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STEM Education and the Water Management. An Entrepreneurship Initiative

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Abstract – The aim of the paper is to establish the current state of a new STEM (Science – Technology – Engineering - Mathematics) learning method concerning entrepreneurship towards different ages of students by evaluating the situation of water sustainability. Based on the findings of the study, the new and the old one, we could be able to develop a motivational program taking into consideration all the key findings and suggest policies and initiatives that could empower and enhance them to keep clean water. The analysis will be fundamental to develop entrepreneurial competences taking into consideration exchange of good practices project also.

Keywords: Science, Technology, Engineering, Mathematics, STEM, Entrepreneurship, Water, Sustainability

I. INTRODUCTION

In the article published online entitled *"Water - One of the greatest challenges of the 21st century"*, under the aegis of the global company "RAMBOLL - Bright ideas. Sustainable change", Danish author Søren Hvilshøj, Global Market Director at Water Rambøll Danmark, states the following: "One of the biggest global challenges, now and in the future, is water. Torrential rains are more frequent due to climate change, causing sewage to overflow, but at the same time, water shortages in other areas threaten public health and reduce food production. By 2050, the world's population will have grown from 7 to 9 billion. This huge increase means that the need for water will increase by more than 50 percent, if we continue to consume at the current rate.

In the report *"An Environmental Outlook for 2050"* published in 2012, the OECD (Organization for Economic Co-operation and Development) estimates that around 1.5 billion people live today in areas severely affected by water scarcity. According to the report, the number will increase to almost 4 billion by 2050, which will trigger a global food crisis if the current approach is not changed. He said: "*The biggest global challenge is the lack of water, because it affects food and energy production. Climate change, water pollution and huge waste of water are also crucial issues that need to be addressed".*

An excerpt from a United Nations report exemplifies this common refrain: The existing 263 transboundary lake and river basins cover nearly one half of the Earth's land surface and account for an estimated 60 per cent of global freshwater flow. A total of 145 States include territory within such basins, and 30 countries lie entirely within them (Thomas, 2017).

By exploring the implications of the ontological turn for water governance debates, however, we contribute most directly to a growing body of literature that is reformulating our understanding of the nature of water and human – water relations (Yates et al., 2017).

Water pollution is a problem for all of humanity. Everything is right when you open yourself to the possibilities, perception is the key in the business: Why keep the water clean? Because when polluted waters are modified biological, chemical, or physical, making them unsuitable or dangerous to the health, aquatic life, industry, tourism, or industrial fishing.

Sustainability is a word we throw around a lot, but study of entrepreneurial education helped me see that *you*, as an individual, must understand *who you are* to know how you fit into your community, or *how you can* make a better world. *You* must face *who you are* before can give best. And *you* must understand who others are and what makes them special. Because real sustainability is not going to be about any of the things that any company involved into this process already bring to the table, but about perspective, motivation, and resources. It is going to be about figuring out what part we *all* can play in the future, the part that fits us best, and then fitting ourselves into the wider world, making it our mission to keep those connections – our relationships – with each other and the land – the planet – strong.

About STEM pedagogy: the wonderful universe of science, technology, engineering, and mathematics brings in this pedagogy the examples from the

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surrounding reality that link them together, so that with their help, scientific discoveries will motivate us to invent new things that will make our lives easier and protect nature, at the same time. In this respect, the paper will take into consideration a couple examples (experiences or/and experiments) concerning environment protection and water protection as the source of life.

About STEM history: „In the 1990s, the National Science Foundation (NSF) began using "SMET" as shorthand for "science, mathematics, engineering, and technology." When an NSF program officer complained that "SMET" sounded too much like "smut," the "STEM" acronym was born. As recently as 2003, relatively few knew what it meant. Many that year asked if the STEM Education graduate program I was beginning to envision had something to do with stem cell research. That was still very much the case in Fall 2005, when the Technology Education Program faculty at Virginia Tech launched STEM Education graduate program.

But when Americans learned the world was flat (Friedman, 2005), they quickly grew to believe China and India were on course to bypass America in the global economy by outSTEMming. Funding began to flow toward all things STEM, and STEMmania set in.

Now, nearly everyone seems somewhat familiar with the STEM acronym. And yet, it remains a source of ambiguity. Technology educators proudly lay claim to the T and E in STEM. But so, too, do Career and Technical educators, who seem to have claimed the "E" as their own. Most, even those in education, say "STEM" when they should be saying "STEM education," overlooking that STEM without education is a reference to the fields in which scientists, engineers, and mathematicians toil.

