

Climate Change e-Learning Bibliography 2019-2021*

v1.0

The researcher will find no shortage of articles on Climate Change and related topics, nor any lack of material on the strengths and pitfalls of e-learning. What proves more elusive is description and analysis of the comparative effectiveness of conventional and of the various forms of e-learning in the communication of these ideas and in the field of climate change denial.

This overview of the literature suggests that in higher education, the interdisciplinarity of Climate Change, embracing for instance engineering, biological and environmental sciences, politics, and psychology makes e-learning a tool which is potentially of particular value irrespective of the legacy of the pandemic - there is an urgent need to report and share experience on devising and delivering effective curricula.

Outside academia, Climate Change has created a storm of fake news requiring vigorous counter-attack. Solutions might involve adjusting the way information is delivered – quantity delivered per session, tone (the topic is potentially so alarming as to risk disengagement), graphic style (Cartoons? Posters? Animation?) - in other words adopting the same tools as the climate deniers) – the science establishment needs to approach this in a serious way maybe working with young people to tailor an effective e-response; however, very little investigation and analysis of what works has been undertaken (though see for instance ‘How to Fight Fake Climate Science on YouTube’ <https://therevelator.org/climate-science-youtube/>).

It will be crucial to offer effective climate literacy skills, for which many practical generic sources are available eg from Media Smart Ireland <https://www.bemediasmart.ie/tips> or from Indiana University East in the US <https://iue.libguides.com/fakenews>. At a more conceptual level, this paper from the UK’s JISC is relevant <https://www.jisc.ac.uk/guides/developing-digital-literacies/curriculum-change>

As Hannah Arendt observed (in her ‘Crises of the Republic’, 1972, p.6):

Lies are often much more plausible, more appealing to reason, than reality, since the liar has the great advantage of knowing beforehand what the audience wishes or expects to hear. He has prepared his story for public consumption with a careful eye to making it credible, whereas reality has the disconcerting habit of confronting us with the unexpected, for which we were not prepared.

The references which follow are, we believe, a fairly full listing of what has been published over the last three years. It is followed by a more eclectic selection of some of the more

recent exemplars of e-learning materials in this field. They are arranged under the headings Fake News; Higher Education; Mobile Technologies and Social Media and Gaming; MOOCs; Schools; Technical Training.

Fake news and disinformation

Cook, John. 'Understanding and Countering Misinformation About Climate Change'. In *Handbook of Research on Deception, Fake News, and Misinformation Online*, 2019. <https://www.igi-global.com/gateway/chapter/230759>.

Explains the problem and suggests solutions, but does not address using e-learning
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Johnston, Julie D. 'Climate Change Literacy to Combat Climate Change and Its Impacts'. In *Climate Action*, edited by Walter Leal Filho, Anabela Marisa Azul, Luciana Brandli, Pinar Gökcin Özuyar, and Tony Wall, 200–212. Encyclopedia of the UN Sustainable Development Goals. Cham: Springer International Publishing, 2020. https://doi.org/10.1007/978-3-319-95885-9_31.

PAYWALL

Treen, Kathie M. d'I., Hywel T. P. Williams, and Saffron J. O'Neill. 'Online Misinformation about Climate Change'. *WIREs Climate Change* 11, no. 5 (September 2020). <https://doi.org/10.1002/wcc.665>.

Based on a literature review in May 2019, paper points to a sparsity of literature at the intersection of the three topics climate change/misinformation/online "or" social media. Contains some pointers to how to address the problem, though not specifically through e-learning.

Ranney, Michael Andrew, and Leela Velautham. 'Climate Change Cognition and Education: Given No Silver Bullet for Denial, Diverse Information-Hunks Increase Global Warming Acceptance'. *Current Opinion in Behavioral Sciences* 42 (December 2021): 139–46. <https://doi.org/10.1016/j.cobeha.2021.08.001>.

Addresses the particular problems communication given the interdisciplinary and societally threatening nature of the topic, in schools, youth work, and the general population

Reed, Katherine, Sara Shipley Hiles, and Peter Tipton. 'Sense and Nonsense: Teaching Journalism and Science Students to Be Advocates for Science and Information Literacy'. *Journalism & Mass Communication Educator* 74, no. 2 (June 2019): 212–26. <https://doi.org/10.1177/1077695819834415>.

innovative new course designed to teach a mixed group of journalism and science, technology, engineering and mathematics (STEM) majors to evaluate expertise and bias, examine data and misrepresentation, and develop evidence-based communication on complex scientific topics.

