

# General Preface

The main goal of chemistry education research is to understand and improve chemistry learning and teaching. Research studies show the range of research design strategies and results that have contributed to an increased understanding of learning in chemistry. Practitioners, however, are seldom acquainted with the findings of education research and as a consequence they are not applied into school practice. The challenge is how to link together findings of research and effective practice and study their influence on curriculum, on teaching methods, and on assessment. This will require more effective communication between researchers and practitioners to bridge the gap between chemistry and education disciplines.

This publication's aim is to offer an additional stone in the mosaic of efforts toward changing chemistry teaching and learning from incidental and rote learning to learning with understanding and meaningful knowledge. All contributions in the publication try to follow this goal.

Authors from 12 countries, despite cultural differences and economics of schooling emphasize the same trends, which stem from human physiology and psychology that underline learning and teaching chemistry in 18 chapters.

On the basis of a content analysis of the papers published in selected science education journals for a period of 5 years it was found that research in the field of chemical education could be divided into nine categories: (1) teacher education; (2) teaching; (3) learning—students' conceptions and conceptual change; (4) learning—classroom contexts and learner characteristics; (5) goals and policy, curriculum, evaluation, and assessment; (6) cultural, social, and gender issues; (7) history, philosophy, epistemology, and nature of science; (8) educational technology; (9) informal learning. These science education fields are also illustrated from different perspectives in the present book. This book is according to its content divided into three sections: Section I Teaching and learning chemistry; Section II Approaches in chemistry teaching and learning with understanding; and Section III Curriculum reform and teachers.

The first section "Teaching and learning chemistry" focuses on the general aspects of chemical education research and practice. In this section the teaching and learning of chemical concepts are discussed. This section comprises two parts;

the first part “Understanding Chemistry Concepts Teaching Strategies” deals with learning chemical concepts that results in understanding chemical phenomena; and the second part “Students’ characteristics on chemistry learning” describes and analyzes students’ characteristics that can foster chemical concepts learning with a low rate of misconceptions.

The first part of this section focuses on learning chemical concepts, and it has been established that chemical concepts can pose different levels of demand on students’ working memory. This means that especially abstract concepts demonstrating chemical change should be presented to the students in different ways. But before that teachers should understand concepts and should be able to move easily between all three representations of concepts (e.g. macro-, submicro- and symbolic level). Chemical concepts are because of this characteristic specific and even more demanding in terms of understanding compared to those that can be presented only on the macro level for example. Students’ learning chemical concepts with understanding should be stimulated by the teacher. These stimuli should trigger students’ mental activities, so that learning would occur. Without students being mentally (and also manually) active during learning, meaningful learning with understanding will not happen. The concepts describing active learning are frequently discussed in the chemistry education literature but a more in-depth analysis should be provided.

The second part of this section comprises two chapters dealing with students’ characteristics that can significantly influence chemistry teaching and learning. Students’ attributes such as motivation and interest for learning chemistry, different mental abilities (i.e. intelligence, visualization abilities, working memory capacity, formal reasoning ability), social skills, and others, should be considered when the teacher organizes their school lessons, authors design the teaching material, policy makers prepare national curriculums, and teacher educators conduct pre- and in-service teacher education programs.

Section II entitled “Approaches in chemistry teaching and learning with understanding” comprises two parts; the first part “Cooperative and collaborative learning” presents three chapters and the second part “Teaching Strategies” comprises six chapters.

The first part focuses on cooperative and collaborative learning in the science classroom to promote students’ learning with understanding. The first part deals with different aspects influencing science learning as students’ cultural, racial, ethnic, and social backgrounds can influence collaborative and cooperative learning. The authors explain the development of cooperative learning methods and the integration of these approaches into science education to stimulate peer-to-peer teaching and learning hoping that these approaches will enhance students’ academic achievements and stimulate interest for science learning and future careers in science and technology are presented. The differences or similarities between cooperative and collaborative learning are explained by the different authors. Both approaches are sometimes used for the same thing, e.g., small-group

activities in the classroom where learning takes place, but differences can be found in the organization of the specific learning approach. Collaborative learning can have fewer roles assigned, the teacher is not the center of authority, group tasks are usually more open-ended, and complex, so collaborative learning is less structurally defined as cooperative learning.

The second part deals with teaching strategies or approaches that support students' engagement in mental activities in science learning. If learning would take place, students should think about the content presented by the teacher, textbook, online or otherwise. Some of these aspects are presented in Part II (Approaches in chemistry teaching for learning with understanding). The most important problem that science teachers face is how to motivate students to learn for their future lives as active citizens. It is difficult to explain to students the fact that they are not learning just to pass the exams, but to become scientifically literate adults, who will make important and correct decisions. To achieve this, teachers and science education researchers try to find ways to make students learn science concepts with understanding and for life. This usually involves experimental work, using different pictorial material, context-based approaches, and multimedia environments.

The last section of this book entitled "Curriculum reform and teachers" deals with the chemistry curriculum and changes influence the chemistry teacher's education. It is mentioned that chemistry curriculums have changed over the decades from traditionally oriented chemistry teaching emphasizing symbolic and mathematical components of the chemical concepts to more context-based enquiry learning-oriented teaching supported by different applications of the informational-communicational technology. It is emphasized that it is important to develop students' scientific/chemical literacy, so that they will be able to use their science knowledge in different real-life situations. On the other hand, teachers should be adequately educated so that they can efficiently implement curriculum innovations. This means that teachers should in pre-service/university level education develop their sense of permanent in-service education, so that they can instantly and effectively apply those innovations that appear in the curriculum into their teaching. It is stressed that teachers are aware of their possibilities to upgrade their teaching with outside school activities for students. Chemistry presented in museums, industry, agriculture, medicine, science centers, forensic TV shows, etc., can influence students' interest to learn chemistry at a formal level. Teachers should for that matter use the informal ways of showing the importance of chemistry in human society to their advantage.

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