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Ocean acidification education: educational resource analysis

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Abstract

This article aims to establish synergies between Science Education, Environmental Education and Marine Science (Campus do Mar), which has already begun, in order to provide ocean acidification education resources for Primary School teachers in pre-service training Global reports, based on emerging ocean acidification science, indicate that this process can be of the same magnitude as climate change; hence its importance to humanity's future. The existing on-line resources have been located, an initial revision of them has been carried out, and a set of analysis categories has been proposed in order to subsequently design educational interventions connecting scientific knowledge, values and attitudes. These will lead to acquiring scientific competence and to acting in favour of the environment as well as developing critical thinking. A collaboration with other institutions has begun to influence non-formal education.

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1. Introduction

For more than two decades, attention has been drawn to an urgent planetary situation. Climate change is a problem of enormous environmental, social, economic, and political consequence, it hinders equality (Araujo et al., 2015; Álvarez-Lires, 2015), and it poses a major challenge affecting humanity.

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In this sense, the planetary limits concept proposed by the Stockholm Resilience Centre (Rockström et al., 2009) identifies the environmental processes that determine the stability of the components of the Earth's system. These include: climate change, depletion of the ozone layer, ocean acidification (OA), change in land use, the use of fresh water, loss of biodiversity and human interference in the nitrogen and phosphorus cycles. Finally, there is also chemical pollution and aerosol loading. Security limits have been set for the first seven concerns, and the lower ends of the margin of uncertainty as defined by science –those of least risk- have been chosen to implement a precautionary principle. As an example, for climate change the limit was set at 350 ppm (parts per million) of CO2, while science indicates that the risk of crossing an inflection point is within the margin from 350 to 550 ppm of CO2. Rockström (2011) states that we must rethink human development in this new era, the Anthropocene, and that we must urgently invert the trend of negative world climate change to stay within a safe zone for the Earth. Steffen et al. (2015) indicate that four of the planetary limits are in the danger zone: climate change, loss of biodiversity, eutrophication (interference with the global cycles of nitrogen and phosphorus) and changes in the Earth's system.

Among the nine processes mentioned above, OA is one of the threats to its sustainability: when CO2 released into the atmosphere penetrates seawater, a set of chemical reactions occur. This is a problem detected recently, but its implications could reach the importance of global warming. The studies cited show that the CO2 currently captured by the surface zone of the ocean - and its consequent rate of acidification - happens about 100 times faster than it did at the end of the last ice age (20,000 years ago), which was the last time CO2 increased significantly.

The increase in CO2 levels in the atmosphere not only raises the temperature of Earth's atmosphere, but it is also responsible for the drastic alteration of the inorganic carbon chemistry embedded in sea water, generating declines in pH, and giving rise to the OA process. The lowering of oceanic pH values is well documented. The last IPCC report (2013) states that the pH of surface seawater has decreased 0.1 units from the beginning of the industrial era, which corresponds to an increase of 26% in the concentration of hydrons. It is also estimated that the increase of OA will mean a lowering of seawater's pH varying between 0.06 and 0.32 units according to the scenario considered. OA modification implies, in turn, a change in the biogeochemical cycles of many marine compounds and elements. Among the effects resulting from the changes in the carbonic acid and carbonate equilibria in sea water, the most studied and probably the one with the greatest global impact is the decrease in the saturation state of calcium carbonate, which affects the calcareous skeleton building capacity of organisms such as molluscs, echinoderms, or coral but also affects the fall of phytoplankton (UNESCO, 2009). Scientific studies and reports focus on understanding the consequences and mechanisms of this global problem, and on identifying strategies to deal with it (UN GSP, 2012; Mace et al., 2014; Galaz, 2014). There is an urgent need to ensure that these findings are disseminated to address this problem.

2. Scientific education's role

Regarding education's role in this situation of planetary emergency, the Conference on Human Environment (Stockholm, 1972) made a plea to the education contribution in order to form an aware citizenry able to participate in the decision-making process. The Earth Summit (Rio de Janeiro, 1992) repeated the call, but the lack of response and worsening of the situation generated, at the Second Summit of the Earth (Johannesburg 2002), the launch of the Decade of Education for Sustainable Development (2005-2014) so that education can play its role in sustainable development (Vilches and Gil, 2007).

Martínez–Huerta (2009) suggests that sustainability-focused education helps us understand the relationship between the elements of sustainable development from a point of complexity, both in its diagnosis and in the possible solutions, since they give countless inter-retro-actions between economic, social, demographic, political, ideological, religious, etc., processes. (Morin, 2011). Thus, sustainability education (SE) is a complex and intentional process, as is every educational process, which involves acquiring conceptual knowledge and values, as well as the development of attitudes, aptitudes and modes of action in social interaction. This process cannot be carried out exclusively nor detachedly by educational systems, and it involves processes of formal and non-formal education (Varela Losada et al., 2014). Therefore, SE and Environmental Education (EE) must be oriented toward the development of a competition for action based on training the student group in the acquisition of critical thinking that contributes to the formation of an informed citizenry committed to the environment and that plays an active role