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Yuan, Shupej, and Hang Lu. "'It's Global Warming, Stupid": Aggressive Communication Styles and Political Ideology in Science Blog Debates About Climate Change'. *Journalism & Mass Communication Quarterly* 97, no. 4 (December 2020): 1003–25. <https://doi.org/10.1177/1077699020904791>.

effects of aggressive communication styles in the climate change context, focusing particularly on how individuals react to science blogs ... we explore two plausible theory-driven explanations—violation of expectation and psychological reactance—for the effects of aggressive styles. Goal of this study is to explore effects of this nonneutral communication style to help communicators, including science bloggers, determine how to maximize desired impacts and prevent unintended consequences of their messages

Higher Education

Dzambo, Andrew M., Margaret Mooney, Zachary J. Handlos, Scott Lindstrom, Yun Hang, and Steve A. Ackerman. 'An Interactive Online Course in Climate and Climate Change: Advancing Climate Literacy for Non-Atmospheric Science Majors'. *Bulletin of the American Meteorological Society* 101, no. 10 (1 October 2020): E1697–1708.

<https://doi.org/10.1175/BAMS-D-19-0271.1>.

Students... learn the physical principles governing Earth's climate and climate change within the broader context of societal impacts and global political considerations... We present a template for implementation in other Earth science or atmospheric science curricula, which includes discussion forum, quiz, and worksheet examples from this course.

Hennig, S. 'Benefits and Challenges of ELearning in Central Asia'. *Geoinformatics International* 15, no. 4 (2019): 43–51.

https://www.researchgate.net/publication/336346351_Benefits_and_Challenges_of_eLearning_in_Central_Asia

Recommendations to increase the use of eLearning [in HE] in these countries range from awareness-raising on the wide range of web-based tools available for this, to foster further education of teachers regarding the use of eLearning (concepts, tools, s and materials), to focus on local topics to motivate self-study, and to pay attention to required computer resources and Internet connectivity

Jeong, Jin Su, David González-Gómez, and Florentina Cañada-Cañada. 'Prioritizing Elements of Science Education for Sustainable Development with the MCDA-FDEMATEL Method Using the Flipped E-Learning Scheme'. *Sustainability* 11, no. 11 (31 May 2019): 3079. <https://doi.org/10.3390/su11113079>.

Kapenieks, Janis, and Janis Kapenieks. 'Spaced E-Learning for Sustainable Education'. *Journal of Teacher Education for Sustainability* 22, no. 2 (1 December 2020): 49–65.

<https://doi.org/10.2478/jtes-2020-0016>.

In the spaced e-learning method, the course content includes few-minute pauses between repetitions, during which students let their brain rest with different content and then return to the course.

Chai-Arayalert, Supaporn, and Supattra Puttinaovarat. 'Designing Mangrove Ecology Self-Learning Application Based on a Micro-Learning Approach'. *International Journal of Emerging Technologies in Learning (IJET)* 15, no. 11 (12 June 2020): 29.

<https://doi.org/10.3991/ijet.v15i11.12585>.

basic requirements for designing a mangrove ecology self-learning application based on a micro-learning approach. The following section describes the design process and the system design

Lozano, Rodrigo, and Maria Barreiro-Gen. 'Analysing the Factors Affecting the Incorporation of Sustainable Development into European Higher Education Institutions' Curricula'. *Sustainable Development* 27, no. 5 (September 2019): 965–75.

<https://doi.org/10.1002/sd.1987>.

analyses showed (a) teaching in European courses covers many issues of sustainability in a fairly good balance, with the exception of social issues; (b) there are correlations between the economic, environmental, social, and cross-cutting themes; (c) females tend to teach SD in a more balanced way (d) the HEIs types have no influence on how SD is being taught, but education level has; and (e) some countries eg Italy and Spain, may show more interest, yet average results tended to be lower than eg Sweden, UK, Netherlands.
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Oliveira, Leandro, Pedro Pimenta, and Eduardo Luís Cardoso. 'Development of Climate Change Online Modules to Improve Environmental Engineering Curriculum of Jordanian and Syrian Universities'. In *Trends and Applications in Information Systems and Technologies*, edited by Álvaro Rocha, Hojjat Adeli, Gintautas Dzemyda, Fernando Moreira, and Ana Maria Ramalho Correia, 1367:52–59. *Advances in Intelligent Systems and Computing*. Cham: Springer International Publishing, 2021.

https://doi.org/10.1007/978-3-030-72660-7_6.

describes the process of developing online modules under the EGREEN Project to reinforce/insert themes related to climate change in the environmental engineering courses at Jordanian and Syrian universities
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Perbandt, Daniela, Marie-Sophie Heinelt, Paula Bacelar-Nicolau, Mahsa Mapar, and Sandra Sofia Caeiro. 'Towards Effective E-Learning on Sustainability: A Case Study-Course on Participatory Processes in Environmental Politics'. *International Journal of Sustainability in Higher Education* 22, no. 4 (2 July 2021): 801–32.

