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CLIMATE CHANGES IN NON-FORMAL EDUCATIONAL ACTIVITIES - A MULTIDISCIPLINARY APPROACH

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Abstract

Scientific findings clearly indicate that a changing climate has - and will continue to have - a significant impact on human life and natural systems. The *Climate change* has become one of the main threats to the biological diversity of the planet, and is projected to become an increasingly important driver of change in the coming decades. Equally important, the massive changes that humans have made to the environment have reduced the survival options to some species, already under the pressure of the changing climate. Providing children with empowering and relevant education related to climate change can contribute to sustainable development of their communities.

This paper points out some on particular aspects of the climate change issues, seen from the educational perspective in correlation to students' feedback, expressed in dedicated non-formal activities, where they are introduced to such issues. The activities were developed using the discovery-based learning method, so that students were being involved actively in experiments, debates, bringing arguments on their claims. The students were also activated in investigating or solving community problems, introducing several solutions through group discussion, with proposals for alternatives. At the same time, the proposed activities contributed to the formation of conscious and responsible attitudes toward the environment.

All the activities were adapted based on a special unit dedicated to Climate Change, designed in the frame of the EU FP7 project entitled: "*IRRESISTIBLE - Including Responsible Research and Innovation in Cutting Edge Science and Inquiry-based Science Education to Improve Teacher's Ability of Bridging Learning Environments*".

Keywords: Non-formal education, discovery-based learning, climate change, ocean acidification, IRRESISTIBLE project.

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1. Introduction

The skills and knowledge needed to adapt live and livelihood to realities (social, economic, ecological) of a changing environment require a quality education as an essential issue of adaptive capacity. A transformative education must take into account supportive teachers and learning environments, learning and teaching processes (active, inclusive and participatory) and also the inherent links to local communities and local issues (Tang & Unesco, 2015).

Acting as one holistic system to provide a quality education, non-formal and formal education systems are ideally complementary (non-formal elements / components can be gradually included by formal education to meet the needs of society and individuals). After-school activities provide opportunities for students to interact with their environment through field trips, museum visits, research and action projects, and to practically apply the knowledge and information about what they have learned. This kind of approach should determine a series of desired learning outcomes (having in view also appropriate age / school level):

- Knowledge - the learners will understand: the importance of using and discerning relevant information from various sources, basic concepts related with climate change, the interaction and consequences of local and global actions involving environmental issues and climate change;
- Attitudes - the learners will demonstrate: responsibility with regard to the use of environmental resources, consideration related with the impact (social and environmental) of consumer items, appreciation for the interacting complexity of social, economic and environmental aspects. Also, the learners will be able to: review their everyday practices and propose and implement changes related with environmental issues, communicate openly and advised about reducing risks and living in harmony with the local and global environment.

While environment is an active topic, for many organizations, fighting for more sustainable living represents a daily challenge. The message to manage natural resources by using them more wisely and efficiently is not directed only to corporations owing big plants or factories. Millions of people leading everyday environment-not-friendly lifestyles are a real problem (bad habits like leaving the water on, lights left on etc. are hardly influenced). To make people changing their behaviour to become more sustainable by the mean of information campaigns is not enough - a deeper environmental education is necessary. Within non-formal contexts, it is possible to develop more conscious mindset and certain sensitivity to the environment.

2. Problem Statement

An important role of education is to teach people how to learn and think, so that they can react effectively to a changing planet in short and long term. Concerning the climate change education topics, educators and scientists must think about communicating more effectively using both traditional and new pedagogical strategies. The education fills knowledge gaps, challenges apathy, and furnishes the technical knowledge needed to build a better future through innovation. Previous studies highlighted on the students'

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willingness to act by perceiving the relevance of climate change mitigation and by the own believes in themselves, but also in other societal actors, to change the status quo.

As a reliable example, the *Climate Change* Unit, as an educational material, initially designed in Finland (by the staff from University of Jyväskylä) and adapted by the Romanian Community of Learners (set up by Valahia University Targoviste), is included in a series of *Teaching Units* developed within the IRRESSISTIBLE project, focuses on how people and other species must adapt to the consequences of climate change. Related topics include animals changing environments, food production, extreme weather; students were engaged through on-line activities, experimental work and exhibition designing (SYKE et al. 2009, Project Irresistible website 2016). The related non-formal educational activities aimed to the implementing of the knowledge concerning the interaction and consequences of local and global actions related to climate change and environmental issues, enrich with *Responsible Research and Innovation* (*RRI*) issues (Anghel et al., 2015).

