AN ANALYSIS OF CONTEXT AND LEARNING ENVIRONMENT MODELS IN SCIENCE EDUCATION RESEARCH AND PRACTICE

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Abstract: The presentation aims at in one hand reviewing different models of "Context" used in context-based science curricula and teaching, in the other hand identifying different views of the concept "Learning environments" as used within science education literature as well as education more generally, and finally establishing relationships between the views of Context and Learning Environments to show their complementarities as the basis for a unified view. Four models of context are reviewed: (a) Context as direct applications of concepts; (b) Context as reciprocity between concepts and applications; (c) Context as provided by personal mental activity; and (d) Context as social circumstances. In addition three views on learning environments are also reviewed: (a) Learning environment as a psychosocial entity; (b) Learning environment as a system; and (c) Learning environment as a community. The comparative analysis appears to indicate that both Context and Learning Environments experience a sociocultural turn which embraces complexity and diversity. A cartography of contexts for science education is presented based on a set of attributes taking into account the four worlds that are interconnected such as school science, everyday science, professional science and citizens' science. At the end a model of context as Complex Learning Environment is set so that it can be a tool to account for the increasing complexities that science education needs to face today such as interdisciplinariety, students and teachers' diversity, and diversity of settings. The characteristics of such model will be presented, examples from school agroecology provided, and research questions identified during the presentation.

Key words: Context-based science education, learning environments, environmental education, science education, out-of-school learning

INTRODUCTION

Science education has adopted a context-based approach to curriculum and teaching to address the challenges faced by the science education community worldwide. Despite the interest towards context-based approaches very little programs and curriculum developments have been explicit in relation to the framework adopted (Gilbert 2006; King and Richtie 2012). There is an urgent need to clarify the meanings of context used in many influential context-based science education experiences, so that theoretical as well as practical advances can be made.

In addition influential global organizations from economical and political strands like the OECD-CERI (Center for Educational Research and Innovation) are at present undertaking worldwide studies on Innovative Learning Environments (ILE). Although we might not share their ideological background the social and political impacts of this institution's studies and programs are important and need to be taken seriously. The results of the ILE case studies (Dumont, Istance & Benavides, 2010) point at interesting issues which although they are not framed within science education explicitly they might be relevant to initiate a reflection on science education learning environments. The ILE case studies state that there is a need to reconsider learning and learning environments within innovative education reforms since the educational school experiences selected are: (a) Not sufficiently learning focused since they are described in terms of institutions and very little in terms of learning, (b) not sufficiently innovative focused since the experiences assume existing institutions and discourage innovations, hybrid and non-formal or informal learning, and (c) not sufficiently holistic or environmental focused since the experiences encourage fragmented learning based on single schools, single classes, and single teachers.

Finally, our recent work on promoting school agroecology through community networking (Espinet and Llerena, 2011; Espinet 2012) has triggered the need to re-conceptualize both context and learning environment at the interface between science education and education for sustainability. The learning environments and contexts designed in school agroecology are more complex than those usually chosen in science education. How can we develop a model that takes into account the complexities of both contexts and learning environments designed to promote better science education towards sustainability?. How can this model be useful for science education research and practice so that the diversity of educational levels, situations, content, students and teachers are taken into account?

AIMS

The presentation aims at in one hand reviewing different models, attributes and activities associated to "Context" used in context-based science curricula and teaching. On the other hand the presentation introduces the idea of context cartographies in science education as a way to map the diversity of contexts at hand in science education based on the authors work on school agroecology. Finally a model on how to think about the characteristics of science learning environments is presented. The ultimate goal of this discussion is to resituate the concept of learning environment for context-based science education and to set the key characteristics of a Complex Science Learning Environment model with examples taken from school agroecology.

CONTEXTS AND LEARNING ENVIRONMENTS HEADING TOWARDS A SOCIOCULTURAL TURN

The concepts of Contexts and Learning environments are often used interchangeably within the science education literature. Several questions could be asked to identify the place of both concepts in science education research and practice: In what ways are these concepts understood within the science education literature? Is there a progression on their conceptualization so that the situation, the content, the learner, and the teacher are taken into account interdependently? And finally, how is the diversity of content, learners and teachers being considered?

Models of Context

Although very few context-based courses have historically been based on an explicit model of context, Gilbert (2006) identifies four models. Taking into consideration the attributes for defining a context, the author identifies four models which represent four inductive ways of understanding context in chemistry context-based curricula and teaching: (a) Context as direct applications of concepts; (b) Context as reciprocity between concepts and applications; (c) Context as provided by personal mental activity; and (d) Context as social circumstances. These four models are organized in a progressive manner on the line of a continuum from less to more complex. Whereas the first model focuses only on the conceptual aspects of context being the learner and the social totally absent, the fourth model takes into consideration the concepts, learners' engagement and the social in its framing through the concept of community of practice (Greeno 1998). In this latter model I would include the unified view of context developed by King and Richtie (2012) using the sociocultural concept of field and I would stress the important notion the authors develop on fluid transactions among fields as a way to understand context-based learning and transfer in science education.