<https://doi.org/10.1108/IJSHE-07-2020-0262>.

...to evaluate the effectiveness of several e-learning tools on students' knowledge and skills growth and to compare two learning paths, synchronous vs asynchronous, exploring how each affects the level of students' knowledge achievement and skills acquisition.

Posluszny, Monica, Geon Soo Park, Irimi Spyridakis, Sarina Katznelson, and Sam O'Brien. 'Promoting Sustainability through Virtual Reality: A Case Study of Climate Change Understanding with College Students'. In *2020 IEEE Global Humanitarian Technology Conference (GHTC)*, 1–8. Seattle, WA, USA: IEEE, 2020.

<https://doi.org/10.1109/GHTC46280.2020.9342907>.

We used information from the literature and from participants concerning what they believed would impact their thinking regarding climate change and incorporated those perspectives into our VR prototype. We sought to demonstrate the value of incorporating user feedback into the design of a VR experience. Throughout the process, we addressed many of the United Nations' Sustainable Development Goals,
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Salili, Diana Hinge, and Linda Flora Vaike. 'Climate Change, Disaster Risk Management and the Role of Education: Benefits and Challenges of Online Learning for Pacific Small Island Developing States'. In *Climate Change and the Role of Education*, edited by Walter Leal Filho and Sarah L. Hemstock, 189–99. *Climate Change Management*. Cham: Springer International Publishing, 2019. https://doi.org/10.1007/978-3-030-32898-6_11.

Describes University of the South Pacific fully online post graduate diploma in climate change program
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Samek, Jay, David Skole, Rony Teguh, Hendrik Segah, and Siti Maimunah. 'Geography, E-Learning and a Course in Peatland Ecosystems and Climate Change Science': In *Proceedings of the International Conference on Creative Economics, Tourism and Information Management*, 91–97. Yogyakarta, Indonesia: SCITEPRESS - Science and Technology Publications, 2019. <https://doi.org/10.5220/0009865300910097>.

we explore the impacts of geographic location, advances in ICT, the use of Bahasa Indonesia (as opposed to English), and Indonesian scholarship in an e-learning course

Senevirathne, Malith, H.A.C. Priyankara, Dilanthi Amaratunga, Richard Haigh, Nandasiri Weerasinghe, Champa Nawaratne, and Arturas Kaklauskas. 'A Capacity Needs Assessment to Integrate MOOC-Based Climate Change Education with the Higher Education Institutions in Europe and Developing Countries in Asia: Findings of the Focused Group Survey in PCHEI under the BECK Project'. *International Journal of Disaster Resilience in the Built Environment* ahead-of-print, no. ahead-of-print (1 January 2021). <https://doi.org/10.1108/IJDRBE-07-2020-0074>.

PAYWALL

Thürkow, Detlef, Anne-Kathrin Lindau, Gerd Schmidt, Patrick Illiger, Christopher Krause, Henning Gerstmann, and Alina Schürmann. 'Using Interactive Story Maps Enriched by Direct Knowledge Queries for the Development of E-Learning Modules on Climate Change'. *KN - Journal of Cartography and Geographic Information* 69, no. 3 (September 2019): 195–204. <https://doi.org/10.1007/s42489-019-00024-0>.

e-learning platforms introduced in this paper, therefore, focus on sensitizing different educational and agricultural stakeholder to the regional and local impacts of climate change and necessary adaptation strategies. The aim is to combine the possibilities of conventional classroom learning with web-based learning units

PAYWALL

Mobile Technologies, Social Media, & Gaming

Aydoğan, Elif, Ali Derya Atik, Ergin Şafak Dikmen, and Figen Erkoç. 'Development and Usability Testing of an Educational Mobile Learning App for Climate Change and Health Impacts'. *Turkish Journal of Biochemistry* 0, no. 0 (10 March 2021): 20200350. <https://doi.org/10.1515/tjb-2020-0350>.