The main structure of the *Climate Change* unit was designed in three sections (added with appendix - activity worksheets: experiment instructions, carbon footprint activity sheets, and letter tasks):

- Section 1: Structure - includes: general description of the material, contents of the teaching, specific structure;
- Section 2: Teaching methods - include: teaching methods, responsible research and innovation issues, assessment;
- Section 3: Materials for teaching - include: getting familiar with the topic, experimental work, different habitats, carbon footprint, different ways of sharing conclusions, summarizing the project.

The teaching issues along with the related materials and studies have been designed to encompass eight lessons (Figure 1, Project Irresistible website, 2016).

The proposed adapted structure serves as an example of how the teaching activities can be projected and is based on the teaching sequences performed in 2014 and 2015 in the primary schools of Jyväskylä (Finland), followed by the gained experiences acquired during the implementation process.

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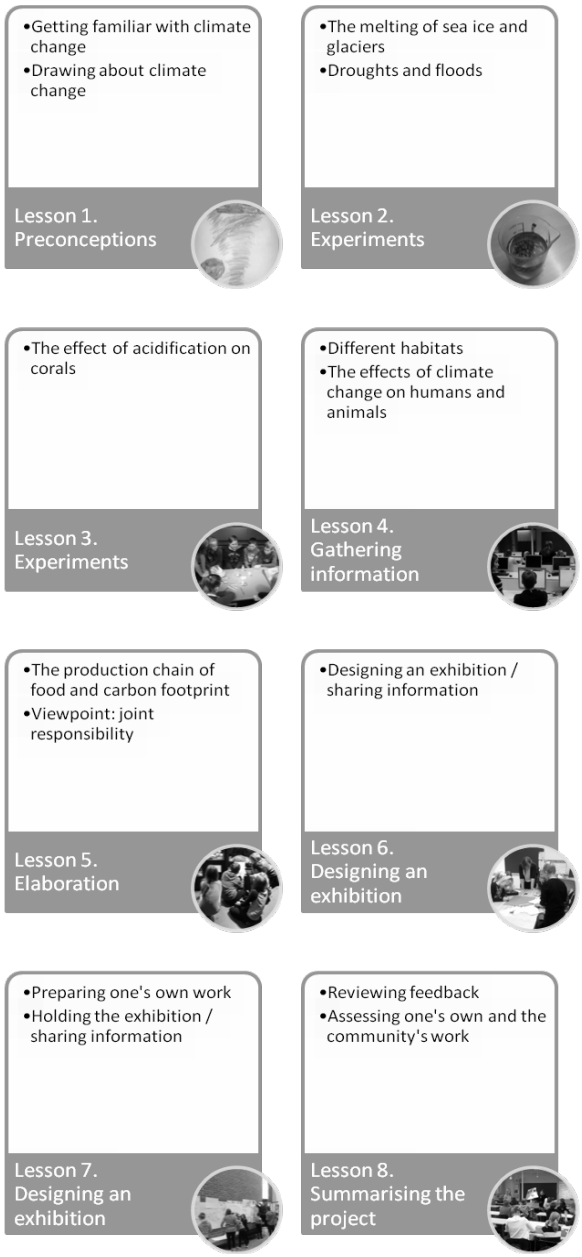

Figure 01. The structure of the teaching activities - The *Climate Change* Unit

3. Research Questions

The *inquiry-based learning* plays a key role in all the learning materials of the above mentioned project. The students have familiarized themselves with the topics, practiced planning and carrying out research, as well as learned about data gathering and source criticism. In fact, *Inquiry-based Science Education* (*IBSE*) strategy represents an active approach involving students to develop key-scientific ideas through learning, on how to investigate and use information to acquire knowledge and to understand the real world (Harlen, 2013).

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Two research questions derived even from the moment of designing the "*Ocean Acidification*" non-formal activity: (a) *How effective can be the non-formal character of the proposed activities, in order to stimulate the students' interest for this global issue?* (b) *How much they know about climate change?* (c) *In which manner and to what extent the students are willing to involve themselves in such demarches?*

4. Purpose of the Study

Generally, it is appreciated that people are aware of the issue of climate change. But there are also other opinions: according to a Pew study (Stokes et al., 2015), an important amount of people was not really concerned that climate change would hurt them; moreover, Yale University researchers (Lee et al., 2015) recently found that 40% of adults worldwide have never heard of climate change! The Yale study concluded that "educational attainment tends to be the single strongest predictor of public awareness of climate change". Having in view also those issues, the present paper tries to provide an insight into students' views on climate change and their willingness to engage in mitigations.

