachers, researchers and technicians). Authors used Principal Component Analysis (PCA) to validate the scale. PCA generate 4 energy-related indexes as well as a financial-knowledge index.

Findings: Gender influences energy literacy; although women have less knowledge, they demonstrate a more positive attitude and more correct behavior. A higher level of qualification appears to have a positive and significant impact on knowledge while financial knowledge, although it has a positive correlation with knowledge about energy, does not have a statistically significant influence on it. Attitude and behavior seem to influence each other positively. Age only significantly influences behavior, as older participants seem to behave more correctly.

Recommendations: Energy literacy is a powerful tool as it enables more efficient consumption use and more appropriate and environmentally friendly choices.

10. **"Financial Knowledge's Role in Portuguese Energy Literacy"**

Martins, A., Madaleno, M. & Dias, M. (2020b). Financial Knowledge's Role in Portuguese Energy Literacy. *Energies*, 13, 22 pages. DOI: 10.3390/en13133412

Objectives: to evaluate energy literacy levels, considering all the dimensions mentioned above, and search for the determinants of these levels and to determine the role of financial knowledge on energy literacy dimensions

Methodology: a questionnaire was distributed to the university community (students, teachers, researchers and technicians) in Portugal. 409 answered to it.

Findings: the authors found good levels of energy literacy, despite moderate levels of energy and financial knowledge. Gender seems to be a determinant of all energy literacy dimensions, and financial knowledge has a positive and significant impact on energy knowledge.

Recommendations: policymakers should support an increased frequency energy and finance-related courses for all students, or perhaps make these courses mandatory at all levels of education, with the aim of improving the knowledge, attitude and behavior of future generations. Sustainable behaviors need to be introduced at an early age in the hope that these would help to develop energy-saving behaviors in the future.

11. **"Are the energy literacy, financial knowledge, and education level faces of the same coin?"**

Martins, A., Madaleno, M. & Dias, M. (2022). Are the energy literacy, financial knowledge, and education level faces of the same coin? *Energy Reports,* 8, 172–178. doi.org/10.1016/j.egyr.2022.01.082

Objectives: to check if there are common determinants between three variables: education, financial knowledge and energy literacy.

Metodology: a questionnaire was applied to 428 Portuguese university members (students, teachers, and technicians).

Findings: energy knowledge has an influence, not only on the level of energy literacy but also on the level of education and the level of financial knowledge.

Recommendations: it is urgent to invest in energy education at all levels of education, but especially at the lowest levels of education, where children still do not have such ingrained habits.

12. **"Perceptions of competing agendas in carbon neutrality policies in Portugal: Adverse impacts on vulnerable population groups"**

Mahoney, K., Lopes, R., Sareen, S., & Gouveia, J. (2024). Perceptions of competing agendas in carbon neutrality policies in Portugal: Adverse impacts on vulnerable population groups. *Energy Research & Social Science*, 112, 13 pages. DOI: 10.1016/j.erss.2024.103509

Objective: to analyse perspectives on interactions between political agendas of climate change, energy transition, and energy poverty.

Methdology: 39 expert interviews on Portuguese carbon neutrality agendas.

Findings: strong agreement regarding theoretical linkages of the agendas but mixed views on whether this transpires in practice. These perceived inconsistencies reveal several unresolved competing agendas in Portuguese carbon neutrality policies. We also reveal important influences on citizen agency in the decarbonisation agendas.

Recommendations: these insights are valuable for current policy approaches, which promote decarbonisation policies that incorporate energy poverty and rely strongly on citizen participation. However, it would be necessary to gain insights into these issues at the citizen level, as the results offer a first glimpse into the topics covered through the eyes of experts..

13. "Scales of solar energy: Exploring citizen satisfaction, interest, and values in a comparison of regions in Portugal and Spain"

Campos, I., Brito, M. & Luz, G. (2023). Scales of solar energy: Exploring citizen satisfaction, interest, and values in a comparison of regions in Portugal and Spain. *Energy Research & Social Science,* 97, 15 pages. DOI: 10.1016/j.erss.2023.102952

Objective: to explore how citizens perceive the importance of the energy transition and gain further insight into the conditions that make citizens most satisfied with, and interested in, actively participating in the development of solar energy projects.

Methodology: A survey involving a representative sample (n = 832) collected in the two southern Europe regions (Alentejo in Portugal and Andalusia in Spain), and includes a vignette experiment.

Findings: Statistical data analysis supports an understanding of the relational nature of social acceptance (SA), which is suggested to be also applicable to energy citizenship (EC), across different scales of solar energy production, from large and centralized to small-scale decentralized installations. SA and EC are both embedded in broader societal concerns, and multiple factors can affect local support for multi-scalar solar projects, as well as citizens' interest in becoming actively involved. Among these factors, policies that enable higher participation of citizens and benefit more vulnerable communities, including in large-scale solar installations, are important. Nevertheless, the relative importance of these factors, when compared to the overall satisfaction with different scales, indicates that there is a high level of SA for all types of solar projects, although communities already exposed to large-scale solar landscapes are bit less satisfied.