Chai-Arayalert, Supaporn, and Supattra Puttinaovarat. 'Designing Mangrove Ecology Self-Learning Application Based on a Micro-Learning Approach'. *International Journal of Emerging Technologies in Learning (IJET)* 15, no. 11 (12 June 2020): 29. <https://doi.org/10.3991/ijet.v15i11.12585>.

integrates the advantages of mobile-based learning and the benefits of micro-learning into the virtual learning of mangrove ecology. The system was designed based on a case study in the Leeled mangrove forest, Thailand and encourages young learners to understand the value of mangrove forests

Menezes Neto, Elias Jacob de, Djackson Garcia de Lima, Ivanilda Soares Feitosa, Sávio Marcelino Gomes, and Michelle Cristine Medeiros Jacob. 'Plant Identification Using Artificial Intelligence: Innovative Strategies for Teaching Food Biodiversity'. In *Local Food Plants of Brazil*, edited by Michelle Cristine Medeiros Jacob and Ulysses Paulino

Albuquerque, 379–93. *Ethnobiology*. Cham: Springer International Publishing, 2021.
https://doi.org/10.1007/978-3-030-69139-4_19.

narrative summary of main ideas in our web-based app, including its elaboration, and show how widely used CNN - convolutional neural networks - architectures, namely, ResNet and VGG, performed when identifying food plants in our dataset. Finally, we discuss the educational implications of innovative methods in biodiversity conservation and provide all code and datasets

Narula, Sumit, Swapnil Rai, and Archana Sharma, eds. *Environmental Awareness and the Role of Social Media: Advances in Environmental Engineering and Green Technologies*. IGI Global, 2019. <https://doi.org/10.4018/978-1-5225-5291-8>.

Chapter from 'Importance of Social Media to Create Environmental Awareness in Sustainable Higher Education System'; other chapters include: Social media for disaster awareness; Role of social media on environmental awareness; Study of consumers' attitudes towards marketing of environmentally friendly products

PAYWALL

Ouariachi, Tania, Maria D Olvera-Lobo, and Jose Gutierrez-Pewrez. 'Gaming Education: the sustainiLearning about Climate Change through Digital Game-Based Teaching'. In *Education for Democracy 2.0: Changing Frames of Media Literacy*, edited by Michael Hoechsmann, Gina Thesee, and Paul R Carr. BRILL, 2021.
<https://doi.org/10.1163/9789004448490>.

climate change skepticism and denial forces us to consider a more effective strategy...educators should embrace digital media literacy to inspire independent thinking with the goal of participating in meaningful ways to a society with a changing climate. Taking into consideration that young people are constantly exposed to digital games, there is an urgent need to explore this type of media

PAYWALL

Poole, Robert, and Sydney Spangler. "'Eco This and Recycle That": An Ecolinguistic Analysis of a Popular Digital Simulation Game'. *Critical Discourse Studies* 17, no. 3 (26 May 2020): 344–57. <https://doi.org/10.1080/17405904.2019.1617177>.

analysis of a popular digital simulation game, *Animal Crossing: New Leaf* (2012). Argues that the promotion of sustainable ecological action is undermined by some of the assumptions at the heart of the game.

PAYWALL

Rousell, David, Thilinka Wijesinghe, Amy Cutter-Mackenzie-Knowles, and Maia Osborn. 'Digital Media, Political Affect, and a Youth to Come: Rethinking Climate Change Education through Deleuzian Dramatisation'. *Educational Review*, 10 September 2021, 1–21.
<https://doi.org/10.1080/00131911.2021.1965959>.

theorises how young people are using digital platforms to perform climate activism and construct new political subjectivities through affective investments. We develop these ideas by describing the process of co-developing a climate change education App with young people

PAYWALL

Salas-Rueda, Ricardo-Adán, Gustavo De-La-Cruz-Martínez, Clara Alvarado-Zamorano, and Estefanía Prieto-Larios. 'Innovation in the Teaching-Learning Process of Global Climate Change through the Collaborative Wall'. *LUMAT: International Journal on Math, Science and Technology Education* 9, no. 1 (3 May 2021).
<https://doi.org/10.31129/LUMAT.9.1.1471>.

analyzes students' perception about use of the collaborative wall in the educational process of global climate change considering data science. The collaborative wall is a web application that allows active participation of students and discussion of ideas in the classroom. During the face-to-face sessions, the students use mobile devices to share the information and images of the courses

Sknavis, Constantina, Aristeia Kounani, Athanasios Koukoulis, Georgios Maripas-Polymeris, Konstantinos Tsamopoulos, and Stavros Valkanas. 'Climate Change Communication: A Friendly for Users App'. In *Addressing the Challenges in Communicating Climate Change Across Various Audiences*, edited by Walter Leal Filho, Bettina Lackner, and Henry McGhie, 263–79. Climate Change Management. Cham: Springer International Publishing, 2019. https://doi.org/10.1007/978-3-319-98294-6_17.

research concerns the establishment of an environmentally oriented application for mobile phones, focused on climate change

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Ouariachi, Tania, María Dolores Olvera-Lobo, José Gutiérrez-Pérez, and Edward Maibach. 'A Framework for Climate Change Engagement through Video Games'. *Environmental Education Research* 25, no. 5 (4 May 2019): 701–16.