In this sense, based on the *Climate Change* unit, we want to point out some particular aspects of understanding that issue, but also related students' feedback collected after the implementation of non-formal activities in Romania, where secondary school students are introduced to the topic of global climate change - all the proposed activities were adapted based on the sub-unit entitled: "*the effect of acidification on corals*" (Figure 1). The designed activity is based on the knowledge gained by the students during Sciences lessons (Biology, Physics, Chemistry), and aims (involving the *IBSE* pedagogical strategy) on acquiring skills for the investigation of the environment, development of synthesis and analysis capacity, acquisition / development of personal skills, communication and relationship.

The adapted activity scenario related to *Ocean acidification*, presented synthetic in figure 2, was divided in several stages following the educational *6E method* (*Engage*, *Explore*, *Explain*, *Elaborate*, *Exchange*, and *Evaluate*) and being also related with *Responsible Research and Innovation* (*RRI*) issues (*Engagement*, *Gender Equality*, *Science Education*, *Open Access*, *Ethics*, *Governance*).

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Engage
Science talks in class (experimenting, debates, discussions)

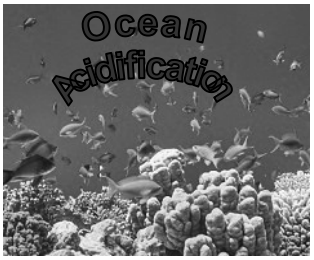
Explore
- Pupils introduced to different data sources (videos, maps)
- Researcher helped pupils formulate explicit research questions for inquiry studies at museum

Explain
- Pupils gather data from direct observations and made measurements (e.g. water and different solutions / liquids / substances pH level)
- Researcher led pupils to give answers by connecting observations (data) with the questions; explicit guidance

Elaborate
- Pupils elaborate their findings and ideas by making debates / discussions in groups
- Researcher discussed RRI ideas with pupils in contexts relevant to their life
- Pupils are encouraged to express their concerns about the topic

Exchange
- Pupils could decide on the methods (videos, posters, drawings)

Evaluate
- feedback discussions at the end of activity correlated with museum visit; pupils questionnaire



Engagement
- Visiting researchers, whole class and small group discussions to come up with contexts where all societal actors are needed
- Pupils questionnaire

Gender Equality
- Addressing interests of pupils in science education, representation of women in research; visiting researchers included women
- Pupils questionnaire

Science Education
- Science in context, using science results for personal decision making

Open Access
- Using online data sources for video / poster production, discussions between teacher / researcher and pupils about climate changes (e.g. ocean acidification) and how it is based on research

Ethics
- Raising awareness about pupils' personal choices and connection to climate change; researchers' choice of examples to illustrate how research and innovation can make products that help prevent climate change

Governance
- Discussions about climate policy, globally and locally
- Pupils questionnaire

Figure 02. The *Ocean Acidification* activity stages, related with RRI issues

5. Research Methods

For collecting the secondary school students feedback - after the implementation of the proposed activities where students had been introduced to issues related to global climate change - a specific questionnaire was provided to them (as *Student's Questionnaire*), measuring their interest on being involved

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in such activities (as *Ocean acidification*) or in educational issues having also RRI as fundament. 135 secondary school students (from Dambovita and Prahova Counties) who were very active during the process, were asked to express their opinions. The data processing was done electronically, using statistic software.

6. Findings

Life in any way is interdisciplinary by nature. The social, economic, technological, environmental issues, and also the irreversible climate change, are problems that cannot be solved by a single disciplinary perspective (Klein, 1990). More connected learning and coherence in the curriculum is the best choice against the artificial fragmentation of the knowledge. Integrated teaching approach is a way to teach students in a more meaningful way; it allows two or more concepts or skills within or across subject areas to be integrated in one lesson. In this approach, knowledge from all of the traditional subjects is accessed without labelling them as such. The concepts or skills are embedded in real-life situations where students are given problem solving tasks that necessitate connection of ideas already known to them with those they encounter for the first time.