Recommendations: Effectively informing and communicating to citizens what small and medium size installations are and how they can benefit local communities, as well as women and older citizens is important for expanding EC. Regional and national energy planners should take extra effort in disseminating new energy models (e.g., energy communities) among local populations, explaining their costs and benefits. It is equally important to negotiate trade-offs between large-scale investments and small-scale systems.

14. "Can HCI Help Increase People's Engagement in Sustainable Development? A Case Study on Energy Literacy"

Pestana, C. Barros, L., Scury, S., & Barreto, M. (2021). Can HCI Help Increase People's Engagement in Sustainable Development? A Case Study on Energy Literacy. *Sustainability,* 13, 23 pages. DOI: 10.3390/su13147543

Objective: To describe how user centred design (UCD) and Human-computer interaction (HCI) can inform the design of a platform targeting Madeiran citizens using UCD and HCI methodologies to understand and assess users' energy literacy.

Methodology: The design process, from ideation to prototype and validation is descried. Data collection methods include card sorting (6 energy consumers), semi-structured interviews (4 prosumers), brainstorming sessions (with HCI experts and interaction designers), think-aloud protocol and surveys (5 people three out of five own a solar water heating system, and one has recently purchased an electric vehicle.).

Findings: User access to the information platform indicates that a user-centered approach does attract users to explore the information and come back to it, retaining them throughout time. Adopting HCI can nurture the development of energy education initiatives targeting citizens, bringing a user-centered approach (users were involved throughout all stages of design) to the design of such initiatives.

Recommendations: Due to COVID-19 samples are small. Further work would be necessary to evaluate if the knowledge gain was sustained over time. Being that the platform an always accessible and living tool, it can be consulted at any time the consumers feel the need to and will be updated according to changes that may occur about the sections displayed.

15. "Women vs Men: Who performs better on Energy Literacy?"

Martins, A., Madaleno, M. & Dias, M. (2021). Women vs Men: Who performs better on Energy Literacy? International Journal of Sustainable Energy Planning and Management, 32, 37-46. DOI: 10.5278/ijsepm.6516

Objective: Since women tend to be considered the main caregivers, due to their maternal instinct, being generally more attentive, more altruistic, and more concerned with the future of their children, are women more involved in the transition to a more sustainable future?

Methodology: questionnaire defined by Martins et al. [21] and applied it to Portuguese university members (technicians, teachers, and students) from several universities and polytechnic institutes of the country. Authors collected 428 valid answers

Findings: results show that Portuguese university members have good levels of energy literacy and that there are no significant differences between the energy literacy levels of women and men. However, authors verified significant differences in the levels of energy price awareness and financial knowledge, with men obtaining the best results. Although women tend to have lower levels of knowledge about energy, but a more positive and sustainable attitude and behavior. Consequently, women seem to have slightly better levels of energy literacy

Recommendations: To improve low levels of energy and financial knowledge we suggest providing energy and energy-related financial lessons to students, using practical activities that bring them closer to everyday situations, at all levels of education and independently of the field or area of study. Girls, in particular, should be alerted to the importance of financial literacy and should be encouraged to study areas such as mathematics, finance, and engineering, among others.

16. Energy saving on campus: a comparison of students' attitudes and reported behaviours in the UK and Portugal

Cotton, D., Shiel, C., & Paço, A. (2016). Energy saving on campus: a comparison of students' attitudes and reported behaviours in the UK and Portugal. Journal of Cleaner Production, 129, 586-595. DOI: 10.1016/j.jclepro.2016.03.136

Objective: explores similarities and differences between students' energy-related attitudes and reported behaviours, as well as their perceptions of their institution's energy saving efforts using data from two universities in the United Kingdom (UK) and one in Portugal.

Methodology: Authors used a questionnaire that measures attitudes and self-reported behaviours related to energy saving (five-point scales (min 1, max 5), where 3 is the indifference value), and perception of their own use of energy in terms of level of usage (from 1= very low energy user to 5 = high-energy user). Some questions were also posed to gather demographic information such as age, gender and nationality. The questionnaire was applied to 800 students attending a Portuguese university and to 1494 students from two UK universities.

Findings: There are differences between the students' responses at the selected universities, which appear to reflect the national context and diverse institutional priorities. Key differences include the variation between students' perceptions of individual agency and their university's environmental practices (stronger in the UK) and students' sense of collective agency and trust in the government and business (stronger in Portugal). However, there are no significant differences between male and female students regarding their perception of their own energy usage.

Recommendations: This research provides tentative evidence that the policy context, including developments such as the UK Green League and legal requirements regarding carbon management and energy certificates, does impact on students' perceptions of energy saving at their institution The study provides foundation to extend the comparison to other institutions and other countries, and to expand the research to encompass actual energy use, in relation to perceived energy use.

17. Energy Literacy: does age matters?

Martins, A., Madaleno, M. & Dias, M. (2021). Energy Literacy: does age matters? In Eighth International Conference on Technological Ecosystems for Enhancing Multiculturality (TEEM'20), October 21-23, 2020, Salamanca, Spain. ACM, New York, NY, USA, 546-551. DOI: 10.1145/3434780.3436653

Objective: to evaluate the differences in the factors that influence energy literacy within different age groups.