Science, mathematics, and technology teachers are STEM educators working in STEM education. It is an important distinction. In addition, there is the common misconception that the "T" (for technology) means computing, thereby distorting the intended meaning of the STEM acronym. Suffice it to say, STEM is often an ambiguous acronym, even to those who employ it." (Sanders, 2020).

STEM was born from the desire to emulate how life operates by merging four core disciplines: science, technology, engineering, and math. In the real world, these disciplines often work together seamlessly, and with little fanfare.

But if we want to prepare children to be future scientists, we need to inform them about the past. By doing so, we demystify scientific advancements by revealing their messy historical reality; we show students how science is conducted; and we could spotlight scientists who have been written out of history - and thus invite more students into the world of science (Ramirez, 2020).

II. FIRST EXPERIMENT: CROSSROADS IN LIFE

„*There were always going to be crossroads in life...*", this was the beginning of my 2018 Entrepreneurial Skills course within the Project entitled: A chance for marginalized communities in Caransebes Municipality - code 2014+: 101559, project co-financed by the European Social Fund, Human Capital Operational Program 2014-2020, POCU/18/4/4.1 "Integrated local development (DLI 360 degrees) in marginalized communities where there is a population belonging to the Roma minority - Less developed regions", because those involved in the project trying to change their lives, through a new professional entrepreneurship approach.

The first and one of the important topics of discussion was Environmental Management and Sustainable Development, and the part related to water usage and water pollution were intensely debated.

Interesting for the actors participating in the debates (aged between 25 and 55) was the STEM linked to History approach of the subject, starting from the following images, about an early and most-essential water wheel machine, named Noria (Machinery Lubrication, Noria corporation, 2008):

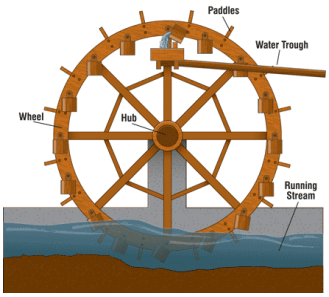

Figure 1. Parts of the Noria water wheel machine

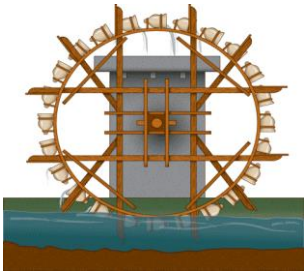

Figure 2: Persian Noria Using a Wheel of Pots for Raising Water

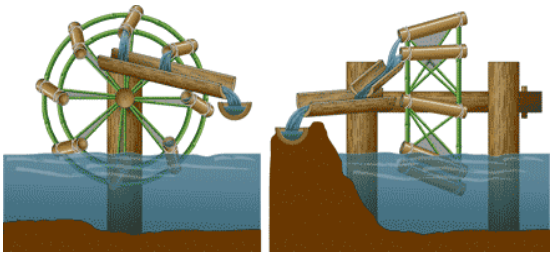

Figure 3. Example of the Chinese Noria

Figure 1 and Figure 2 represent parts of “noria” (comes from the Arabic term, Na-urah) meaning “the first water machine”. It was the earliest mechanical device propelled by means other than man or animal. The noria was an inevitable invention that sparked the development of countless types of hydraulic and rotating machines. Over the centuries, it has allowed civilizations to nourish their villages and crops with water, the most fundamental of resources. In time, this triggered the beginning of a new era - the turning of arid lands into prosperous empires. (Machinery Lubrication, Noria corporation, 2008)

Figure 3 speaking about some possible evidence of water wheels in early China, but they were likely derivations of the western norias. Because the Chinese had developed geared machinery from an early age, it is likely that they powered these mechanical devices using water wheels and norias that were originally advanced in the West during the Hellenistic Age (Machinery Lubrication, Noria corporation, 2008).

The water protection subject has been intensely debated starting from these three images. At the end of the last class, the following results are important: the unanimous conclusion to elaboration and design of a possible new project, having the following main objectives:

- To know, to identify and to promote the importance of keeping clean water to those involved through research activities, partnerships with environmental institutions and experimental activities;
- To identify environmental problems related to water resources through exchange of information with all the actors involved;
- To identify the possible improvement solutions for environmental problems concerning water use and water quality through study visits, research activities, workgroups;
- To develop civic attitudes concerning the protection of nature and life, concerning ecological problems including through scientific and artistic activities to improve water wastage;
- To develop civic skills on environmental issues.

III. SECOND EXPERIMENT: THE GATEWAY TO SUCCESS

The second experiment focused on 12th grade students (aged between 17 and 19 years old), from a technological high school with an environmental protection profile.