<https://doi.org/10.1080/13504622.2018.1545156>.

objective of the present article is to propose a set of game attributes that could maximise the cognitive, emotional, and behavioural engagement of players, and lay the foundations for future work

PAYWALL

MOOCs

Ferrari-Lagos, Enzo, Fernando Martínez-Abad, and Camilo Ruíz. 'The Importance of Motivation and Communication in MOOCs as Elements to Increase Completion Rates: A Study at MOOCs on Climate Change'. In *Eighth International Conference on Technological Ecosystems for Enhancing Multiculturality*, 1042–47. Salamanca Spain: ACM, 2020.

<https://doi.org/10.1145/3434780.3436633>.

Investigates how completion rates of MOOCs on climate change can be improved among primary and secondary teachers

PAYWALL

Hueske, Anne-Karen, Caroline Aggestam Pontoppidan, and Lavinia-Cristina Iosif-Lazar. 'Sustainable Development in Higher Education in Nordic Countries: Exploring E-Learning Mechanisms and SDG Coverage in MOOCs'. *International Journal of Sustainability in Higher Education* ahead-of-print, no. ahead-of-print (10 September 2021).

<https://doi.org/10.1108/IJSHE-07-2020-0276>.

study's results suggest that to avoid overlaps and fill gaps in Education for Sustainable Development, the offer of open online courses should be orchestrated. Furthermore, HEIs can use our method to analyze their E-Learning courses related to SDGs. This study shows how business schools, especially Nordic UN PRME (Principles for Sustainable Management Education) members, contribute to the SDGs by their MOOC coverage.

PAYWALL

Meinert, Edward, Abrar Alturkistani, Kris A Murray, Philippe Sabatier, and Josip Car. 'A case study examining the cost measurements in production and delivery of a Massive Open Online Course (MOOC) for teaching the relationship between human health and climate change'. In *Proceedings of the International Conference on E-Learning 2019*, 211–18. IADIS Press, 2019. https://doi.org/10.33965/el2019_201909F027.

understanding the costs associated with their production and delivery will provide evidence to develop sustainable models for deployment of this form of citizen engagement education.

BOOK

Otto, Daniel, Sandra Caeiro, Paula Nicolau, Antje Disterheft, António Teixeira, Sara Becker, Alexander Bollmann, and Kirsten Sander. 'Can MOOCs Empower People to Critically Think about Climate Change? A Learning Outcome Based Comparison of Two MOOCs'. *Journal of Cleaner Production* 222 (June 2019): 12–21.

<https://doi.org/10.1016/j.jclepro.2019.02.190>.

PAYWALL

Stevens, Carly J., Rebecca Whittle, William J. Davies, and Jane E. Taylor. 'Raising Awareness about Food Security Using a Massive Open Online Course'. *PLANTS, PEOPLE, PLANET* 2, no. 2 (March 2020): 140–43. <https://doi.org/10.1002/ppp3.10069>.

we organized an 8-week massive open online course (MOOC) on the e-learning platform FutureLearn. We show that online courses have the potential to broaden and facilitate conversations to help develop new forms of understanding of food security.

Schools

Chang, Chew-Hung, and Gillian Kidman. 'Encouraging Preparedness in Geographical and Environmental Education for a Post-Pandemic Future'. *International Research in Geographical and Environmental Education* 29, no. 4 (1 October 2020): 279–82.

<https://doi.org/10.1080/10382046.2020.1831204>.

Editorial. Issue includes: Game-based e-Learning for urban tourism education through an online scenario game; Inclusion of GIS in student teacher training and its significance in higher education in southern African countries

PAYWALL, except for editorial

Dannwolf, Lisa, Tobias Matusch, Johannes Keller, Ronja Redlich, and Alexander Siegmund. 'Bringing Earth Observation to Classrooms—The Importance of Out-of-School Learning Places and E-Learning'. *Remote Sensing* 12, no. 19 (23 September 2020): 3117.

<https://doi.org/10.3390/rs12193117>.

basis for this study is a Geo:spektiv module about the endangered rainforest, established at an out-of-school learning place and designed for students in secondary education

Earthday. 'Global NDCs Get Failing Grade On Climate Literacy Ambitions and Gender Education Commitments'. Accessed 28 September 2021. <https://www.earthday.org/ndc-tracking-on-literacy-and-gender/>.