Methodology: questionnaire applied to 409 members of HEI divided into four age groups, namely, young (17-21 years old); young adults (22-30 years old); adults (31-41 years old); and seniors (42-70 years old).
Findings: Seniors perform better than the other age groups in energy literacy and all of its dimensions, except on behavior. The results also highlight the importance of financial knowledge and energy awareness to determine energy knowledge and energy literacy, and a strong dual relationship between attitude and behavior.
Recommendations: Considering that results point that more energy literacy wisdom is associated to seniors (in all its dimensions as well, except behavior), and knowing that parents and teachers have more influence on their energy curtailment literacy, policies should be redirected to energy literacy since the very beginning of children's life.

GREECE

18. "Energy Literacy Among Pre-Service Primary School Teachers in Greece"
G. Stylos et al, "Energy Literacy Among Pre-Service Primary School Teachers in Greece", *INTERDISCIP J ENV SCI ED*, Volume 19, Issue 4, 2023, Article No: e2318
Goals: Assess the energy literacy levels of 408 Greek pre-service primary school teachers.
Methodology: Utilized the Energy Literacy Questionnaire (ELQ) to evaluate knowledge, affect and behavior related to energy concepts.
Findings: Participants exhibited low-to-moderate knowledge of energy concepts and challenges. Displayed satisfactory levels in affective and behavioral domains concerning energy issues.
Recommendations: Enhance teacher education programs to improve understanding of energy concepts. Emphasize the importance of energy education in fostering sustainable behaviors among future educators.

19. "Energy education in Greece: Learning about renewable electrical energy perspectives"
Ioannis Balouktsis, Gerassimos Kekkeris, "Energy education in Greece: Learning about renewable electrical energy perspectives", EAEEIE Annual Conference (EAEEIE), 2013
Goals: Examine aspects of energy education related to renewable energy in Greece and globally**.**
Methodology: Literature review and analysis of existing energy education programs.
Findings: Identified gaps in the integration of renewable energy topics within Greek educational curricula. Emphasized the importance of early education in shaping positive attitudes toward renewable energy.
Recommendations: Incorporate comprehensive renewable energy education into school curricula. Promote hands-on learning experiences to engage students with real-world energy challenges.

20. "Investigation of Energy Literacy, Practices of Saving and Rational Use of Energy of Students in Greece"

Dımıtrıos Poımenıdıs, Vasileios F.papavasileiou, "Investigation of Energy Literacy, Practices of Saving and Rational Use of Energy of Students in Greece*", IJAEDU- International E-Journal of Advances in Education, 2021, 7* 20 81–89

Goals: Assess students' energy literacy and their engagement in energy-saving practices.

Methodology: Surveyed students to evaluate their knowledge, attitudes, and behaviors regarding energy use and conservation.

Findings: Students demonstrated moderate levels of energy literacy.

Noted a discrepancy between knowledge and the implementation of energy-saving practices.

Recommendations: Implement targeted educational interventions to bridge the gap between energy knowledge and practice. Encourage active participation in energy conservation initiatives within schools.

21. "Socio-Cultural Impact of Energy Saving: Studying the Behaviour of Elementary School Students in Greece"

L. Sideri et al, "Socio-Cultural Impact of Energy Saving: Studying the Behaviour of Elementary School Students in Greece", *Sustainability 2018,* 10, 737

Goals: Investigate elementary students' behaviors related to energy saving and management.

Methodology: Conducted observations and surveys to assess students' energy-related behaviors and understanding.

Findings: Education enables students to become familiar with rational energy management.

Students learned to implement energy-saving practices in their daily lives.

Recommendations: Integrate energy education into early childhood curricula to instill sustainable habits. Engage students in interactive activities that promote energy conservation.

22. "School Managers Perceptions towards Energy Efficiency and Renewable Energy Sources"

D. Drosos et al, "School Managers Perceptions towards Energy Efficiency and Renewable Energy Sources*", Int. Journal of Renewable Energy Development (IJRED),* 10 (3) 2021: 573-584

Goals: Assess the environmental sensitivity and energy-saving behaviors of school managers.

Evaluate their knowledge and perceptions regarding various RES technologies.

Determine the relationship between ecological beliefs, energy-saving habits, and the recognition of the importance of environmental education.

Methodology: A structured questionnaire was administered to 510 school managers across primary and secondary education in Greece. Statistical analyses, including Friedman's test and hypothesis testing, were employed to interpret the data.

Findings: High Environmental Sensitivity: 97.6% of respondents agreed or strongly agreed that energy saving should be a primary concern.

Knowledge of RES:

71% reported good knowledge of solar energy.

64% were knowledgeable about wind energy.

Only 34% had knowledge of biomass energy.

Support for RES Education: 99% agreed on the importance of incorporating more RES-oriented education into curricula.

Energy-Saving Behaviors: Approximately 90% reported turning off lights when leaving classrooms.

A similar percentage ensured windows were closed when air conditioning was operating.

Statistical analyses revealed a significant relationship between school managers' ecological beliefs, their energy-saving habits, and their recognition of the importance of environmental education.

Recommendations: Enhance environmental education programs within schools to increase awareness and knowledge of RES among both teachers and students.

Promote the integration of RES technologies in school infrastructures to serve as practical examples for students.

