Chemical safety training in chemistry teacher education: Case University of Helsinki

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Abstract: Experimental work is essential in chemistry education, and chemical safety is the base of all laboratory work. Therefore, chemistry teacher education studies must include a chemical safety training. In this poster we describe the chemical safety learning path implemented in the chemistry teacher education in the University of Helsinki.

Keywords: chemical safety, training, chemistry teacher education

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Bachelor level

In the University of Helsinki chemistry teachers' bachelor degree (180 ECTS) consists of chemistry studies (35%), chemistry education studies (18%), 2nd teaching subject courses (30%) and general studies (17%). Laboratory safety training starts immediately in the first fall during their first chemistry laboratory course, where they need to complete a lab safety module (1 ECTS). Next phase is to transform this general laboratory safety knowledge in the chemistry educational expertise. This is achieved in the chemistry education courses that are distributed evenly throughout the degree.

- **Everyday chemistry** (1st year, 5 ECTS) is a course where students perform simple laboratory exercises and demonstrations that are linked to everyday life and suitable for school chemistry. Laboratory safety is addressed from the perspective of school chemistry. Chesse.org site is introduced to students in already in this first chemistry education course (Figure 1).
- **Inquiry in chemistry education** (2nd year, 5 ECTS) is a laboratory-work driven course where students start to build their laboratory work design skills and teaching competence. In the University of Helsinki, we are able to use real pupils in chemistry teaching exercises via the Chemistry-Lab Gadolin. Gadolin is a non-formal chemistry science class that has over 4 000 learner and

teacher visitors annually. This allows student teachers to build a solid base for safe laboratory work for the future teaching career.

- **Chemistry concepts and phenomena** (2nd year, 5 ECTS) is a course where future chemistry teachers familiarize themselves with every chemistry concept mentioned in the curriculum. Every concept has an interface to practical work and laboratory safety.
- **ICT in chemistry education** (2nd year, 4 ECTS) is a course where practical work is addressed from technological perspective.
- **Sustainable chemistry** (3rd year, 5 ECTS) is the last chemistry education course for the bachelor level which adds sustainable competences to future chemistry teachers' skillset. The course also addresses green chemistry and its relation to chemical safety.
- **Non-formal science education** (2–3 years, 5 ECTS) is a hybrid course including a science education MOOC (2 ECTS) and a practical module (3 ECTS). In the practical module students design and implement a non-formal learning module such as a science club. These clubs are offered for example to families for afternoon hobbies. Also, chemical safety has an essential role in non-formal learning.

In addition to described courses, there are multiple shorter multidisciplinary courses multidisciplinary courses that offer student teachers chemical safety training within course tasks and exercises.

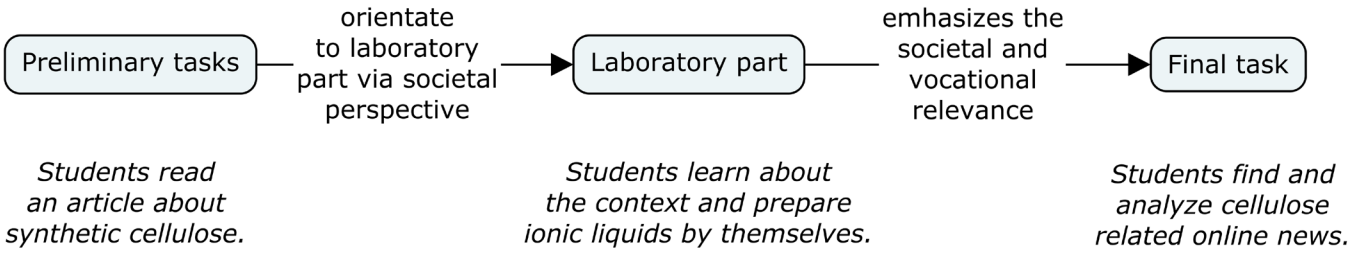
Figure 1. Chesse.org materials are used as the chemical safety learning material in every chemistry education course.

Master's level

Master's level (120 ECTS) studies consist of 50% of pedagogical and 50% of chemistry education studies. In practice, pedagogical phase means one year study time in the Faculty of Education. Studies include several months of teaching practice in schools. In the pedagogical studies future chemistry teachers can apply the chemical safety knowledge acquired in the bachelor level within a real school context. According to feedback from training schools' teachers, our distributed model of chemical safety training offers a solid base for building high-level competence for implementing experimental work to chemistry education.

The fifth and last study year focuses on chemistry education research. Many students execute a design-based research project as their master's thesis work. This is an excellent framework to complete the degree by building once more competence on chemical safety in the context of research-based laboratory activity design. Some of these projects even lead to scientific publications. Chemistry education research studies are conducted in the Faculty of Science, which enable seamless collaboration with the Chemistry Departments research groups (Figure 2) (Pernaa et al., 2022).

Figure 2. Example of an exercise schema designed in collaboration with a chemistry research group.



Future research on continuous learning

As described, the chemistry teacher education program in the University of Helsinki offers versatile chemical safety training during the bachelor and master's studies. Based on feedback, decades of experience and research-based development (Aksela, 2010), this amount of training is enough for building a solid skillset and know-how as the starting point for a chemistry teacher career.

However, many teachers feel that they do not have enough chemical safety competence, and this is one of the most requested in-service training themes. In Finland

multiple stakeholders support teachers continuous learning on the topic by offering courses and training sessions.

Therefore, the current models are not efficient enough to match the massive need that teachers express. For solving this challenge, the Unit of Chemistry Teacher Education has started to develop research-based models on supporting chemistry teachers continuous learning through non-formal study visits. The preliminary results indicate that study visits have great potential to support in-service teachers' continuous learning (Pesonen, 2022), but much more research is needed to understand the possibilities and challenges that non-formal framework offers.

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Visit: www.helsinki.fi/seco

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