ESERA 2017 Conference
Dublin City University, Dublin, Ireland.
21st - 25th August 2017

PRE-SERVICE CHEMISTRY TEACHERS LEARNING ABOUT INTEGRATED SCIENCE EDUCATION BY COLLABORATION AND DESIGN

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Integrated science education has been promoted by many science education researchers and educational reforms for its potential to teach the key competencies to cope in society in the 21st century and in making science subjects more interesting. Part of this is an understanding of chemistry and its role in everyday life. In order to transfer integrated science education into chemistry classroom practices, it is not enough to ask chemistry teachers to implement integrated approaches into their teaching. We need to educate and support the teachers for them to be able to implement integrated approaches in a relevant manner that supports the pupils' understanding of chemistry as well as the key competencies at the core of integrated education. During fall semester 2016, at a master level course for pre-service chemistry teachers this has been one of the main purposes for making the students design, in collaboration with school teachers, their own pedagogical models and teaching material for integrated science education. The preliminary results of this case study show little conceptual change in understanding of integrated education. However, there are indications that the course has had a positive effect on students' willingness to integrate and their general skills related to research, design and integrated science education. The data needs to be further analysed for more conclusive results.

Keywords: Integrated learning, Collaboration, Pre-service teacher education

CASE STUDY: TEACHING INTEGRATED SCIENCE EDUCATION TO PRE-SERVICE CHEMISTRY TEACHERS BY COLLABORATION AND DESIGN

The case study presented here is a part of an ongoing research that aims to promote relevant and integrated chemistry education and teacher training. Main research question is how pre-service teachers' pedagogical content knowledge (PCK) skills and conceptual knowledge about integrated science education (ISE) develop during a course where they engage in design and collaboration.

Many science education researchers (e.g. Czerniak & Johnson, 2014; Samson, 2014; Wei, 2009) and curriculum reformers (e.g. Finnish National Board of Education, 2014; Next Generation Science Standards, 2013) promote the use of integrated approaches in teaching the key competences of the 21st century. The basis of integrated education is derived from Dewey's (1902, 1915) concepts of school as a small society where learning is based on everyday life and activities, and it aims at learning skills and knowledge relevant to the learners as individuals and members of society. Therefore interdisciplinary contexts and student-centred approaches are at the core of ISE.

Studies on the education of science and math (e.g. Brante & Brunosson, 2014; Bennett, Lubben & Hogarth, 2007; Lavonen & Laaksonen, 2009) have shown that similar interdisciplinary and contextual approaches to education can potentially give pupils a more coherent understanding of complex everyday life phenomena and increase students' interest towards school and science subjects.

Haatainen, Turkka and Aksela (2017) revealed study results on Finnish secondary school science teachers' perceptions on integration. Most science teachers seem to have an understanding of the meaning of integration, but these vary. Furthermore, teachers' attitudes towards ISE were positive in general, but they do not see the benefits of integration for teaching the subject matter itself. Also integrated approaches were not implemented into their own science teaching or it was done irregularly and seldom. Similar results have been found in other studies (Czerniak & Johnson, 2014; Samson, 2014; Wei, 2009).

The main barriers for implementing integrated approaches to science teaching are lack of time for planning with other teachers and rigorous timetables in school. Also the support (or lack of it) from the school's community have an effect on the implementation of ISE (Czerniak & Johnson, 2014; Samson, 2014).

These are elements that can partly be avoided with pre-service teacher training. If students have an understanding of ISE, ready tested model for implementation and practice, they will be more prone to use integrated approaches in their chemistry classroom in the future. The most efficient way to ensure research results and pedagogical models transferring into classroom practices is a long-term training that is closely linked with practice, includes reflection and offers peer support (e.g. Van Driel & Berry, 2012; Nilsson, 2014).

Research has not sufficiently shown how ISE should be implemented into classrooms, particularly, in a relevant manner that supports also the learning of science subjects. If moving towards more relevant and integrated science education is a desired goal as has been suggested by researchers and educational reforms, then there is an acute need for research and mapping out of the potential models for successful implementation and teacher training.

Method

This case study was conducted in Finland during a master level course for pre service chemistry teachers from September 2016 to December 2016. The course is one of the last courses pre-service teachers are expected to take and, therefore, they are expected to have a solid understanding of chemistry and pedagogy of teaching science subjects. There were altogether nine students attending the course.

Case study was chosen as a research method because the aim is to understand how pre-service teachers' PCK skills and conceptual knowledge about ISE develop during a course where they engage in design and collaboration.

