

Towards integrated science education through collaborative project-based learning: Teachers' perceptions, experiences, and practices

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Honored Custos, honored Opponent, members of the audience

The topic of my doctoral dissertation is "Towards Integrated Science Education through Collaborative Project-Based Learning: Teachers' Perceptions, Experiences and Practices". In this introductory lecture I will shortly present my thesis starting with the aims and finishing with the main findings and conclusions.

ISE is not a new idea. The basis of integrated education was put forward in the early 20th century by John Dewey with his idea of school as a small society where education is integrated to everyday life and learning is based on doing. So why are we still talking about integration a century later?

Mainly, because we need to promote the relevance of science education. In the beginning of the 21st century, school science was critiqued for:

- producing fragmented understanding of science concepts
- for not providing pupils an understanding of how science is actually done and how it is linked to everyday life

For example, in chemistry real-life phenomena are explained with scientific concepts, symbols and submicroscopic particles; atoms and molecules that are invisible to the eye even with a microscope. This abstract nature is an integral part of school chemistry; however, many pupils are unable to see the connection between real-life phenomena and the chemistry knowledge. As a result, pupils have seen chemistry as difficult and uninteresting.

Consequently, the interest in ISE has increased. It is a potential method to teach the key competences of the 21st century and for making science education more relevant.



Even though integrated education has been widely adopted in curricula across the globe, including in Finland, there are still issues that require our attention as researchers.

1. The lack of a uniform vision of ISE makes it difficult to determine the quality of integrated education and to evaluate its effects.
2. Research has shown that implementing ISE is difficult to teachers.
3. Research has shown a strong relationship between teachers' perceptions and their practices.

If we wish to increase the relevance of science education through integrated approaches, then we need to understand teachers' perceptions of and experiences with ISE as well as their current integrated practices. These formed the three research questions of this thesis.

The aim of the thesis is to understand how integrated science education (ISE) can be promoted at different educational levels by supporting teachers.

The theoretical framework of my thesis is largely built upon the following concepts.

- Integrated science education (ISE) aims at integrating science curriculum content into a meaningful whole by a constructive and context-based approach that crosses subject boundaries and links learning to the real world.
- Collaborative Project-based learning (PBL) organizes learning around collaborative, inquiry-based and student-centred projects which can promote interconnected worldview and links among disciplines.
- Teacher's perceptions and self-efficacy beliefs are a part of an educational belief system which includes various interconnected educational beliefs that affect teacher's behaviour in the classroom.

This thesis is a qualitative-dominant mixed-method research that is based on 4 publications. The publications focus on teachers'

- practices of art and science integration
- perceptions and self-efficacy related to ISE,
- perceptions and practices of PBL
- design principles of ISE.

The research methods used in the individual studies are survey and case study. The data has been collected from 2015 to 2020, and it is during this time that the current national curricula promoting integrated approaches have been implemented in Finland. The main analysis method was qualitative content analysis.

For addressing each research question, multiple methods have been used and data has been collected from various sources and during different times.

Here are the main findings per research question.

First, how do science teachers perceive ISE and PBL? A majority of science teachers seemed to have an understanding of integration, however their definitions and design principles for ISE varied. In addition, teachers perceived integrated approaches as relevant for science education but challenging to implement. Self-efficacy emerged as a key factor explaining teachers' perceptions of and their lack of confidence in implementing ISE.

Second, what kind of experiences do science teachers have of integrated practices? Teachers' experiences varied greatly. Based on these results it seems that especially secondary school science teachers in Finland have little experience with integrated practices such as PBL, and they are unaccustomed with interdisciplinary collaboration. The results indicate that teachers' experiences with integrated activities and interdisciplinary collaboration correlate with their views of ISE and self-efficacy beliefs.

Third, what kind of integrated practices do science teachers have? Teachers integrated practices with science and art integration and PBL were studied within this thesis. The presented framework from study I highlights the possibilities of connecting art and science through activities or links in content. The results on teachers' PBL practices indicate that even the implementations of active teachers who voluntarily share their practices and participate in a PBL competition seem to be lacking in certain key aspects, for example, in relation to assessment and reflection.

To conclude I wish to highlight two things.

1. First, teachers need a flexible and feasible pedagogical model for ISE that can be implemented with various student groups, subject combinations; with different curriculum contents; and in various learning environments. To answer this need, a pedagogical model for ISE was drawn that takes into account the design principles stated in research literature as well as teachers' perceptions.
2. Second, supporting teachers through educational programmes and by providing feasible pedagogical models for ISE can have a positive effect on teachers'

perceptions, experiences and self-efficacy beliefs that in turn affect teachers' willingness to implement more integrated practices as is recommended.

Honored Opponent, Professor Miia Rannikmäe, I now call upon you to present your critical comments on my dissertation.