

# Interdisciplinary Lesson Study in Italian High School focused on the energy transformations.

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**Abstract.** This research focuses on the educational experiment of Interdisciplinary Lesson Study, carried out with 15-year-old students in Italy on the energy transformations. The teaching was carried out following the IBSE model of 5E and involving teachers from several disciplines. The theoretical lens used to read the data is the Lotman's idea of Semiosphere revisited in the educational context. It seems that collaborative teaching processes make teachers aware that asymmetry between disciplines can be an engine of knowledge. Moreover, these processes can also improve the teaching disciplinary actions.

## Introduction

Lesson Study (LS) is an approach to continuing professional development [1]. LS has its roots in Japan, where it has been practiced by Japanese teachers for 140 years or more [1]. And since the beginning of the twenty-first century LS has become a global phenomenon [1]. In Italy, LS is being practiced especially in the field of mathematics education [2], and in physics education [3]. In this work, Interdisciplinary Lesson Study (ILS) is proposed. It is a research line that, at least in Italy, has not been followed as much as that of Lesson Study on single disciplines. The ILS experimentation that we will describe is focused on the energy transformations, a physics field, but it requires reflections and attempts at solutions that come not from a single discipline. It was carried out in two scientific high schools in Campania, in the south of Italy and involved 15-year-old students, teachers of Italian, Mathematics, History, and Physics and researchers from the University of Salerno and the University of Bari. The teacher who works within a cognitive domain, understood as the set of knowledge and epistemologies that characterize a discipline, often sees as non-culture - in Lotman's sense - [4] the cognitive domain of other disciplines. The aim is to analyze the overcoming of certain disciplinary boundaries [5], making the teacher more aware of what he sees and feels is foreign to himself; to analyze whether the disciplinary teachers can approach the teaching of their discipline in a different way, taking advantage of the contact with epistemologies and methodologies of other disciplines; to see if, in addition to a collaboration between teachers and researchers, the collaboration of teachers of different disciplines can be successful for the teaching-learning process of Physics.

## Theoretical framework

The theoretical framework that allows us interpreting ILS is J. Lotman's one [4], from which we borrow the idea of Semiosphere and its boundary as an element that defines the identity of the disciplines but does not separate; on the contrary, it becomes a meeting place for various cultural and disciplinary domains, a fertile ground for the cross-cultural competences necessary for the student of the 21st century. In this LS, we want to cross the borders between disciplines by showing how it can also be a method for teacher professional development from an interdisciplinary perspective. The research question guiding this work is: how can collaboration between teachers from different disciplines foster teacher professional development in their disciplines?

## Methods and findings

The Lesson Study follows a cyclic way [1] set out in 5 phases: co-planning, teaching, observing, reflecting, refining. The project group, which experimented with this LS, consists of two researchers in mathematics and physics education and four teachers from different disciplines (physics, mathematics, history, italian). The lesson is taught by the physics teacher. The other teachers contributed to the planning of the lesson and provided students with the prerequisites needed to deal with the lesson. During the co-planning phase, teachers from different disciplines came together to choose the topic of the lesson and plan the activities (Lesson Plan). It was chosen to focus the lesson on the topic of Energy Transformation because it is a topic very close to the current world political situation and included in Goal 7 of the 2030 Agenda. The lesson was planned by following the 5E IBSE methodology [6]. During the engage, students were provided with documents from newspapers highlighting the energy problem, which has been emphasized by the war in Ukraine. Students were challenged to question what forms of energy that could be alternatives to produce electricity. During the explore, statistical data of different energy sources provided by the BP Statistical Review of World Energy were analyzed. During the explain, the mechanisms of energy transformation were clarified. The extend consisted of making an electric motor that enables the transformation from electrical energy to mechanical energy. During the teaching phase, physics teacher implemented the lesson with her students, while a researcher and the other teachers assisted with the lesson. During the reflecting phase, the videos of the lesson and the observation sheets completed by the observers were analyzed. Some critical issues of the lesson emerged. At the end, during the refining phase, changes were made to the Lesson Plan with reference to the critical issues that emerged.

## Conclusions

Collaboration among teachers from different disciplines proved to be valuable. Teachers realized that some topics, specific to the physics curriculum, do not have a clearly delineated disciplinary identity but need to be addressed by crossing boundaries. Teachers gain awareness that asymmetry between disciplines can be an engine of knowledge. Only by crossing some borders do they contribute to forming students as 21st-century citizens.

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