Main learning goals for the students were to understand ISE, learning to use research when designing lessons and teaching materials and practise implementing ISE in collaboration with in-service teachers. The main task was to design in pairs a unit plan implementing ISE and writing a research article about it. The units consisted of two to four lessons of chemistry and other subjects (e.g. mathematics and home economics). The designed units were tested in the classrooms of collaborating teachers. Contextual and interdisciplinary approaches as well as relevance for subject matter teaching was emphasised while designing. The design was based on a single cycle of design-based research (Edelson, 2002).

Constant support, reflection and feedback opportunities during the design were offered to students, e.g. online platform for questions, group discussions, sharing ideas by presentations, peer review and written feedback from the course assistant. The students were given a lot of autonomy in designing their unit plan (e.g. every-day life context, teaching methods and materials). The appropriate chemistry content and other subjects to integrate into the unit lesson plan were discussed together with the teachers in schools.

The assessment of the course focused on formative assessment, with peer review, discussions and self-reflection as key elements. The assessment had two major parts. 1) The designed unit plans and articles written about the design-based research. 2) A written self-evaluation and a personal oral evaluation with the course assistant at the end of the course.

The data for this case study includes pre and post questionnaire about ISE, students course works (unit plans and articles) and transcriptions of the oral evaluation. A comparison of the pre and post questionnaires has been made. The main method for analysis is qualitative content analysis. However, this content analysis is under way.

Discussion

Because the analysis of the data is at the moment incomplete, only preliminary tendencies are discussed here. There seems to be only limited evidence to show development of understanding and conceptual change relating to ISE. More interesting this course offers many changes for reflection, peer review and it links studies to real classroom teaching settings. These are all aspects of supporting teachers PCK development. The preliminary results seem to indicate the course having positive effect on the pre-service chemistry

teachers' general skills related to collaboration, ISE, design and research. The data will be further analysed and at the ESERA 2017 Conference confirmed results can be presented.

REFERENCES

Bennett, J., Lubben, F., & Hogarth, S. (2007). Bringing science to life: A synthesis of the research evidence on the effects of context-based and STS approaches to science teaching. *Science Education, 91*(3), 347-370. doi:10.1002/sce.20186

Brante, G. & Brunosson, A. (2014). To double a recipe – interdisciplinary teaching and learning of mathematical content knowledge in a home economics setting. *Education Inquiry 5(2)*. Luettu osoitteesta: http://www.education-inquiry.net/index.php/edui/article/view/23925

Cherniak C.M. & Johnson C.C. (2014). Interdisciplinary Science Teaching. In Lederman & Abell (Eds.). *Handbook of Research on Science Education*. (395-410).

Dewey, J. (1902). The Child and the Curriculum. Chicago: University of Chicago Press. From internet: https://archive.org/details/childandcurricul00deweuoft

Dewey, J. (1915) The School and Society. Revised edition. Chicago: University of Chicago Press. From internet: https://openlibrary.org/books/OL13524022M/The_school_and_society

Edelson, D. C. (2002). Design research: What we learn when we engage in design. *Journal of the Learning Sciences, 11*(1), 105-121. doi:10.1207/S15327809JLS1101_4

Finnish National Board of Education (2014). The National Core Curriculum for Basic Education 2014. Helsinki: Finnish National Board of Education. From Internet: http://www.oph.fi/download/163777_perusopetuksen_opetussuunnitelman_perusteet_2014.pdf

Haatainen, O., Turkka, J. & Aksela, M. (2017) Science Teachers' Perceptions on Integrated Science Education. Manuscript in preparation.

Lavonen, J., & Laaksonen, S. (2009). Context of teaching and learning school science in Finland: Reflections on PISA 2006 results. *Journal of Research in Science Teaching, 46*(8), 922-944. doi:10.1002/tea.20339

NGSS Lead States. (2013). *Next generation science standards: For states, by states*

Nilsson, P. (2014). When teaching makes a difference: Developing science teachers' pedagogical content knowledge through learning study. *International Journal of Science Education, 36*(11), 1794-1814. doi:10.1080/09500693.2013.879621

Samson, G. (2014). From Writing to Doing: The Challenges of Implementing Integration (and Interdisciplinarity) in the Teaching of Mathematics, Sciences, and Technology. *Canadian Journal of Science, Mathematics and Technology Education, 14 (4)*, 346 -358

Van Driel, J. H., & Berry, A. (2012). Teacher professional development focusing on pedagogical content knowledge. *Educational Researcher, 41*, 26-28. doi:10.3102/0013189X11431010

Wei, B. (2009). In Search of Meaningful Integration: The experiences of developing integrated science curricula in junior secondary schools in China. *International Journal of Science Education, 31(2)*, 259-277, DOI: 10.1080/09500690701687430