

Reducing national energy illiteracy through MOOCs

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In July 2008, Richard Aldrich (Department of Educational Foundations and Policy Studies of the Institute of Education at the University of London) wrote: "...is essential to review the nature and aims of education, both formal and informal, in the light of the unprecedented situation in which the human race is placed, and to give priority to education for survival." (Aldrich, 2008). In the beginning of the twenty-first century, many issues have arisen as important, being climate change and energy security as two of them.

As states and companies continue to develop their infrastructures to increase their production or improve their services, the needs for energy increase. Humans transfer and transform energy from the environment into useful forms for human endeavors (U.S. Department of Energy, 2017, p. 12). Primary sources as coal, oil or natural gas can be used for different purposes as: transportation, urban development or electricity generation. According to the a future scenario proposed by the United States Energy Information Administration (EIA), the expectation of energy demand around the world will increase around 28% between 2015 and 2040 – an average annual increase of 1.12% (U.S. Energy Information Administration, 2017). In electricity, the International Energy Agency (IEA) has measured that, between 1974 and 2015, world gross electricity production increased from 6287 TWh to 24345 TWh, an average annual growth rate of 3.4%; with non-OECD countries accounting for 55.1% of the world electricity generation in 2015 - near of the double of the 28.1% in 1974 (International Energy Agency, 2017a; p. 3).

Changes around the globe to reduce the use of fossil fuels has been occurring slowly over the last 50 years. As an example, in the world's Total Final Consumption (TFC) by fuel, oil usage continues similar across the years. In 2015, the TFC was 9384 Mtoe¹, and oil occupied a 41% of the share. This trend has been declining slowly since 1973, year in which the TFC was around 4661 Mtoe, however, oil took a similar share, 48.3% (International Energy Agency, 2017b, p. 34). The consequences of the use of fossil fuels has become a major concern. "Melting of ice sheets and glaciers, combined with the thermal expansion of seawater as the oceans warm, is causing sea level to rise. Changes in the chemistry of the oceans, ecosystems and incidents with extreme weather are also projected to increase as a result of climate change" explains the document *Climate Literacy* (U.S. Global Change Research Program, 2009; p. 16).

Similarly, the Intergovernmental Panel on Climate Change (IPCC) considers also that the "adaptation and mitigation choices in the near term will affect the risks of climate change throughout the 21st century" and that "... uncertainties

¹ Million Tonnes of Oil Equivalent.

about future vulnerability, exposure and responses of interlinked human and natural systems are large.” (IPCC, 2014, pp. 9-11).

The increasing of both supports the importance of prevention: the average number of natural disasters and their economic damage (see Figure 1). Only in 2015, the economic impact is calculated around US \$66.5 billion (UNISDR, 2016).

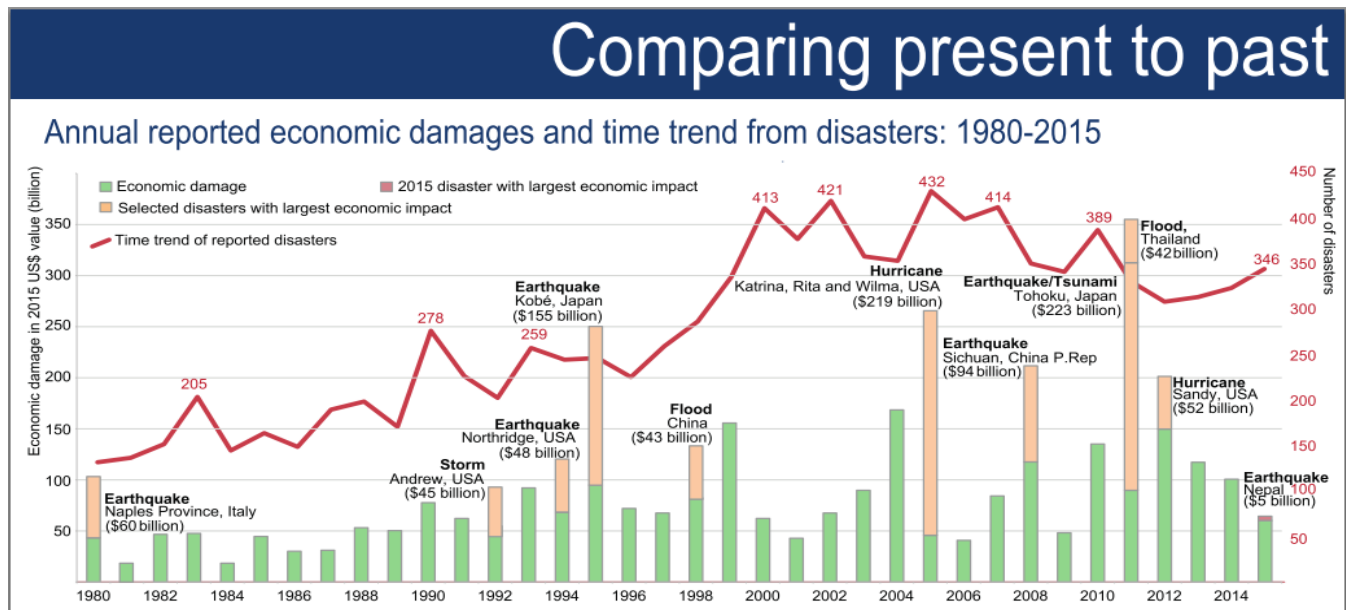


Figure 1. The number of natural disasters has been increasing in the last decades, as their impact in the economy.

Source: UNISDR (2016).

