On the Importance of Education When Implementing Renewable Energy

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Abstract

The twelfth International Symposium on Renewable Energy Education ISREE was held in Strömstad, Sweden on 19-22 June 2017, twelve years after the eleventh ISREE. The re-started series of ISREE symposiums marks a renewed understanding that education is a vital part of implementation of renewable energy. Renewable energy education could gain by including aspects of revolution, evolution, enrichment and provocation of established educational approaches. It is important to identify important target groups regarding renewable energy education. This is discussed in the present paper. Furthermore, good methods are presented. It is important to understand that implementation of renewable energy is more than pure technology. We therefore suggest that it would be fruitful to make a "*quantum jump"* in renewable energy education: from "*hard"* discourses as science, technology and mathematics to more "*soft"* discourses like sociology of science, psychology and educational neuroscience.

Keywords: Renewable energy, renewable energy education, renewable energy implementation.

1. Introduction: ISREE 2017

Presently it has finally been internationally accepted, through the important work of IPCC scientists and the UN COP conferences including COP-21 in Paris in December 2015 that fossil fuels have to be terminated and replaced by renewable sources of energy in order to keep the planet's atmospheric temperature below 1.5°C above the pre-industrial era temperature. Of major importance to achieve this goal is intense and world-wide education of a number of target groups. This has been understood by renewable energy educators and scientists for several decades, and a recent review article, *Renewable energy education: A global status review* (Kandpal and Broman 2014) lists no less than 376 publications on the subject.

"Progress to a truly sustainable renewable energy world requires a strong workforce of renewable energy professionals and practitioners, and an informed public supportive of the energy transformation" (Middleton 2018a).

In 1989 International Association of Solar Energy Education IASEE was formed and in 1990 it became ISES Working Group for Education (Broman 1990). During the years 1991 – 2005, eleven International Symposiums on Renewable Energy Education ISREE were held in six different countries: Dalarna University in Borlänge, Sweden, 19-20 June 1991. Carl von Ossietzky University in Oldenburg, Germany, 10-11 June 1992. Borlänge, 14-16 June 1993. Asian Institute of Technology in Bangkok, Thailand, 12-14 December 1994. Oldenburg, September 1996. Tata Energy Research Institute TERI in New Delhi, India 26-28, November 1998. University of Oslo in Oslo, Norway, 15-18 June 2000. In Orlando, Florida, 4-8 August 2002. Chalmers University of Technology in Göteborg, Sweden, 14-15 June 2003. In Perth, Australia, 28 November - 1 December 2004. Orlando, Florida, 6-7 August 2005.

Then the series of topical symposiums took a long pause, even if educational papers were presented regularly at ISES Solar World Congresses. Last year, it was however felt that it was time to re-start the series of educational symposia. Thus, the 12th ISREE was hosted by Strömstad Academy 19-22 June in Strömstad, Sweden. The close to 40 participants came from over a dozen countries in six continents and 29 papers were given as keynote, oral, and poster presentations. 18 of them were written up as papers in the symposium proceedings (Broman 2017). Several of them have since been extended to full-length articles, and accepted for publication in Solar Energy, Volume 173, published in October 2018:

Sustainable Living Education: Techniques to Help Advance the Renewable Energy Transformation by Paulette Middleton (2018b)

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From Experiential To Research-based Learning: The Renewable Energy Online (REO) Master's Program by Christiane Stroth et al. (2018)

Development of a Holistic Method for Assessing Success of Renewable Energy Study Programs by Hans Holtorf et al. (2018)

Influence of Diversity in Lectures on the Students' Learning Process and on Their Perspectives About Renewable Energies in an International Context - the Students' View by Mónica Gutiérrez et al. (2018)

A Pedagogical Approach to Solar Energy Education by Aadu Ott et al. (2018)

Dealing With Victor's History in Renewable Energy Education for Transportation Applications by Ari Lampinen. (2018)

On the Alumni Networking of the Postgraduate Programme Renewable Energy at the University of Oldenburg by Evelyn Brudler and Hans Holtorf. (2018)

Education and Training Gaps in the Renewable Energy Sector by Hugo Lucas et al. (2018)

It seems like ISREE 2017 has marked the beginning of a new era where more interest is being given to renewable energy education issues. Thus, when ISES Board meets on 10 March this year, the (re-)formation of an ISES Working Group on Education was on the agenda. A thirteenth ISREE supported by ISES is being planned to be held together with ISES Solar World Congress in Santiago, Chile, in November 2019.

