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# The local territory as a resource for learning science: A proposal for the design of teaching-learning sequences in science education

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**Abstract**

The present work arises from the need to reform Science Education, particularly through the contextualization of teaching. It is proposed to achieve this through the use of local territory as a resource for the design of teaching-learning-sequences (TLS). To do this, an interdisciplinary group of researchers and teachers from a Secondary School created a Professional Circle for Reflection on Teaching, which constructed an emerging conceptualization of Territory, analyzed the possibilities of the local area and established a relationship with the national curriculum. On this basis the TLS were designed, with an interdisciplinary aspect, and implemented with pupils aged 14 to 17. The results show that the contextualization of teaching through the use of local territory is possible, and is positive for pupils, and that collaborative work and reflection by teachers are fundamental for this process.



*Keywords:* territory, teaching-learning sequence, science education;

## 1. Introduction

Science is a strategic axis of human development, since it implies not only strengthening the critical capacity of a society, but also a contribution to social inclusiveness and equality, considering that today *scientific literacy* is a universal necessity. Scientific literacy is understood as a set of scientific knowledge, capacities and attitudes which will allow a better understanding of the natural-social medium, the realities established there and the power to act in one's Territory participatively and on a well-grounded basis. This has become an important issue, both for educational research and for promoting a scientific culture (AAAS 1989; Driver, Newton and Osborne 2000; Ratcliffe and Grace 2003; Sadler et al 2007). Chile's results in international science tests place the country below the international average, and in particular they show great inequality in learning (González-Weil, et al., 2009). This is serious, because the inability to understand scientific contents and the implications of these for everyday life also

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implies that the pupils are unable to understand their natural and social environment. This in turn makes it difficult to create a sense of responsibility towards the environment, leading in the future to a lack of citizens who can play a part in the development of their country. One reason which explains the low level of the results of science learning is a teaching system which does not sufficiently contextualize the contents of school curricula, and does not link them to the environment in which pupil and school exist. This implies that what they are learning often does not make sense to the pupils, and therefore they lack the motivation to learn. At best, the local area is mentioned as a simple example of some topic, without active teaching techniques, instead of being used as a resource for presenting the pupil with problems rooted in known situations which will help towards a real understanding of the Territory in which he/she lives. In general, this lack of connection between the content taught and the pupil's environment is expressed not only in classroom teaching, but also in the relative absence and/or irrelevance of any teachers' science projects which place value on the natural and cultural environment in which the pupils study and live. Less frequent is the integrated presentation of curriculum contents taken from different subjects, and this is one reason why in general there is no collaborative, interdisciplinary work by teachers and little incentive to carry out such work. Thus, even if the intention exists to foment inter- and multi-disciplinarity through the contents and objectives of the Chilean National Curriculum (MINEDUC, 2009a; 2009b), focuses and materials are required for a more explicit and concrete proposal for such integration. At the same time, school textbooks, like the majority of teaching materials, are generic throughout the country. Because they are for nationwide distribution, they do not contextualize each particular situation, and therefore do not encourage the use of the local territory by the teacher in his/her teaching, nor understanding of it by the pupils. In this situation, it is of fundamental importance to involve teachers in works of collaborative reflection which will enable them to incorporate the use of the local territory, from a multi-disciplinary viewpoint, into their teaching. This underlies the proposal to work with local territory as a resource for the design of Teaching-Learning Sequences (TLS) in sciences.

## 2. Literature review

The use of territory as a source of research, exploration and experimentation allows pupils to observe, describe, hypothesize, record, analyse, evaluate and appreciate. This will help them to develop their scientific literacy and their capacity to express ideas and experiences, propose their points of view and act on an informed basis. Nevertheless, the implementation of the proposal implies a series of changes in the classroom and in teaching practices. It requires teamwork, to promote dialogue and exchange between pupils and teachers, and among pupils.

