Differentiation in chemistry teaching

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This article discusses how themes on science, technology, society and environment, connected to everyday life, besides interest and motivate towards learning, also can act as a good base for planning and carrying out of differentiating teaching. In the Unit of Chemistry Teacher Education in the University of Helsinki, the needs of Finnish teachers have been observed and research has been conducted to find out how it would be possible to support chemistry teacher-students and teachers already in the working life in the best possible way. With the help of suitable additional and further education, it is possible not only to answer to the need of support but also to offer versatile teaching materials and information, which come in handy in teaching all kinds of learners.

Themes on science, technology, society and environment can awaken pupils' interest in chemistry both in the classroom and in everyday life. "Science for all" thinking (Aikenhead, 2006) is connected to STSE education (Science, Technology, Society and Environment). Cultural, societal, ethical, political, economic and ecologic meanings are also connected to STSE education (Hodson, 2003). The main objective of STSE education is to make pupils into such future citizens who have a good enough science education on natural sciences so that they can act as responsible citizens and as active decision makers (Marks & Eilks, 2008).

STSE education is a basis of curricula in many countries (Hodson, 2003). However, teachers do not always have enough time to include STSE themes in their teaching (Pedretti, Bencze, Hewitt, Romkey & Jivraj 2008; Torres Gil, 2011). Also teachers' lack of information concerning technology, environment and society has acted as a barrier for using STSE themes widely in teaching. STSE-themed teaching can be, however, included in normal teaching without either of them closing the other out. This is achieved, when topics are linked to themes familiar in a pupil's everyday life (Pedretti et al., 2008). Overloading of teaching contents can be avoided by choosing themes at hand carefully for example based on the pupils' interests (Gilbert, Bulte, & Pilot, 2011). Linking everyday phenomena to theory increases interest towards chemistry (Gilbert, 2006; Overton, Byers, & Seery, 2009; King & Ritchie, 2012).

STSE education and interest in support of differentiating teaching

According to the Finnish National Core Curriculum for Basic Education (2014), all pupils have the right to succeed and to receive individual support that they need. One of the biggest challenges for teachers is to take all the pupils' individual needs into consideration (Konstantinou-Katzi, Tsolaki, Meletiou-Mavrotheris, & Koutselini, 2013). Chemistry teachers do not have enough information on different learners or sufficient training, how to take different learners into consideration in teaching. There is a shortage of suitable teaching

materials and methods. (Markic & Abels, 2014) However, a teacher is able to get support and a boost for their teaching, when getting to know different teaching methods and instructions (Tomlinson, 2005). For example materials and teaching methods designed to support learning difficulties, are usually suitable for all the pupils in the same class (Brigham, Sruggs & Mastropieri, 2011; Caseau & Norman, 1997). STSE themes connected to everyday phenomena create an opportunity to teach everyone, also different learners successfully and by doing this, to increase the pupils' equal part in the lesson. STSE- themed teaching increases both the different learners and their teachers' interest and motivation and improves classroom behavior, co-operating skills as well as critical and problem-based thinking (Caseau & Norman, 1997). Teachers can be supported towards STSE education with the help of training and different support services as well as with practicing authentic exercises (Yore & Treagust, 2006). In authentic exercises, themes and problems at hand should be such that are handled also in everyday life and in society. Authentic sources of information such as scientists, politicians, stockholders, media or ordinary citizens (interviews, role play, debates etc.) can be used as a tool to teach the subject (Marks & Eilks, 2009).

There is not a specific recipe for differentiating teaching (Tomlinson, 2005). In Finland, differentiating teaching is based on knowledge and skills of pupils and the prevention of the need for support (Finnish National Board of Education, 2014). The following things can be thought of as the starting point for differentiating teaching:

- Learning environment is safe and its level is suitable
- An individual, a group and as well the class is taken into consideration in everyday teaching and learning routines
- Clear goals for learning, which aim at essential knowledge and skills
- Both homework and schoolwork have clear instructions and goals
- A teacher takes advantage of time, place, equipment and strategies in a flexible and varying way
- The classroom is a learning community, where mutual respect, responsibility and the intention for everyone to reach best learning results, dominate. (Tomlinson, 2005)

Different kind of chemistry in the Kumpula campus

Previously, no courses on teaching differentiating chemistry have been organized in Finland for teacher-students in chemistry education. A course that is voluntary and complements chemistry studies, is "Different Learners in Chemistry Teaching", which was organized for the first time in the spring of 2016. During a short intensive course, the teacher-students were first interviewed and the need of support and knowledge was asked. After orientation basic things on differentiating teaching of chemistry such as learning difficulties, language, teaching methods and classroom management were learned. The students also applied the learned things in the LUMA days 6.-8.2.2016 in Lahti, where they presented a lesson plan suitable for differentiating teaching and a hands-on activity model, for teachers. Constructive feedback, a

positive atmosphere, new ideas and lively conversation and experiences of experienced teachers were a unique and an encouraging experience for both the students training to be teachers, the audience and the conductor of the course. The lesson plans that the students have planned in Finnish can be found on the internet, for teachers to share them freely. The need and the goal for teachers and student-teachers' additional and further education have become clear as the research has progressed. Additional information of interesting themes which are familiar from pupils´everyday lives as well as different teaching materials and methods that take different learners into consideration and that are based on the curriculum are needed in chemistry teaching. The aim is that even more pupils will understand why knowledge and skills in chemistry are needed also outside of the school community. It is possible to learn chemistry in spite of the level of knowledge and skills of the pupil, if the suitable tools and support are given to the teachers and teacher-students.

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