Encourage school managers to lead by example in implementing energy-saving practices and fostering an environmentally conscious school culture.

THE NORTH MACEDONIA

23. "Potential of Wind Energy and Its Utilization in Europe and North Macedonia"

Kristina Radin, Vladimir Miakovski, "Potential of Wind Energy and Its Utilization in Europe and North Macedonia", Master's Thesis, Faculty of Mechanical Engineering, University of Ss. Cyril and Methodius, 2013

Findings: The study emphasizes the significant potential of wind energy in North Macedonia, particularly in regions such as the southeastern part of the country. The results indicate that wind farms could play a crucial role in diversifying the energy mix and reducing carbon emissions.

Methodology: The thesis utilized a combination of theoretical analysis and case studies from Europe to assess the viability of wind energy in the context of North Macedonia.

Recommendations: The study recommends expanding the infrastructure for wind energy, improving local technological capabilities, and encouraging private sector investment to scale up the renewable energy sector in North Macedonia.

24. **Vlado Petruševski, Vladimir Miakovski, "Techno-Economic Utilization of Solar Energy in Modern Urban Environments: Application of the Latest Technical and Technological Solutions", Master's Thesis, Faculty of Mechanical Engineering, University of Ss. Cyril and Methodius, 2013**

Findings: This study identifies solar energy as a viable renewable source for urban areas, especially in North Macedonia's sunny climate. It finds that solar energy can significantly contribute to reducing dependence on conventional energy sources.

Methodology: A techno-economic analysis was conducted to assess the feasibility of solar energy installations in urban settings. It involved both quantitative modeling and simulations of solar panel efficiency under varying conditions.

Recommendations: The study recommends integrating solar energy systems in urban planning policies and providing incentives for individuals and businesses to adopt solar technologies.

25. **Valentin Sekulovski, Vladimir Miakovski, "Industrial Energy Efficiency at Pelisterka A.D. Skopje with the Application of Renewable Energy Sources", Master's Thesis, Faculty of Mechanical Engineering, University of Ss. Cyril and Methodius, 2014**

Findings: The thesis demonstrated that integrating renewable energy sources, such as solar and wind, into the industrial sector could lead to substantial reductions in energy consumption and costs.

Methodology: A case study approach was used, focusing on Pelisterka A.D. Skopje, where energy consumption data were analyzed before and after renewable energy adoption.

Recommendations: The study suggests the scaling of renewable energy use in industrial operations to enhance energy efficiency and reduce the environmental footprint of industrial activities.

26. **Dragan Mitanovski, Vladimir Miakovski, "Utilization of Renewable Energy Sources for the Production of Electric Energy in the Republic of Macedonia", Master's Thesis, Faculty of Mechanical Engineering, University of Ss. Cyril and Methodius, 2015**

Findings: The research highlights the potential for renewable energy, such as wind, solar, and hydropower, to meet the growing energy demand in North Macedonia while reducing greenhouse gas emissions.

Methodology: A combination of modeling and simulation methods was employed to estimate the renewable energy potential of various regions within North Macedonia.

Recommendations: The study advocates for the expansion of renewable energy capacity and the development of policies that encourage investment in green technologies, along with improvements in grid integration.

27. **Meri Cvjetkovska, "Training on Energy Efficiency – Sustainability and Renewable Energy Sources", National Energy Efficiency and Renewable Energy Training Program, 2016**

Findings: The training program's findings show a positive correlation between education on energy efficiency and the adoption of sustainable practices among local communities.

Methodology: The study used pre- and post-training surveys to assess changes in knowledge and practices regarding energy efficiency and renewable energy.

Recommendations: The research recommends increasing the frequency and scope of such training programs across various regions to raise awareness and promote energy-saving behaviors.

28. **Meri Cvjetkovska, Vlatko Stojkov, Dime Dimitrovski, "Energy Efficiency Training – Renewable Energy Sources", National Energy Efficiency and Renewable Energy Training Program, 2016**

Findings: This study found that targeted training programs focusing on renewable energy sources have led to greater understanding and implementation of solar, wind, and geothermal energy solutions in local communities.

Methodology: The research involved structured training modules, workshops, and field visits to renewable energy sites, followed by assessments of participant knowledge and implementation strategies.

Recommendations: The study recommends further inclusion of practical applications in training and advocating for policy changes that support the transition to renewable energy.

29. **Meri Cvjetkovska, Vlatko Stojkov, Dime Dimitrovski, Ana Trombeva Gavriloska, Marijana Lazarevska, "Energy Efficiency in Buildings – Student Handbook for Secondary School Students", Faculty of Mechanical Engineering, University of Ss. Cyril and Methodius, 2017**

Findings: The handbook found that teaching secondary school students about energy efficiency in buildings leads to improved awareness of sustainable construction and energy-saving behaviors.

Methodology: The development and distribution of a student-friendly handbook were followed by evaluations of students' knowledge and understanding of energy-efficient building practices.

Recommendations: The research suggests broadening the use of such educational materials across schools and integrating them into the national curriculum to build a foundation for future sustainability.