In this view, during the "*Ocean Acidification*" non-formal activity, it was trying to link concepts, subjects related with curricula from different disciplines:

- Physics (e.g. global warming related with carbon dioxide level in atmosphere, greenhouse effect, electromagnetic radiation, air molecules);
- Chemistry (e.g. acidity, alkalinity, pH buffer, water hardness, solubility, basic carbonate chemistry involved in ocean acidification);
- Biology (e.g. marine organisms, biodiversity);
- Geography (e.g. ocean currents, ocean temperature level).

The process of ocean acidification is the progressive decrease in the average pH of ocean waters caused by the excessive absorption of atmospheric CO_2. Over the past few centuries, approximately 50% of the CO_2 produced by humans has remained in the atmosphere, 20% has been taken up by terrestrial ecosystems such as tropical forests, while another 30% has been absorbed by the oceans. These numbers suggest that the effects of climate change would likely be much more severe if the oceans were not able to absorb CO_2 and act as a global buffer. However, the ability of Earth's oceans to absorb excess atmospheric CO_2 is finite and the carbon dioxide level is starting to be close to buffering capacity limits (Bradley et al., 2009).

The concepts and notions were related with real-life issues beginning with materials / reagents used for experimenting (e.g. natural pH indicator made from red cabbage, food / food ingredients with different pH level, artificial seawater etc.) so that the students to be more familiar with it and at the same time to relate easily notions from different disciplines through main activity topic. It was remarked especially students exciting during experiments performed (e.g. testing pH level of different commonly liquids potable and seawater, buff capacity of seawater, carbon dioxide solubility, acidity impact over marine shells organisms

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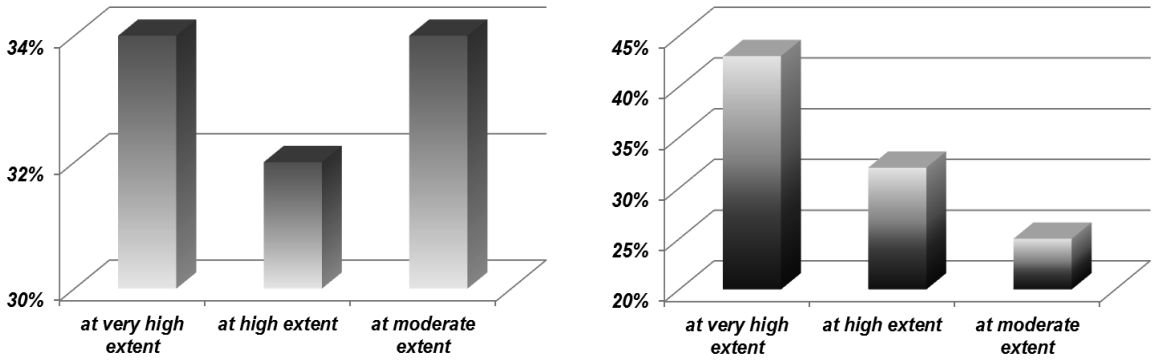
etc.) and how they related theoretical notions that already known form different disciplines with practice during experiments.

At the end of activity, the students have been asked to answer to the *Student's Questionnaire*, their answers being shown in the following figures - rating on an interval level (figures 3 and 6), attitudinal views (figures 4 and 7), open answers (figure 6) and closed questions (figures 4 and 5).



(a) (b)

Figure 03. Students' opinion considering the importance of the ethical principles of research-innovation process (a) and how school can act relative to research-innovation process (b)

As can be seen in figure 3, most of the students (~ 70%) consider as very or great important to respect and valorise the ethical principles in the research-innovation process (figure 3a), but also the idea that school should empower the students with necessary knowledge and skills for the RRI process (figure 3b).