2. Renewable Energy Education: Target Groups and Methods

In recent years, the renewable energy sector has been growing at a rapid rate with investments in the sector being more than that in the fossil fuel sector for past couple of years. As a consequence, a variety of employment avenues including those of researchers, engineers/technicians/mechanics for design, fabrication/manufacture, installation, operation and maintenance of renewable energy technologies, sales and marketing professionals, project appraisal and financing specialists, policy makers as well as professionals to engage in capacity building at all levels. One of the barriers to large scale development and deployment of renewable energy technologies is the unavailability of qualified human resource with the shortage being more acute in developing countries (Ciriminna et al. 2016, Lucas et al. 2018). For example, in case of photovoltaics industry it has been reported that, in several countries, the training of required technicians within approved and accredited training centers has not kept pace with industry requirements within the specific training framework of the country (Stapleton and Collins, 2017).

It is also important to educate politicians, media professionals and potential entrepreneurs and project developers so that they are able to appreciate and assess the strength as well as limitations of the renewable energy options in an objective manner (Oliphant, 2017). Science communication workshops were developed by the ESConet group with members from some 20 European universities and research institutions (Miller et al. 2009); the major target group was young post-docs and renewable energy was one of several topics included. Similarly, education and training of school teachers in the field of renewable energy is also important so as to ensure that relevant inputs could be introduced in the school curricula (Ocetkiewicz, 2017). Above all, there is a critical need for improving awareness and understanding of the common public about various renewable energy options and their direct relevance for long term sustainability of the planet earth (Broman and Kandpal, 2010).

Some target groups have been approached quite strongly during the decades through the establishments of master programs in renewable energy engineering; as an example the European Solar Engineering School that started in Borlänge, Sweden (Broman et al. 1998) and since then has created a yearly group of Masters from all over the world. However, other target groups have to be approached by other means. It is also quite important to ensure the relevance of the knowledge and skills imparted through the renewable energy education programs. For example, in the case of developing countries, a disconnect has been reported between the education system and the expertise required by the industry (Lucas et al. 2018). In order to ensure that latest in the field is provided to the students, the need to involve industry professionals in renewable energy education has also been highlighted (Goswami, 2017). Moreover, there is a strong case for including social, sociological and pedagogical aspects in renewable energy education (Ott et al. 2018).

In 2010 (Broman and Kandpal 2010) we wrote: "Public understanding of science PUS is a central concept among science communicators. Public understanding of renewable energy PURE is proposed as an important sub-concept of PUS. Four separate important questions for a PURE research project can be identified: (A) Is PURE important? (B) Which issues of PURE are the most important ones, according to renewable energy scientists? (C) What understanding of renewable energy has the general public today, worldwide? (D) How to achieve PURE? These question marks have to be straightened."

3. A New View on Renewable Energy Education

10th grader "Johanna" (alias): "It's a pity that I'm not so interested in physics. For example, I am interested in religion. One meets people with different religious faith all the time. But physics is only with you two hours per week." (Gustafsson et al 2001). Obviously science has to be taught in a very different way – not only in schools but everywhere.

The research question: Could it be fruitful to introduce and merge, in a tentative way, in contemporary time and with contemporary knowledge scientific *know why* and technological *know-how* with insights in pedagogical, social, societal, humanistic and cultural aspects on transfer and acquisition of knowledge about utilization of renewable energy sources on a personal and/or societal level?