### *2.1. Problem-solving as a learning strategy which will help bring the pupil closer to his/her environment*

The basis for the generation of scientific knowledge is facing problems which demand the generation of new models, languages and techniques/procedures in order to solve them. This may mean extending knowledge to embrace new phenomena, using an inter- or intra-disciplinary approach, and resolving disagreements. Nevertheless, problem-solving as a learning strategy implies re-thinking these problems as learning situations, in other words, it is they that permit the emergence of new knowledge. They must be real problems (Lee, 2007; Norton *et al*., 2007; Reigosa and Jimenez-Aleixandre, 2007), in the sense that they ask good questions: that make the pupil think, that he/she can understand and share, and formulate in his own words (Garlick & Laugksch, 2008). Likewise they must be relevant for the pupil in the context of science learning, in other words, relevant to the subject. They must also connect with global (territorial) problems which are of interest to specialists, because they are also problems from which the pupils will learn to become scientists (Dalongeville, 2007; Dunn, 2011). In short, the problems which the pupils have to solve must be relevant to the key ideas of the contents and objectives of the curriculum; they must take into account the pupils' prior knowledge (contents and procedures), and they must ask good questions.

### *2.2. The process of transforming teaching practices to incorporate territory as a teaching resource*

The design of new ways of teaching (TLS) for science learning, which consider the concept of territory, necessarily involves the transformation of the practices used traditionally by teachers to teach science. According to a report by the Chilean Academy of Sciences, the scientific education of the pupil, particularly in secondary schools, is characterised by the learning of disaggregated contents by rote, with a comprehension of science which is decontextualized and unrelated to everyday experience (Albertini *et al*., 2005). There is therefore an imperious need for a change in teaching practices, from being based on the teacher's knowledge to concentrating on the pupil's learning process, which requires the teacher to reflect on his/her classroom actions.

### *2.3. Design of teaching-learning sequences (TLS) in sciences*

One of the important lines of research into science teaching, dating back to the 1980s, involves the design and application of science TLS. One distinctive characteristic of a TLS is its inclusion in a gradual, research-based process, in an evolving framework, with the object of interweaving the pupil's perspective with the scientific community (Méheut & Psillos, 2004). In this particular case, TLS have been designed to allow the interdisciplinary teaching of Sciences involving the use of the local territory. Our ideas are based on the proposals of Méheut (2004) and Viiri & Savinainen (2008), both empirical and theoretical, as well as the methodological tools, the classroom validation processes and the focuses proposed to describe the design of these sequences.

## 3. Research methodology

### *3.1. Participants and context*

TLS focused on problem-solving were drafted in a partially subsidised private school in the city of Viña del Mar, Chile. In this context, a group of researchers from four disciplines (Biology, Physics, Geography and Chemistry) worked in a logic of participative observation with the school's teaching team in the following subjects: Biology, Physics, History, Geography and Social Sciences, Mathematics and Philosophy. They were all secondary school teachers, with pupils aged between 14 and 18, from a middle to low socio-economic background. The research process was supported by a group of Science-pedagogy and Geography university students, and by the school directors.

### *3.2. Focus and design*

The focus of our work was interpretative. This research assumes that the knowledge gained from teachers' contributions and what we can learn from them is epistemologically valid. Likewise this knowledge guides teacher training and/or improvements in educational practices, and is more relevant when illuminated by critical reflection and self-reflection (Imbernón, 2002). The strategy used was a Professional Circle for Reflection on Teaching, which favours collaboration and dialogue concerning beliefs in teaching, questioning of one another's beliefs by participants, argumentation, reflection, construction and consensus of a collective agreement, and taking teaching decisions. The work was divided into four phases: 1) Formation of the team and Curricular Mapping, 2) Design of TLS, 3) Implementation of TLS, 4) Monitoring and Evaluation. The TLS developed were validated by experts, by application in the classroom, with data from the pupils and against the national curriculum.

### *3.3. Curricular mapping*

A curricular map is a graphic representation of one or more curricular disciplines to enable them to be organized and their contents-learning distinguished. Curricular maps show the general structure of a subject, allowing a general overview of the distribution of the elements of which it is composed, and the relations between them. They are created using a variety of sources, with various curricular instruments being compared and analysed: Curricular Contents and Objectives, and the Learning Progress Map (MINEDUC, 2009a; 2009b). Construction took account of the concept of Territory, and how the different contents are linked to the local area.