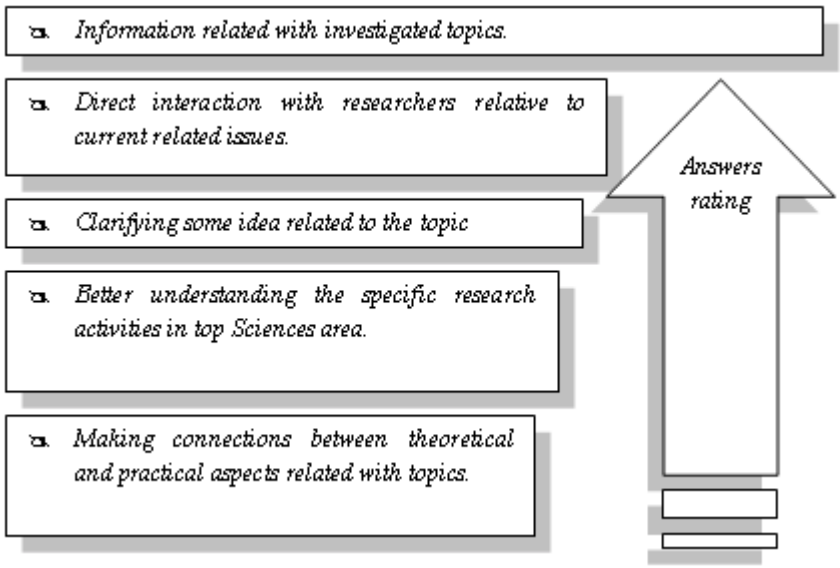


Figure 04. Students' gains, in their own view, based on the acquisitions determined by the non-formal activity in which they were involved

Based on students' opinions (figure 4), the resulting discussions performed during the activity, provided the opportunity for the offered responses to be *checked out* for clarity and explored in further depth;

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the activity has proved to be particularly useful on enabling the students to consider the topic from different perspectives and may be beneficial to a group on facilitating the discussions between participants, making connections between theoretical and practical aspects related with the presented topic.

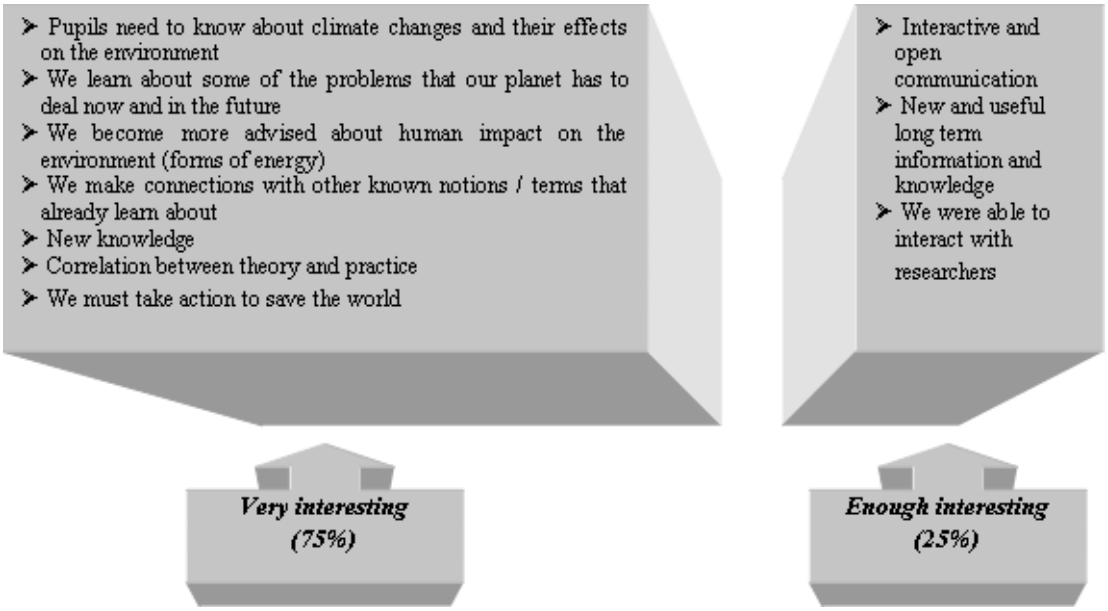
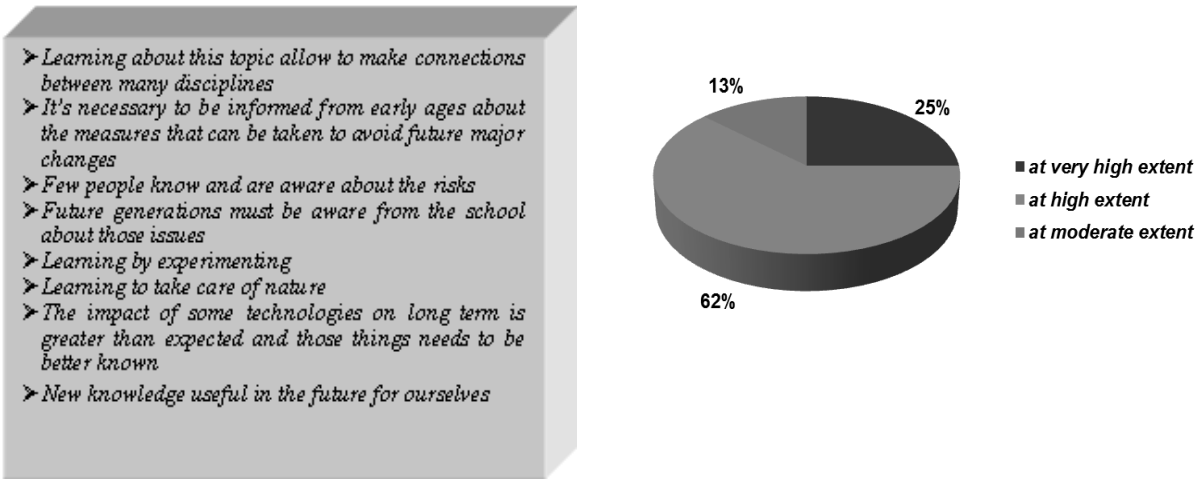