Analysis of each country's Nationally Determined Contributions (NDCs) for the prevalence and depth of inclusion of climate literacy and gender equality,... every school in the world must have with a strong civic engagement component... and gender equality also embedded

How, Vivien, Ezza Sabrina Binti Azmi, Nur Fariyah Binti Mohd Zaki, and Khairuddin Bin Othman. 'Integrating Flood Education Miniature and Interactive E-Learning in a Prototype of Flood Learning Kit for Knowledge Resilience among School Children'. In *Interdisciplinary Approach for Disaster Resilience and Sustainability*, edited by Indrajit Pal, Jason Van Meding, Sangam Shrestha, Iftekhar Ahmed, and Theyaparan Gajendran. Springer, 2019.

Study of the practicality of a blended learning model of disaster precaution awareness for Malaysian schoolchildren

BOOK

Minan, Muhammad, Sulisty Saputro*, Sentot Budi, and Suranto Suranto. 'Student's Critical Thinking Skills Through Discovery Learning Model Using E-Learning on Environmental Change Subject Matter'. *European Journal of Educational Research* 10, no. 3 (15 July 2021): 1123–35. <https://doi.org/10.12973/eu-jer.10.3.1123>.

In junior high school

Mulero, Lorena, Maria Dolors Grau, and Imma Torra. 'The forest and climate change: example of application in open science schooling', Paper from 11th International Conference on Education and New Learning Technologies. Palma, Spain, 2019.

<https://upcommons.upc.edu/bitstream/handle/2117/178059/Edulearn357.pdf;jsessionid=F C8BEBAC295CBC4689F0FEC8DBB71956?sequence=1>

A virtual platform... makes students the centre of the project . Provides facilities for measuring and controlling energy consumption in the Secondary School...e and at home ... use of techniques of "social Gamification" and e-learning as a tool encourage participation in the project.

Mustari, M., A. L. Hoya, M. Akmansyah, R. Diani, and A. Asyhari. 'Development of E-Learning Based Blogs on Global Warming Subject'. *Journal of Physics: Conference Series* 1155 (February 2019): 012036. <https://doi.org/10.1088/1742-6596/1155/1/012036>.

Study of Indonesian senior high school students' responses

Nadhifah, Azuminatun, and Mukhayyarotin Niswati Rodliyatul Jauhariyah. 'The Use of The Quizizz Application in The Scientific Literacy Assessment of High School Students On Global Warming Material'. *Jurnal Ilmiah Pendidikan Fisika* 5, no. 2 (30 June 2021): 162.

<https://doi.org/10.20527/jipf.v5i2.3309>.

Describes feasibility of the scientific literacy assessment instrument, describes the high school students' scientific literacy profile on global warming material, and examines the instrument's practicality.

Occhioni, Michelina. 'Techland: New Educational Paths Focused on Energy Resources and Sustainability Using Virtual Worlds'. In *Handbook of Research on Teaching With Virtual Environments and AI*, 316–40. Advances in Educational Technologies and Instructional Design. IGI Global, 2021. <https://doi.org/10.4018/978-1-7998-7638-0>.

Techland has made a slow transition from a general STEM (science, technology, engineering, mathematics) world to a more specific and contextualized environment, with the aim to apply scientific concepts to the challenge that society has to face today: climate change, exploitation of raw materials, pollution/remediation, green energy – using virtual worlds for storytelling (machinima videos) gamification etc

Petersen, Gustav B., Sara Klingenberg, Richard E. Mayer, and Guido Makransky. 'The Virtual Field Trip: Investigating How to Optimize Immersive Virtual Learning in Climate Change Education'. *British Journal of Educational Technology* 51, no. 6 (November 2020): 2099–2115. <https://doi.org/10.1111/bjet.12991>.

Immersive Virtual Reality (IVR) is being used for educational virtual field trips (VFTs) involving scenarios that may be too difficult, dangerous or expensive to experience in real life, in this case a virtual visit to Greenland
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Salas-Rueda, Ricardo-Adán, Gustavo De-La-Cruz-Martínez, Clara Alvarado-Zamorano, and Estefanía Prieto-Larios. 'Innovation in the Teaching-Learning Process of Global Climate Change through the Collaborative Wall'. *LUMAT: International Journal on Math, Science and Technology Education* 9, no. 1 (3 May 2021). <https://doi.org/10.31129/LUMAT.9.1.1471>.

experience from biology teaching in a Mexican secondary school

Smith, Glenn Gordon, Metin Besalti, Molly Nation, Allan Feldman, and Katie Laux. 'Teaching Climate Change Science to High School Students Using Computer Games in an Intermedia Narrative'. *EURASIA Journal of Mathematics, Science and Technology Education* 15, no. 6 (1 February 2019). <https://doi.org/10.29333/ejmste/103570>.