In words of van der Horst, Harrison, Staddon, and Wood (2016) “given the role of fossil fuel consumption in anthropogenic climate change, our twenty-first century energy dilemma is how to flourish as a society without using quite so much (conventional) energy” (p. 67).

However, the economics of energy may be a reflection of what is happening in our society and in our schools. In 2001, the National Environmental Education and Training Foundation applied a basic quiz to a nationally representative sample of 1,503 people, age 18 and older, on energy knowledge and found that only a 12% of them could approve it (The National Environmental Education and Training Foundation, 2002). Years later, in 2010, DeWaters and Powers (2011) would do a similar research using a questionnaire with three sub-scales: cognitive, affective and behavioral. They applied it to middle school and high school students and found that the average cognitive scores were discouragingly low: less than 1% of all students scored above 80%, while the 75th percentile score was lesser than 60% of correct answers.

Similar research has been done by other researchers Aguirre-Bielschowsky, Lawson, Stephenson, and Todd (2017) highlighting the need for energy education for citizenship at school. Lee, Lee, Altschuld, and Pan (2015) adapted a

version of the questionnaire developed by DeWaters and Powers to apply it in Taiwan. They got similar scores (crossing the 60% in the same sub-scale) and concluding that: “in the long term, there should be national curriculum standards for what should be taught along with procedures to ensure if they have been met” (p. 105).

Other researchers have used similar frameworks, as DeWaters and Powers (2011), but using the term “environmental literacy” and measuring the effect of a curriculum-based learning. Their results show that improving the environmental literacy of the students could decrease their energy consumption in more than 15% in students’ homes and more than 30% at the school (Craig & Allen, 2015). Although the research related to energy literacy has increased over the last ten years, few articles had explored the use of online education to increase energy literacy.

Energy literacy is a term that has had different meanings according to each author. According to the U.S. Department of Energy (2017), energy literacy is “an understanding of the nature and role of energy in the universe and in our lives. Energy literacy is also the ability to apply this understanding to answer questions and solve problems.” (p. 1). Additionally, van der Horst et al. (2016) considers that it can be included “a technical knowledge of energy units and ratings, an awareness of typical domestic energy usage around the world in order to place their own usage in context, the variable carbon intensity of “the” grid and an appreciation of the environmental social and economic costs associated with energy production.” (p. 72-73). Finally, in accord with DeWaters and Powers (2013), have defined an energy literate individual “as one who: a) has a basic understanding of how energy is used in everyday life; b) understands the impacts that energy production and consumption have on all spheres of environment and society; c) is cognizant of the impacts of individual, collective, and corporate energy-related decisions and actions on the global community; d) is aware of the need for energy conservation and the need to develop alternatives to fossil fuel-based energy resources; e) strives to make choices, decisions, and take actions that reflect these understandings and attitudes with respect to energy resource development and energy consumption, and; f) is equipped with the necessary skills to do so” (p. 43-45).

In summary, one of the main challenges facing humanity is energy sustainability, both in normal conditions and in situations of natural disasters. Experience and some studies have highlighted the lack of basic skills of citizens for energy management. Samsudin, Harun, Nordin, Haniza, and Abdul-Talib (2014) examined the use of online project-based learning (e-PBL) to improve the students attitudes towards renewable energies. Their conclusion suggests that e-PBL is suitable for online implementation, because “students can more easily interact without the limitations of time and space.” (p. 39).

Given this situation, in México, the Binational Laboratory for the Intelligent Management of the Energy Sustainability and the Technological Formation, with funds from the energy sustainability fund CONACYT-SENER is producing and has offered a series of free MOOCs to the entire population. The objective of this research is to evaluate the extent to which these technological platforms would help reduce the participants' energy illiteracy.

As part of this research, we are interested in understanding how Japan has reduced their energy illiteracy. Japan is the world's fifth-largest electricity user and has a population of 127 million, the fourth-highest among the International Energy Agency (IEA) countries. In 2014, Japan's Total Final Consumption (TFC) of energy was 296 million tonnes of oil-equivalent (Mtoe) (International Energy Agency, 2016, p. 41). Mexico, in comparison, had a TFC of 118.3 Mtoe (International Energy Agency, 2017b, p. 57), however, huge contrasts exists between the two countries: "Japan is a large economy with few mineral resources. It relies on imports for almost all of its oil, natural gas and coal supply. Domestic energy production accounted for around 7% of the Total Primary Energy Supply (TPES) in 2015." (International Energy Agency, 2016, p. 20). Meanwhile, "Mexico's energy production totaled 196.1 Mtoe in 2015, with around 105% self-sufficiency (production as a share of total demand)" (International Energy Agency, 2017b, p. 21). Even Mexico has proved to have more natural resources and territory to use; the data shows that Japan has a better administration of their energy resources, and we believe that education has a role in Japan energy efficiency.

According to METI (2014, cited by Akitsu, Ishihara, and Okumura, 2017) "since 2002, The Japan Science Foundation (JSF) has undertaken the Energy Education Model Schools Project commissioned by the Ministry of Economy, Trade and Industry Agency for Natural Resources and Energy (METI). [...] The project administered a school appointment system to learn energy security, global warming, energy resource diversity, and energy conservation for our future" (p. 1068).

Perceiving that no previous work related to the understanding of energy issues has been studied using MOOCs, and considering the possibilities and differences between Mexico, Japan and other countries, we propose a mixed study to understand how the use of MOOCs may have an impact in increasing national energy literacy.

The first stage is qualitative, to construct an instrument to evaluate the level of energy literacy, and includes the analysis of artifacts, non-participatory observation and interviews with Japanese and Mexican experts. The second stage is quantitative; to evaluate the improvement of the level of energy literacy, and pre and post surveys will be used.

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