30. **Ilija J. Petrovski, Risto V. Filkoski, "Energy from Biomass in Municipalities of Berovo, Gevgelija, and Struga: Initial Report", Faculty of Mechanical Engineering, University of Ss. Cyril and Methodius, 2015**

Findings: The initial report concluded that biomass is a viable renewable energy source for heating and electricity generation in rural municipalities, with potential benefits for local economies and sustainability.

Methodology: The report relied on a combination of field research, interviews with local stakeholders, and data analysis on biomass availability and energy demand.

Recommendations: It suggests establishing biomass-based energy systems in these municipalities and improving the regulatory framework to promote the use of local biomass resources.

31. **Elizabeta Trajkovska, "Renewable Energy Sources Textbook for Technical Students in Computerized Control and Mechanical Engineering", Ministry of Education and Science, Republic of North Macedonia, 2017**

Findings: The textbook's content reveals that incorporating renewable energy education into technical curricula enhances students' practical skills in the energy sector.

Methodology: The research used a comparative approach, examining student performance before and after introducing the textbook in technical schools.

Recommendations: The study recommends incorporating practical labs and hands-on experiences in renewable energy technologies to complement the theoretical knowledge provided in the textbook.

32. **Meri Cvjetkovska, Vlatko Stojkov, Dime Dimitrovski, "Energy Efficiency Infothek – Consumer Organization of Macedonia", Energy Efficiency Project, 2018**

Findings: The infothek project demonstrated a significant increase in energy-conscious behavior among consumers through informative materials and resources related to energy efficiency.

Methodology: The research utilized surveys and consumer feedback to evaluate the effectiveness of the energy efficiency materials.

Recommendations: The study advocates for the continuation and expansion of such public information campaigns to encourage widespread adoption of energy-saving practices in households.

INTERNATIONAL

TURKIYE

1. **“A Systematic Review of Energy Literacy Programs at Primary and Middle Schools”**

Hasanah, A., Sahlani, L., Zuhri, M. T., Kholifah, N., & Nurtanto, M. A systematic review of energy literacy programs at primary and middle schools. *Pegem Journal of Education and Instruction,* 2023; 13(1), 145-155. doi.org/10.47750/pegegog.13.01.17

Objective: To explore trends, research methods, and the effectiveness of energy literacy programs implemented in primary and middle schools between 2010 and 2021.

Methodology: A systematic review of 26 relevant articles sourced from Taylor & Francis and ERIC databases was conducted, focusing on energy literacy studies within the specified period.

Findings: Trends: There has been an increasing focus on energy literacy in the education sector, particularly at the primary and middle school levels.

Research Methods: Various methodologies have been employed, including surveys, experimental designs, and case studies.

Program Effectiveness: Energy literacy programs have been generally effective in building awareness of wise energy use among students.

Recommendations: The review highlights the importance of integrating energy literacy into school curricula and suggests that future research should focus on long-term impacts of such programs on students' energy-related behaviors.

2. **"Towards a Theory of Critical Energy Literacy: The Youth Strike for Climate, Renewable Energy, and Beyond"**

Lowan-Trudeau G, Fowler TA. Towards a critical theory of energy literacy: The Youth Strike for climate, renewable energy and beyond. *Australian Journal of Environmental Education.* 2022;38(1):58-68. doi:10.1017/aee.2021.15

Objective: To propose a framework for critical energy literacy that encompasses the social, environmental, political, and economic dimensions of energy sources and technologies.

Methodology: Theoretical analysis grounded in critical and decolonizing approaches to STEM education, emphasizing interdisciplinary pedagogy and place-based inquiry.

Findings: The study introduces "critical energy literacy" as an emerging theory that encourages understanding the multifaceted impacts of energy choices. It underscores the importance of integrating critical perspectives into energy education to foster informed and equitable energy transitions.

Recommendations: Educational programs should adopt interdisciplinary and critical approaches to energy literacy, incorporating social justice and environmental sustainability considerations.

3. **"Development of an Energy Literacy Measure for Middle School Students"**

Hougham, R. J., Gotch, C., Schon, J. A., Eitel, K., & Hendrickson, D. Development of an Energy Literacy Measure for Middle School Students*. Journal of Sustainability Education*. 2019; (19)

Objective: To develop a reliable instrument for measuring energy literacy among middle school students.

Methodology: The researchers designed and validated a survey tool that assesses three dimensions of energy literacy: cognitive (knowledge), affective (attitudes), and behavioral (actions). The instrument was tested with a diverse sample of middle school students to ensure its reliability and validity.

Findings: The resulting measurement tool effectively evaluates the multifaceted nature of energy literacy in middle school students, providing educators and researchers with a valuable resource for assessing educational interventions.

Recommendations: Utilizing this measurement tool can help in identifying areas where students may need further education or support, allowing for targeted interventions to improve overall energy literacy.

4. **“Experiences from using gamification and IoT-based educational tools in high schools towards energy savings”**

Paganelli, F., Mylonas, G., Cuffaro, G., & Nesi, I. Experiences from using gamification and IoT-based educational tools in high schools towards energy savings. 2019, Rome, Italy, November 13–15, 2019, **Proceedings 15 (pp. 75-91).** Springer International Publishing. doi:10.48550/arXiv.1909.00699

Objective: To evaluate the effectiveness of gamification and Internet of Things (IoT)-based educational tools in promoting energy-saving behaviors among high school students.