Study from South-Eastern USA

In this article, three members reflect on how the network is helping advance sustainable development and preparing the region's youth to be sustainability change agents who take equity and justice seriously. The article features a case study of a recent network project, the UNITAR Youth and the Sustainable Development Goals e-learning course, developed by students from eight Atlanta HEIs to provide SDG training for youth from around the world

Technical Training

Diego, Lara de, María Luisa Marco, and Mirian Bravo. 'Capacity Building Itinerary on Sustainable Energy Solutions for Islands and Territories at Risk for the Effects of Climate Change'. In *Climate Change and the Role of Education*, edited by Walter Leal Filho and Sarah L. Hemstock, 237–53. Climate Change Management. Cham: Springer International Publishing, 2019. https://doi.org/10.1007/978-3-030-32898-6_14.

educational and training project is aimed at meeting the general and specialized training needs required to establish critical mass of personnel with broad skill levels - the general public to the public and private stakeholders in the sustainable energy sector (experts, engineers, project managers and financiers, policy makers, etc.) capable of identifying, designing and implementing effective sustainable energy, climate change issues and disaster risk management measures.

BOOK

Nwachukwu, R U, M U Agboeze, C M Ugwunnadi, and M O Ugwueze. 'Social Media: An Adult Education Approach for Improving the Environmental Awareness of Timber Merchants in Udeno, Enugu State'. *IOP Conference Series: Earth and Environmental Science* 730, no. 1 (1 April 2021): 012022. <https://doi.org/10.1088/1755-1315/730/1/012022>.

85% of the timber merchants in Udeno, Nigeeria made use of social media sites especially Facebook and Whatsapp; hence, social media provides opportunity for timber merchants to share ideas on environmental

issues through online group discussions. The study concluded that social media could be used to promote environmental awareness

Yahuarcani, Isaac Ocampo, Vicente Guadalupe, Roberto Sanchez Saravia, Rodolfo Cardenas Vigo, Juan Jose Bellido Collahuacho, Lelis Antony Saravia Llaja, Angela Milagros Nunez Satalaya, Evelin Alana Rojas Alva, and Jorge Armando Ayarza Rengifo. 'E-LEARNING Tool for Virtual Capacitation in Sustainable Forest Management of the Urban and Rural Sector in Cities of the 8 Countries of the Amazon Basin'. In *2020 XV Conferencia Latinoamericana de Tecnologias de Aprendizaje (LACLO)*, 1–7. Loja, Ecuador: IEEE, 2020. <https://doi.org/10.1109/LACLO50806.2020.9381180>.

development and validation of a computerized e-learning platform for training in sustainable forest management and biodiversity conservation oriented to urban, rural and indigenous populations in the 8 countries of the Amazon basin - "Regional Platform for Information and Knowledge Exchange" - PRIC
PAYWALL

SOME PRACTICAL RESOURCES

We list below a number of free e-learning courses and resources available on an on-going basis of exemplars of e-learning in action (excludes one-off or occasional courses):

APAY e-Learning on Climate Change <https://apay-elearning.org/>

Course from the Asia and Pacific Alliance of YMCAs to reach 'unlimited number of youth who wish to devote themselves to advocacy and lobby for our environmental protection and to combat climate change' including addressing sustainable tourism

Asia Development Bank Institute lecture series free online courses

<https://elearning-adbi.org/courses/>

includes "Climate change and sovereign risk"; 'Introduction to sustainable development' etc

Climact [sic] elearning course on sustainable development <https://e-learning.climact.net/>

for teachers who participate in the Interreg Sudoe ClimACT project, but also for all teachers interested in the topics discussed here... for the promotion of environmental education for sustainability and low carbon economy.

Climalt e-Learning Platform

<https://www.climaltproject.eu/resources/e-learning-platform>

course for youth workers and young people available in English Italian Bulgarian and Croatian

Climate Centre (Red Cross and Red Crescent) 'Y-adapt'

https://www.climatecentre.org/priority_areas/youth/y-adapt/

a curriculum for young people consisting of games and playful activities to help them understand climate change and take practical action

Climate Change eLearning for Kids (Rise)

https://rise.articulate.com/share/cfCs6uGLjDscKORnz0c0VPxscquDvcqQ?_ga=2.130464778.483229589.1612155498-205662480.1611074492#/

quizzes, interactive Storylines, using the elearning authoring tool RISE

Climate Feedback <https://climatefeedback.org/>

'Climate Feedback is a worldwide network of scientists sorting fact from fiction in climate change media coverage. Our goal is to help readers know which news to trust'

Climate Literacy <https://www.climate-literacy.eu/en/>

elearning for adults with no prior scientific knowledge, funded by EU Erasmus+ programme