### *3.4. Design of Teaching- Learning Sequences (TLS)*

Design of the TLS drew on the result of the curricular mapping, and on the characteristics of the local area around the school, which was where the pupils lived (geo-referencing). These data were obtained by surveys. The guiding strategies for drafting the TLS were basically problem-solving and scientific inquiry. Once designed, the TLS were implemented at different levels and evaluated in the final presentations, given by the pupils at a science fair.

## 4. Results and discussion

### *4.1. Curricular mapping*

The first result of this process was a document with the consensus achieved in the construction of the concept of *Territory* by all the participants. This concept was of key importance for orienting the course of subsequent work. The pupil surveys produced a geo-referenced map showing the homes of the school's pupils, complemented with photographs of places (urban or rural spaces) which hold significance for them. Finally, curricular maps were obtained for all the disciplines involved. A concrete example of this may be cited from the History-Geography area, in ninth grade. The contents refer to six study fields. For five of these, the objective is to understand the 20th century as a period in which the roots of the achievements, problems and conflicts of today's society can be found: The two World Wars and the New International Political Order, The World in the second half of the 20th century, The Urbanization Processes of the 20th century, World Population Geography, and The Globalized World are its successes and failures. As an example of these contents, the axis of Migratory Processes was linked to the repercussions which this phenomenon has had in the cities of Viña del Mar and Valparaíso (the local territory where the school is located and the pupils live). Based on this information, the pupils talked about the settlement patterns of the immigrant population and their influence on the political, economic, architectural and cultural development of these cities. The curricular maps for each discipline became raw material for developing interdisciplinary teaching sequences.

### *4.2. Teaching- Learning Sequences (TLS):*

The teaching sequences were designed and implemented with an interdisciplinary focus. Thus three teams were formed with teachers from different disciplines: 1) Biology, Chemistry and Philosophy; 2) Physics, History-Geography and Chemistry; 3) History-Geography and Mathematics. In this dynamic, the concept of Territory acted as a common focus between the disciplines. The three teams developed their TLS following a learning cycle (Sanmartí, 2002), consistent with problem-solving and scientific inquiry, consisting in carrying out four types of activity: 1) Initial activities, which involved presenting problems or hypotheses; 2) Activities to promote the evolution of the initial models, introduce new variables, identify other ways of observing and explaining, and reformulate the problems; 3) Synthesis, drawing conclusions, structuring of knowledge; 4) Application, transfer to other contexts, generalization.

Among the various sequences generated, two general types could be distinguished. The first was a sequence which developed interdisciplinarity and the concept of territory around a common concept: the *scientific model* (teams 1 and 2). The object was to generate understanding in pupils of how scientists generate explanations of a particular phenomenon. These phenomena were seen in the local area, particularly the beach. The second type of teaching sequence (team 3) adopted a methodological focus. The object was to achieve convergence in the type of activities required of the pupils. These concentrated on processes of collection by pupils of data about the territory, through interviews. The way in which these elements were processed varied according to the discipline. In mathematics they were processed quantitatively through frequency tables, while in History and Geography they were processed qualitatively by attaching value to the biographical accounts of the interviewees.

## 5. Conclusion

In general, this experience provides evidence about an innovative and practicable teaching method for teachers in the school system. The focuses of the work were the collaborative relationship between peers, and curricular analysis as a way of making integrating proposals which improve science learning and skills development among our pupils. Curricular Mapping, in particular, allowed all the curricular instruments designed and established by the Education Ministry to be homogenized and integrated, with the object of inter-relating them under certain learning contents and objectives, which become the foundation for the design and implementation of TLS. The process of implementing the TLS showed that the contextualization of teaching as a function of the local territory is possible, even from an interdisciplinary perspective, and that its use is highly positive, both for motivating the pupil to study science and other sub-sectors involved, and for the link that this can create with contents in relation to their local area.

In terms of professional development, the project allowed teachers to participate voluntarily in a space for reflection, in which they were directly involved in the process of taking decisions on the curriculum, and moreover committed themselves to an initiative which allowed them to propose a different way of carrying out the teaching-learning process, which takes into account the origins and interests of their pupils. In this way, the generation of interdisciplinary TLS allowed problems to be identified which were common to the disciplines, and this had the direct effect of making it easier to form the teacher work teams.

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