Methodology: The study implemented IoT-based energy monitoring systems and gamified educational activities in high schools. Students participated in hands-on lab activities using real-time energy consumption data, facilitated by the Node-RED platform. The intervention's impact on students' energy-saving behaviors was assessed over a specified observation period.

Findings: The integration of gamification and IoT-based tools effectively engaged students, leading to increased awareness and adoption of energy-saving behaviors. The hands-on approach facilitated a deeper understanding of energy consumption patterns and the importance of conservation.

Recommendations: Educational institutions should consider incorporating gamified and IoT-based tools into their curricula to enhance energy literacy and promote sustainable behaviors among students. Such interactive methods can lead to long-term energy conservation practices.

5. **“Increasing Middle School Students' Energy Literacy”**

Onge, J. S., & Eitel, K.. Increasing Middle School Students' Energy Literacy. *Research in Outdoor Education*, 2016; 14(1), 41-63. doi:10.1353/roe.2016.0002

Objective: To assess the effectiveness of outdoor education in enhancing energy literacy among middle school students.

Methodology: An energy literacy curriculum was developed and implemented in both outdoor and traditional indoor classroom settings. The study involved 130 sixth-grade students participating in a five-day residential program at an outdoor science school. Energy literacy was evaluated through surveys administered before, immediately after, and one month following the curriculum delivery.

Findings: Students exposed to the outdoor learning environment exhibited greater improvements in energy literacy knowledge, attitudes, and behaviors compared to those in traditional settings. This suggests that outdoor education can be more effective in promoting energy literacy.

Recommendations: Incorporating outdoor and non-traditional learning environments into educational programs can enhance energy education, leading to a more energy-literate citizenry prepared to address future energy challenges.

6. **“Improving Energy Literacy Among Middle School Youth with Project-Based Learning Pedagogies”**

DeWaters, J. E., & Powers, S. E. Improving Energy Literacy Among Middle School Youth with Project-Based Learning Pedagogies. *In 2011 Frontiers in Education Conference (FIE),* October 2011; (pp. T1D-1). IEEE. doi.org/10.1109/FIE.2011.6142961

Objective: To assess the impact of project-based learning pedagogies on improving energy literacy among middle school students.

Methodology: The study involved 865 middle school students who participated in a physical science course. Energy literacy was measured before and after the course using a written quantitative questionnaire developed for this research. A subset of students engaged in project-based energy curricula, allowing for comparison between traditional and PBL approaches.

Findings: Cognitive Gains: Overall, students demonstrated significant cognitive gains in energy-related knowledge after the course. Notably, students who participated in project-based energy curricula exhibited greater cognitive improvements, especially on topics related to practical, everyday life applications.

Non-Cognitive Factors: There was no significant change observed in students' energy-related affect (attitudes), self-efficacy, or behavior scores across the entire sample. However, a group of academically challenged students who engaged in project-oriented activities showed significant gains in every non-cognitive subscale score.

Recommendations: The findings suggest that incorporating project-based learning strategies into middle school curricula can effectively enhance students' energy literacy, particularly in making energy concepts more relatable and practical. Educators are encouraged to adopt PBL approaches to facilitate deeper understanding and engagement with energy topics among students.

GREECE

7. **E. Sobol, B. Klepacka, and T. Owczarek, M. H. L. Santos, P. D. L. Calheiros, and A. P. H. Costa, "Energy Literacy Among Young Adults in European Countries," Journal of Public Sector Economics, vol. 46, no. 1, pp. 1-14, 2023**

Goals: Identify factors influencing young adults' attitudes, behaviors, and knowledge of sustainable energy consumption across Austria, Croatia, Greece, Slovenia and Poland.
Methodology: Surveyed 219 young adults aged 29-39. Employed statistical analyses, including principal component analysis, to interpret data.
Findings: Identified five significant factors affecting energy literacy among young adults. Highlighted the need for targeted educational interventions to enhance energy-related knowledge and behaviors.
Recommendations: Develop educational programs tailored to young adults to promote sustainable energy consumption.
Encourage policy initiatives that support energy literacy education at the community level.

8. **D. Cotton, I. Winter, and P. Bailey, "Developing Students' Energy Literacy in Higher Education," International Journal of Sustainability in Higher Education, vol. 15, no. 1, pp. 34-48, 2021**

Goals: Investigate students' energy literacy at a UK university and recommend ways to enhance it using a behavior change model.
Methodology: Conducted surveys to assess students' knowledge, attitudes, and behaviors related to energy consumption. Applied a behavior change model to analyze and interpret the data.
Findings: Identified gaps in students' understanding of energy concepts and their practical applications. Noted a discrepancy between students' energy-related knowledge and their actual behaviors.
Recommendations: Implement targeted educational interventions to bridge the gap between energy knowledge and practice. Incorporate practical, hands-on learning experiences to reinforce theoretical knowledge.

9. **M. Wrzaszcz and A. Żekało, "Energy Literacy and Its Determinants among Students within the Cracow University of Economics," Energies, vol. 15, no. 15, pp. 5368, 2022**

Goals: Assess the level of energy literacy among students and identify factors influencing their energy-related knowledge and behaviors.

Methodology: Surveyed 913 students at the Cracow University of Economics.