The right words can be the gateway to success, even though money does speak volumes in a language everybody can understand. But giving to the students a few choice words had made all the world of difference, deserved by the best representation money could buy. So, in this experiment, the right words were sustainability, water usage and water protection.

While STEM skills are themselves increasingly important in our technologically rich world, STEM is also a pathway to engage students as critical thinkers, and even as future citizens. By placing science in the broader context of history and culture, we can remind students of how scientific inventions play a role in our evolving cultural and even moral belief systems. And by giving students the space to critique inventions, we give them the skills to shape the future (Ramirez, 2020).

Figure 4. Rudaria water mill.

Figure 5. Inside the Rudaria water mill.

Figure 6. Mill from Rudaria after the floods.

Figure 7. Other mill from Rudaria after the floods.

Geographically, the second experiment took place in our natal county, although the 22 water mills from Rudaria (Figure 4 and Figure 5) are in Caras-Severin County and included in the UNESCO world heritage. The water mills from Rudaria, unique in Eastern Europe, suffered terribly from the floods of September 2014, 21 of them being severely affected (example, Figure 6 and Figure 7, photos by Radio Romania Resita).

Historically, today, as a hundred of years ago, at Rudaria in Banat, the locals prepare their corn and wheat flour at the water mills with sieves, mills older than the village and with which everyone found themselves. The complex has a special ethnological and anthropological value, a first-rate historical and architectural value, each mill within it being a monument of architecture, of popular civilization.

As a teacher I understand now: When history is included in STEM, students learn science, but they also learn about the much broader impact of science (Ramirez, 2020).

So, from history to present day: There are still 22 mills on the water, which still grind the "corn" grains but also the time, as the locals like to submit. In the interwar period, there were 48 mills in Rudaria. Some are over 400 years old others are placed there on the hearths of mills used by the Dacians and later by the Romans.

The housing constructions of the mills are made of wood, covered with shingles, and the installations have the same technical, constructive, and functional principle - the water turbine. It is said that the Land of the Mills in Banat was founded by the Dacians.

The 22 mills are held in disrepair, a kind of fellowship just like sheep lathes and pastures. Each mill is associated with between 15 and 25 owners, each with his own row or rows. A big row means a day and a night - a small row - just a day or a night. Nobody pays anything, and the old and huge key is held by the “head of the mill” (Popovici, 2019, InfoCS.ro),

Figure 8. Rudaria water mills map

This second experiment lead to these questions: ***What kind of society will we be in the future? What happens if the “noria” was never invented?*** And students result after a couple of hours debates concluded: The overall objective of this STEM approach was to develop skills that will lead to the attitudes and abilities of a creative, reflective, cognitive, social interaction and communication, to promote cooperation in order to shape an active entrepreneurial education in order to protection of nature and life by improving the environmental problem, in particular the one connected to the water.

By placing science and technology in the broader context of history and culture, we can remind students of how scientific inventions play a role in our evolving cultural and even moral belief systems. And by giving students the space to critique inventions, we give them the skills to shape the future (Ramirez, 2020).

So, the path to success of this second experiment has been travelled both geographically and historically and has led to a better understanding of an ancient technology, which has survived to the present day. The path to success (from ancient times – to the present day - to the future) is the open door (gateway) through creativity, imagination, and innovation to become successful future entrepreneurs.

IV. CONCLUSION

The two experiments led to the elaboration of an extracurricular project, with possible non-reimbursable financing, considering the following:

a) Integrated approach: Through the project, the results and experience gained will be integrated into the environment protection education strategy and high school PAS (SAP – School Action Plan) for 2020-2023.

b) Transferability to other people/students in difficulty who wish to move from the status of a person in possible school dropout to the status of a person who has passed the maturity examination. This objective will be achieved through the possibility of participating in a wide range of educational programs offered, including on environmental protection by keeping clean water.

c) It is intended that after the project is completed, the experience gained will be transferred to multiply the effects of the project, to reduce school dropout and absenteeism, including with the help of the local community.

d) The established working team will also be the promoter of the pupils in difficulty, being a platform for the project's sustainability through active involvement and social responsibility.

After the experiments other students’ conclusion were:

1. Humans make mistakes. They are only unforgivable if you don't do anything to make right.
2. Not everybody is cut out to be an entrepreneur. For that you need qualities and competencies.
3. Anyone can appreciate an objective look, another perspective on things.
4. The road to success is strewn with many obstacles.

5. Sustainability must consider both the needs of the people and the resources of the land.
6. The tension between needs and resources must not lead to any kind of war.
7. The unlimited character of human needs, desires and necessities will remain unchanged, as well as the limited character of the earth's resources.
8. STEM pedagogy includes real-world examples and experiments that will help us connect these four areas of life around us.

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