Pedagogical traditions. A part of an answer could be found in some of the common educational theories: *The pragmatic or progressive theory*, founded by the American philosopher and educationalist John Dewey (1859-1952). This theory (Dewey, 1966) is connected to the well-known expression "Learning by doing", or in the individual constructive theory for learning founded by the Swiss biologist and researcher Jean Piaget (1896 – 1980). Piaget regarded children as mini scientists. In contemporary time a lot of interest has been focused on a combination of *the sociocultural theory for learning* founded by the Russian psychologist Lew Vygotsky (1896 – 1934). Known for his merging of pedagogy with cultural and historical aspects (Vygotsky, 1978). In recent years *neuroscience* and OECD´s publications about the interaction between research and practice (Dumont et al. 2010, The Ille Handbook, 2016) contain valuable insight and inspiration, as well as a "road map" for pedagogical implementation of cultural and societal aspects in the field of education.

Four key aspects: This could also, tentatively, be gained by application of a perspective including aspects of *revolution, evolution, enrichment* and *provocation* of established approaches to utilizing energy for our society from different sources in nature.

To many people a transition from fossil to renewable energy sources may seem to imply a *revolution*. At the same time even utilization of energy sources have an inherent *evolution*. Many times it is possible to just *enrich* standard energy sources with renewables. Some people may even find that using renewable energy involve a *provocation*. These four aspects implied by energy transition have to be carefully explained by pedagogical methods.

STEMM to HACD. The American scientist Robert Root-Bernstein proposes in an article in Science (Bernstein, 2018) that the key concept "STEMM" (Science, Technology, Engineering, Mathematics and Medicine) in education should be changed to "HACD" (Humanities, Arts, Crafts and Design). This means the incorporation of humanities, arts, crafts and design into curricula in order to educate scientists to be more insightsful and this paradigmatic change of *mindsets* should also affect their scientific results.

Robert Root-Bernstein proposes also in his book "Sparks of Genius" (Bernstein et.al. 1999) a number of "mental tool" for thinking. These are: observing (using any or all senses); abstracting; pattern recognition; pattern forming; dimensional thinking; analogizing; proprioceptive (or body) thinking; empathizing or play acting; modeling; playing; transforming between these various ways of thinking and synthesizing.

These *mental tools* could be utilized within the sociocultural theory of learning in order to function as "mediating artifacts" for the learner in her exploration of phenomena in the surrounding world.

MIT. Charles M. West, president emeritus of MIT, is cited by Root Bernstein (ibid): "(Engineering) systems cannot be wisely envisioned, designed, or deployed without an understanding of society, culture, politics, economics, and communications – in other words – the very stuff of the liberal arts, and also of the social sciences."

Climate Change. Changes in society, culture, politics economics and most of all in Climate Change suggests strongly introduction of renewable sources of energy and thus implies a need of education in this field in order to provide acceptance in our society for this kind of technology.

Mind Change. The English neuroscientist Susan Greenfield points in her book "Mind Change" (Greenfield, 2014) out that human mind change is as important as the more well-known Climate Change. This aspect stresses the need for utilization of renewable sources of energy but also the need for education about these options in order to promote the needed transition from fossil to renewable sources of energy.

MegaMind. In the beginning of the decade 2010 work started on a new basic exhibition at the National Museum for Science and Technology in Stockholm. The name of the project became *MegaMind*.

The aim of the exhibition was to present a pedagogical and educational neuroscientific overview of our learning brain. The project has as its key concept the acronym *STEAM* (Science Technology, Engineering, Art and Mathematics). This exhibition is presented extensively Online with pictures which show how "hard" technological discourses could be "softened" with an early application of the one key concept *HACD* in order to fit expectations of general public.

ILE. In summary it could be concluded that these aspects which demonstrate the need for a pedagogical approach to solar energy education including that a transformation from *STEMM* to *HACD* or from *STEM* to *STEAM* would be favorable in creating an *Innovative Learning Environment, ILE* as suggested by OECD in five publications. (The ILE Handbook –Preliminary Draft Online 2017.

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