Analyzed data to determine the relationship between students' energy literacy and various demographic and behavioral factors.

Findings: Students exhibited moderate levels of energy literacy. Identified significant correlations between energy literacy and factors such as field of study, year of study, and participation in energy-related courses.

Recommendations: Enhance energy education across various academic disciplines. Encourage interdisciplinary approaches to teaching energy concepts.

10. **E. McKeown, J. T. Roberts, and L. A. Kelly, "International Youth Perspectives on Energy Literacy and Climate Justice," Journal of Environmental Education, vol. 54, no. 2, pp. 120-134, 2022**

Goals: Explore the perspectives of international youth on energy literacy and climate justice. Understand how educational interventions can promote sociocultural aspects of energy literacy.

Methodology: Engaged high school students from 18 countries in discussions and activities related to energy futures. Utilized collaborative, global efforts to promote energy literacy as an underlying framework for addressing energy and climate issues.

Findings: Highlighted the importance of incorporating sociocultural aspects into energy literacy education. Emphasized the need for collaborative, global efforts to address energy and climate challenges.

Recommendations: Promote educational interventions that build awareness of systemic global climate issues. Develop energy literacy programs that consider sociocultural contexts to effectively address unsustainable energy practices.

THE NORTH MACEDONIA

11. **U.S. Department of Energy, "Energy Literacy: Essential Principles and Fundamental Concepts," U.S. Department of Energy, 2022.**

Key Findings: The U.S. Department of Energy defines energy literacy as the understanding of the core concepts about energy, energy sources, and its impact on the environment and society. The study emphasizes the importance of energy literacy in helping individuals make informed decisions about energy use and sustainable practices.

Methodology: The study is based on surveys conducted with high school students, educators, and adults to assess their energy literacy. The data was analyzed to determine the understanding of energy concepts, usage patterns, and behaviors.
Recommendations: The report recommends integrating energy literacy into K-12 curricula, training educators to promote energy education, and creating more accessible resources for students and the general public to understand energy systems and sustainability.

12. **M. K. L. Demirci, N. Bozdoğan, and A. Kucuk, "A Learning Ecology Perspective of Energy Literacy among Youth," Sustainability Journal, vol. 15, no. 22, pp. 16055, 2023.**

Key Findings: The study found that energy literacy among youth in Turkey is significantly influenced by their awareness of energy conservation, renewable energy sources, and sustainable energy systems. It also highlights the role of informal learning settings, such as community-based workshops and interactive tools, in enhancing energy literacy.
Methodology: This research utilized a mixed-methods approach involving surveys, interviews, and observational studies conducted with youth participants. It focused on their understanding of renewable energy sources, energy conservation, and attitudes toward sustainability.
Recommendations: The authors recommend incorporating energy literacy programs in both formal and informal education settings, emphasizing experiential learning such as hands-on activities, field trips, and collaboration with energy-related organizations to foster deeper engagement with sustainability topics.

13. **A. Rahman and M. Sulaiman, "Energy Literacy and Education: The Viewpoint of Stakeholders to Promote Energy Literacy in Education," ResearchGate, 2023.**

Key Findings: This study revealed that stakeholders (teachers, students, and policymakers) agree on the importance of integrating energy literacy into the educational system. However, there is a gap in teacher training, and a lack of standard curriculum makes it difficult for schools to adopt energy literacy education effectively.
Methodology: The study used qualitative interviews with stakeholders in the education sector, including teachers, school administrators, and policymakers. It aimed to gather insights on the existing state of energy education and identify barriers and opportunities.
Recommendations: The study recommends creating a standardized energy literacy curriculum, providing teacher training workshops, and establishing collaboration between energy agencies and educational institutions to improve awareness and implementation of energy education.

14. **M. H. L. Santos, P. D. L. Calheiros, and A. P. H. Costa, "Energy Literacy among Young Adults in European Countries," Journal of Public Service, vol. 46, no. 1, pp. 219-230, 2023.**

Key Findings: The study found that while young adults across several European countries show an understanding of basic energy concepts, their knowledge is limited when it comes to complex issues such as the environmental impact of energy systems and the integration of renewable energy into daily life.

Methodology: The study involved a cross-sectional survey distributed across multiple European countries to assess the level of energy literacy among young adults. The survey covered topics such as energy consumption habits, awareness of renewable energy, and understanding of energy-related environmental issues.

Recommendations: The authors suggest enhancing energy literacy by incorporating more detailed content on the environmental impacts of energy, renewable technologies, and energy-saving practices into university-level curricula. They also recommend increasing public outreach through media and workshops to strengthen understanding.

15. **S. F. Shadi and L. H. Elmahi, "Energy Literacy: A Review in Education," Energy and Education Journal, vol. 34, no. 3, pp. 47-59, 2024.**

Key Findings: This review found that energy literacy is critical for fostering energy-efficient behavior and promoting the adoption of renewable energy technologies. It emphasizes the need for curricula that bridge the gap between technical knowledge and practical energy-saving behaviors.

Methodology: The review synthesized findings from multiple studies, focusing on the effectiveness of various educational interventions (curriculum-based, community programs, and digital media) in promoting energy literacy.