Figure 05. General view / comments from students' perspective on the "*Ocean Acidification*" non-formal activity

School can intermediate the knowledge transfer related to climate change, as students pointed out, between other things (mentioned in figure 6), that it is necessary to be informed about what can be done - at least - to slow down those changes, but also related to the new knowledge that can be useful for them in the future. However, the issue seems to be very interested for students, taking into account their *definition* for the activity expressed in one word / sentence (figure 7).



(a) (b)

Figure 06. [Students' arguments for: (a) promoting / sustaining learning about climate change in school; (b) large public access to information related to climate change]

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The *Student's Questionnaire* tried also to point out on which can be the difficulties related to the knowledge about the climate change in school. The students' feedback is summarized below:

- Opposite opinions on the topic issues;
- Some people aren't open to those ideas;
- Many people live in the present ignoring the future;
- Lack of resources, experiments and time - at school.

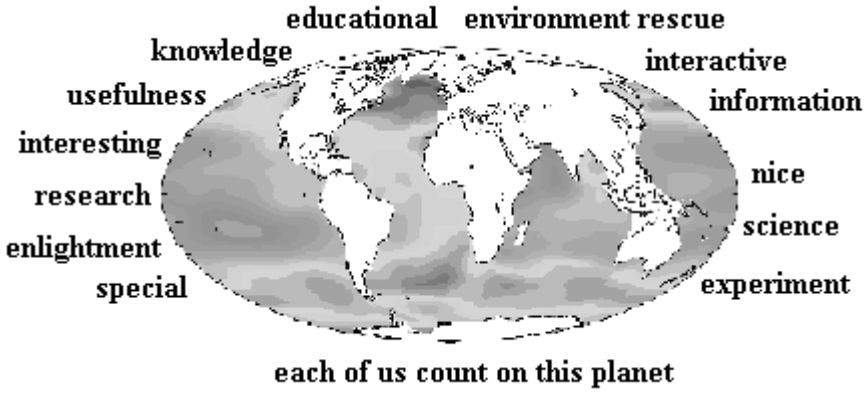

Figure 07. The overall aspects of *Ocean acidification* related activities summarized in one word / sentence by the students

7. Conclusion

The multidisciplinary approach, involving a team which consists of teacher and researcher, both in formal and non-formal education activities, can enhance the students' interest, curiosity and active involvement in the teaching-learning process. The adapted non-formal activity: *Ocean Acidification*, in the frame of the *Climate Change* Unit, produced an important impact both on students and teachers involved, who underlined that such an approach related to Sciences has a stronger impact, comparative to the classical approach.

Numerous reports emphasize the need to revitalize the Science teaching in schools, and it is also often recommended in those reports that Inquiry-based Science Education (or Problem-based Learning) is encouraged, where teaching is conducted through an inductive (rather than deductive) method. The dimensions of *Responsible Research and Innovation* can be valorised by the adequate use of stimulating learning methods in the non-formal education space (Anghel et al., 2015). Any research needs to be clear in its focus and purpose, and provide opportunities for children and young people to engage in a meaningful and relevant way (Clark et al., 2013). In this way, children and young people can become active and empowered citizens in their own communities and beyond.

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