Common Sense Media – US not-for-profit leading to resources eg at

<https://www.commonsense.org/education/articles/6-free-tools-for-teaching-about-climate-change>

and

<https://wideopenschool.org/student-activities/earth-day/grades-3-5/#all/>

Economist Educational Foundation 'COP26: the power of perspectives' topical talk

<https://talk.economistfoundation.org/projects/cop26-the-power-of-perspectives/>

topics change every 8 weeks, but past topics remain available - the site also gives the opportunity for children to exchange opinion around the world

Ellen MacArthur Foundation

The Circular [no waste] Economy – resources developed jointly by the Ellen McArthur Foundation and the Technical University of Delft

<https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview>

<https://online-learning.tudelft.nl/courses/circular-economy-design-and-technology/>

E-space <https://www.ecoschools.global/espace> – a range of resources on ecological and climate change themes for use in primary, secondary and tertiary education

Food and Agriculture Organisation eLearning Academy 'Climate change adaptation and mitigation in fisheries and aquaculture' online course

<https://elearning.fao.org/course/view.php?id=544>

Global Covenant of Mayors - Cities taking action against climate change

<https://academy.europa.eu/courses/global-covenant-of-mayors-cities-taking-action-against-climate-change>

insights into the methodology and key requirements around the three GCoM pillars: climate change mitigation and adaptation, and Energy access. Success stories and interactive activities characterise your learning experience.

International Environment Forum 'Study Course: Scientific and Spiritual Dimensions of Climate Change'

<https://iefworld.org/ssdcc0.html>

Interfaith study course from the Bahai community

Mercy Corps 'Climate change E-Learning tool'

<https://www.slideshare.net/catherinenidos/climate-change-elearning-tool-from-mercy-corps>

introduction to climate change and why it is an important issue in the work of international development organisations

National Center for Science Education resources

<https://ncse.ngo/misconception-of-month>

includes material on Climate Change

Office for Climate Change Educational resources

<https://www.oce.global/en/ressources>

includes video clips, online games OCE has "a special focus on emerging countries"

Practical Action <https://practicalaction.org/knowledge-centre/resources/>

for example 'Assessing and addressing-climate induced loss and damage in Nepal'

Sustainability and Environmental Education 'A Collated List of Online Climate Change Learning Resources' <https://se-ed.co.uk/a-collated-list-of-online-climate-change-learning-resources/>

TINTIN TeachINg about climate change in schools whilST addressINg fake news and constructive journalism

<http://portabily.mydocumenta.com/preview22464>

EU Erasmus+ programme: project will create an open-access online course of environmental journalism addressed to secondary-school students. Under development.

TROP ICSU ("Trans-disciplinary Research Oriented Pedagogy for Improving Climate Studies and Understanding") E-Learning Courses

<https://tropicsu.org/resources/pedagogical-tools-examples/type-of-tool/courses/>

"Our Pedagogical Resources are Locally Rooted, Culturally Appropriate, and Globally Relevant for Climate Change"

Unesco "Education for Climate Action"

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

includes link to Online Workshop on Climate Change Action 2021,

United Nations Climate Change : Learn Resources Library

<https://www.unclearn.org/resources/library/>

United Nations Climate Change : e-Learn <https://unccelearn.org/>

free online courses on Climate Change, Sustainability issues etc

United Nations Development Programme 'Mission 1.5 in Action'

<https://www.undp.org/press-releases/un-launches-e-learning-tool-people-learn-about-climate-policy>

e-learning tool for citizens to learn what governments can do to address climate change. Webpage also links to Mock COP video reporting on the 2020 youth-led online climate conference

Young Climate Leaders 'Free online courses about climate change'

<https://www.youthclimateleaders.org/post/free-online-courses-about-climate-change>

YCL website (from Brazil) also includes video and details of online YCL activities

350.org

<https://350.org/resources/>

350.org is "an international movement of ordinary people". Page links to the campaign's videos, and to online 'Skill-ups' .

These lessons are more interactive than academic courses and allow anyone to participate at anytime anywhere'

This list does not, generally, list free-standing teaching materials. COP26 has worked with Twinkl and with the World Wildlife Fund and the UK Government to produce schools resources in conjunction with COP

<https://www.twinkl.co.uk/resources/twinkl-partnerships/cop26>

...and COP has also produced its "Resource pack for schools"

<https://together-for-our-planet.ukcop26.org/schools-pack-resources/>

...and the Scottish Government, an associated list of resources at

<https://wakelet.com/wake/TxzoCeOxqxvH4T7Wmzqc5>

Sources like **TED Talks** and **Khan Academy** provide access to talks and resources that can be used in secondary school and beyond. **FutureLearn** and **EdX** list forthcoming e-Learning courses which run on a one-off or intermittent basis.

October 2021

*building on resource discovery within [*The impact of Science Literacy delivery methods - what works?*](#)