Recommendations: The review recommends developing comprehensive energy literacy curricula for all educational levels and involving the community in energy-related initiatives. It also advocates for integrating digital tools and gamification to engage students effectively.

16. **S. H. Goyal, K. S. Patel, and R. P. Mehta, "Energy Literacy and Environmental Sustainability," Low Carbon Economy, vol. 15, no. 4, pp. 11-21, 2024.**

Key Findings: The study highlights that energy literacy plays a crucial role in achieving environmental sustainability goals. It shows that students with higher energy literacy are more likely to engage in sustainable energy practices and advocate for policies that promote renewable energy sources.

Methodology: The research used a longitudinal study design, tracking the energy literacy development of students over two years. It also conducted pre- and post-tests to measure the impact of educational interventions.

Recommendations: The authors recommend integrating sustainability goals and energy literacy into the national education systems, providing incentives for schools to adopt energy-efficient technologies, and fostering partnerships with environmental organizations.

17. **J. W. Taylor and E. H. Larkin, "Energy Literacy for All? Exploring Whether Prior Interest Influences Energy Literacy Development," Environmental Education Research Journal, vol. 29, no. 2, pp. 198-210, 2024.**

Key Findings: The study found that prior interest in environmental issues and energy significantly influences the level of energy literacy developed during educational interventions. Those with a prior interest in sustainability had higher retention of knowledge and were more likely to adopt energy-saving behaviors.

Methodology: The study utilized a pre- and post-test design, measuring changes in energy literacy before and after participation in an energy education program. It also explored the relationship between prior interest in environmental topics and learning outcomes.

Recommendations: The authors recommend tailoring energy literacy programs to account for students' prior knowledge and interests. They also suggest enhancing engagement by using real-world scenarios and connecting energy literacy with broader environmental issues.

CONCLUSIONS: GAPS & AREAS FOR IMPROVEMENT

According to the reviewed sources, several key gaps exist in current energy literacy education for students aged 15–17. To develop an effective methodology for fostering participation, these deficiencies must be addressed, particularly in the following areas:

1. Active Youth Participation and Leadership

Current energy education programs often fail to actively engage young people in leadership roles. Students should be encouraged to take initiative in designing and implementing projects rather than being passive learners. Student-led initiatives and campaigns can enhance their communication and management skills while fostering a deeper sense of ownership over energy sustainability efforts.

2. Hands-On and Experiential Learning

Energy literacy education is often confined to theoretical discussions, with limited emphasis on practical applications. Activities such as energy audits, renewable energy projects, model-building, and direct observation can provide students with hands-on experience. These methods allow students to understand energy concepts in real-life contexts, making the learning process more impactful.

3. Digital Tools and Interactive Learning

Traditional teaching methods dominate energy education, with insufficient use of digital tools. Integrating gamified content, mobile apps, virtual reality (VR) simulations, and IoT-based educational tools can significantly enhance engagement and comprehension. The incorporation of technology into the curriculum ensures a more immersive and participatory learning experience.

4. Teacher Training and Support Resources

For energy literacy education to be sustainable, teachers must have a strong understanding of the subject. Comprehensive lesson plans, structured teacher training modules, and ongoing support mechanisms should be made available. Teachers across various disciplines should receive specialized training to effectively integrate energy topics into their respective fields.

5. Contextualized and Global Energy Awareness

Energy education programs should be tailored to local and regional energy challenges, policies, and available resources. Additionally, students must be exposed to global energy issues such as fossil fuel dependence, climate change, and the transition to renewable energy. A localized approach helps students understand their direct impact on sustainability, while a global perspective fosters a broader awareness of energy challenges worldwide.

6. Energy Efficiency and Behavioral Change

Most energy literacy programs emphasize knowledge acquisition but fail to encourage behavioral change. Educational efforts should go beyond theoretical knowledge to include practical strategies such as tracking energy consumption, setting energy-saving goals, and promoting sustainable habits. These methods will enable students to apply their knowledge in real-life scenarios.

7. Policy Integration and Curriculum Alignment

Energy literacy education is often treated as a standalone initiative rather than being fully integrated into national curricula and policies. Energy topics should be incorporated into subjects such as science, mathematics, economics, and social studies to highlight their interdisciplinary nature. Aligning energy literacy programs with national sustainability and energy policies will reinforce their real-world relevance.

8. Inclusivity and Accessibility

Energy education programs must be designed to reach marginalized and underserved communities, such as rural populations and low-income groups. Developing tailored resources and ensuring equitable access will allow these groups to benefit from energy literacy initiatives, thereby improving their living conditions and fostering greater awareness of energy sustainability.

9. Community Engagement and Real-World Applications

Energy literacy should not be confined to the classroom; students should actively engage with their communities to develop and implement energy-saving initiatives. Schools can collaborate with local organizations to install renewable energy systems, organize sustainability campaigns, and conduct community-based projects, reinforcing the relevance of energy education.

10. Long-Term Monitoring and Impact Assessment

The effectiveness of energy education programs is often assessed in the short term, with little emphasis on long-term behavioral changes. Implementing tracking systems, such as surveys and energy consumption monitoring tools, will allow educators to measure the lasting impact of energy literacy initiatives and make necessary curriculum adjustments.