Views on Learning Environments

In a recent study undertaken by OCDE-CERI on Innovative Learning Environments (ILE) (Dumont, Istance & Benavides, 2010), the authors indicate that innovative schools worldwide offer poor learning environments being them too institutionally centered on one teacher, one group of homogeneous students, and only one subject. Espinet (2012) has set an interpretation of views on learning environments used in the science education research literature from different perspectives: (a) Learning environment as a psychosocial construct resulting from the interaction between the environment and the learner personal characteristics exemplified by the work of Fraser (2012) ; (b) Learning environment as a system exemplified by the French work on "didactical situations" and "didactical systems" (Otero 2010); and (c) Learning environment as a community exemplified by the work on science teacher preparation inspired by Wenger (1998). These views are also organized in a progressive manner from less to more complex. In the first view only the nature of social climate for learning is taken into consideration, whereas in the second view the focus is on building systemic learning interactions in didactical situations. Finally the third view acknowledges the social nature of learning environments which is situated and activated through the use of resources.

The comparative analysis appears to indicate that both Context and Learning Environments experience a sociocultural turn which embraces complexity and diversity.

EXPLORATION OF CONTEXT CARTOGRAHIES IN SCIENCE EDUCATION

The identification of context complexity and diversity in science education involves the agreement of a set of attributes which help the characterization of such contexts. In doing so we are better equipped to map the important context types which can be used in science education. I use the concept of cartography as a metaphor to start thinking about context complexity and diversity. Gilbert (2006) and Gilbert et al. (2011) had already identified four context attributes: (a) a setting as the result of social, spatial, and temporal frameworks; (b) a behavioral environment of encounters related to the task; (c) the use of specific language; and (d) a relationship to extra-situational background knowledge. This formulation has one important problem which is to find the place of the subject in this context. From a sociocultural perspective these attributes could be reformulated: (a) a community of practice with a diversity of spatial and temporal arrangements; (b) participating in an activity; (c) using specific language within multilingual environments; and (d) crossing boundaries among different communities of practice.

The context cartography of science education is organized around four intersecting worlds: school, everyday, professional and social worlds. These four context types sustain four different communities of practice which hold different science education aims: school science, everyday science, experts' science, and citizens' science. Science education experiences an important tension related to the way students and teachers interact with these four contexts which I would call "in-out tension": should we take students and teachers out of school to be part of the professional, everyday, or citizens' authentic science contexts leaving school context with no relevance? Or else should we bring to school these different contexts and thus engaging students in a not so authentic activity of learning about these out of school contexts? The central challenge could be formulated as how can school science relate to the other science contexts so that it develops authentic practices for students, teachers and community members?

The cartography of agroecology as a STEM discipline could be mapped using the four intersecting fields just stated: (a) school world as school agroecology; (b) everyday world as community agroecology; (c) professional world as agronomy and ecology; and (d) social world as agroecological activism. The challenge for school agroecology would be how to create authentic contexts in school for students and teachers to develop authentic agroecological practices in relation to the school food system. This would imply to introduce the four components of the food system in the school open to students and teachers' participation: (a) food production by developing the food garden through gardening; (b) food transformation by participating in the school kitchen through cooking; (c) food consumption by participating in the dining hall through the menus; and (d) food distribution by participating in the exchange of food within and outside the school. These four school agroecological practices would act as authentic contexts for science learning and would also facilitate the connection with the out of school agroecological practices as well.

A MODEL OF CONTEXT AS A COMPLEX SCIENCE LEARNING ENVIRONMENT

The comparative analysis appears to indicate that both Context and Learning Environments experience a sociocultural turn which embraces complexity and diversity. A model of context as Complex Learning Environment that takes into consideration the increasing complexities and diversity in science education will be proposed. The characteristics are the following: (a) *Systemic Level:* The model could be general enough to include the systemic level where it is applied in science education: at the level of a specific activity, at the level of a teaching unit, at the level of an inquiry process, or at the level of a whole school.; (b) *Lifelong Learning:* The model could be applicable to all educational levels from infant to secondary science education so that a progressive view on lifelong science learning environments is reflected; (c) *Context:* The model understands context as a focal event embedded in its cultural setting; (d) *Time and space:* The model considers new spatial and temporal arrangements which depart from traditional classroom organizations; (d) *Learners and teachers' communities:* The model acknowledges larger and more diverse communities where to establish learning relationships between diverse learners and teachers; (e) *Learning as boundary crossing:* The model understands learning as a process of boundary crossing among a diversity of learners, teachers and content (Akkerman and Bakker 2011). The characteristics of such model will be presented, examples from school agroecology provided, and research questions identified during the presentation.

IMPLICATIONS

Recent reflections on the nature of learning point at the need to reconsider the traditional learning environments through which we develop science education in schools. The first implication deals with the idea that there are at present many different ways to participate in science depending on the worlds we take as referents. Better ways to connect in and out the different worlds of science should be taken into consideration when implementing school science curriculum. The second implication is related to the fact that school is one but not the only place where to learn science. The systematical planning and designing of learning paths melting formal, informal and non-formal science education learning environments appear as an urgent endeavor to avoid losing learning opportunities through the lifespan of our students. Finally it appears also imperative to rethink schooling so that science learning environments become more authentic, action oriented, equitable, and put at the service of a wider and more transformative general education.

This work has been partially supported by Spanish MCYT grant EDU-2009-13890-C02-02, Spanish MCYT grant EDU-2012-38022-C02-02 and Catalan PRI 2009SGR1543.

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