Affective Dimensions in Chemistry Education

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Editors

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Springer

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Preface

The inspiration for this book was the organization of a symposium entitled *Affective Dimensions in Chemistry Education* for the 2012 Biennial Conference on Chemical Education held at The Pennsylvania State University. The main purpose of that symposium—and of this volume—was to gather the most up-to-date expertise and research about the influence of the affective domain on learning in chemistry into one location. We hope that this book will serve as a resource for those wishing to address the affective domain as they research and solve problems in chemistry education.

About half a century ago, Bloom et al. (1956, 1964) published two handbooks outlining a taxonomy of educational objectives. In their conceptualization—which is not specific to chemistry education, but relates to education in general—educational objectives could be categorized into three major domains: cognitive, affective, and psychomotor. Of these three, the cognitive domain has received significantly more attention by researchers over the years, especially in the context of chemistry learning. With this volume, we intended to gather information about the influence of the affective domain on chemistry learning in order to inspire consideration of the affective domain both in the context of chemistry teaching and in the context of future chemistry education research.

Affective dimensions refer to such psychological constructs as attitudes, values, beliefs, opinions, emotions, interests, motivation, and a degree of acceptance or rejection (Koballa, 2013; Krathwohl, Bloom, & Masia, 1964). For several reasons, these dimensions have often been ignored or minimized in science education research literature, in curriculum development, and in assessment. First, it is challenging to measure affective constructs—such as students' motivation to learn science, their attitudes about learning science, and the degree to which they value scientific knowledge and practices—as these are hard to observe. Additionally, in practice, if a teacher explicitly states specific affective objectives in the classroom, some students will do everything they can to reflect those objectives, as they know that they will get credit for those valued behaviors. In such a case, students' demonstrated behaviors might not reveal their true attitudes and beliefs toward learning science. Second, many practicing scientists attempt to divorce the affective domain—subjectivity and individuals' feelings—from the cognitive domain, which is believed (by the scientists) to be more reason driven and objective. As a consequence, science is often presented in classrooms as being objective and separate from attitudes, values, beliefs, opinions, and emotions. Finally, because it is perceived to be more challenging to measure outcomes in the affective domain than in the cognitive domain, our current educational systems around the world tend to focus assessments on cognitive, instead of affective, objectives.

The Status Quo

So, what is the *status quo*? How is the current emphasis on cognitive objectives and the lack of emphasis on affective objectives influencing student interest in and retention in science fields? The drawbacks of our current educational practices were clearly observed in recent international studies like PISA (Programme for International Student Assessment) and described in a European Union document known as the "Rocard Report" (Rocard et al., 2007). According to this report, the following issues were highlighted:

- The number of young people entering universities is increasing, but they are choosing to study fields other than science; in consequence, the proportion of young people studying science is *decreasing (e.g., In 2003, the total physical science graduates in the USA dropped by 12 % (about 88,000) in comparison to 1995 (about 100,000); the same comparison for Germany is even more dramatic—50,000 vs. 101,000—a 50 % loss).*
- When looked at from a gender perspective, the problem is even worse as, in general, females are *less* interested in science education than males (e.g., females comprised only 31.2 % of the MST [mathematics, science, and technology] graduates in EU27 countries and *only* 31.1 % of MST graduates in the USA in 2005).

The current situation urges us to reconsider our current approaches to science education in general and to chemistry education in particular. Because positive affective dimensions have been shown to correlate with students' persistence and performance in science topics, a focus on affective dimensions is an important part of the solution to the global issues of lack of interest and retention in science education in general (and chemistry education in specific).

The Focus

This book focuses on affective dimensions and their influence on chemistry learning from two different perspectives: Part I reviews the theory related to the influence of affective domains on chemistry learning, while Part II is dedicated to the connection between research about affective dimensions and the practice of teaching and learning chemistry. We believe that all perspectives—theory, research, and practice—should inform the design of future studies about the affective dimensions of chemistry learning and, with this book, we attempt to provide one easy-to-access volume that will provide a foundation for those future studies.

Part I—"Theoretical Considerations"—highlights the following themes:

- Taber examines constructivist ideas about learning and how they might influence educational objectives in the affective domain.
- Rahayu reviews different methods for evaluating affective dimensions in the context of chemistry education.
- Menthe and Parchmann review influential theories of motivation and interest development to support the argument that emotional and affective aspects are crucial for attitudes toward and learning of chemistry in schools. Context-based learning approaches such as the German project *Chemie im Kontext* are reflected from the perspective of their ability to foster students' interest and motivation.
- A. Kahveci focuses on research findings from the literature over a period of several decades regarding the impact of gender on student affect related with chemistry. Student affect is portrayed in tandem with the relationship between affective variables and achievement, followed by the discussion of the gender effect.
- Dittmer and Gebhard highlight the significance of intuitive beliefs concerning socio-scientific issues and suggest that teaching about scientific issues in chemistry education should be done in an unbiased manner.

The following contributions around the globe enriched Part II of this volume, "Research and Practice":

- Abels focuses on students with cognitive and emotional/behavior disorders. She illustrates a case study using the approach of emancipatory action research to investigate how "inquiry-based science education" can successfully be implemented in an inter-year special needs class (5th and 6th graders).
- Taber reports his research findings on meeting the needs of gifted learners. A major problem in the education of gifted learners is lack of challenge, which is needed to ensure such students are able to make progress. Lack of challenge can also influence learner motivation and even lead to boredom. Meeting the needs of gifted learners is therefore a matter of matching task demand to their abilities to meet their emotional as well as their cognitive needs.
- Fechner et al. focus on the evaluation of affective variables in context-based learning (CBL) environments. On the basis of prior research designs and instruments, they argue that attitude has to be perceived as a multifaceted construct. Different research designs and attitude instruments are discussed and related to the theoretical background of motivation and interest.
- Xu et al. argue that instruments in the affective domain may not be equivalent when tests are administered to populations with different sociocultural

influences. They provide evidence from a study in which the same instrument of attitude toward chemistry was used to gather data from students in different sociocultural environments to support their claim.

- Cheung provides an extensive review of the literature on chemistry self-efficacy, reports recent research studies about self-efficacy conducted in Hong Kong secondary schools, and offers some directions for future research on chemistry self-efficacy.
- Yoon et al. report their research on a problem-based learning (PBL) chemistry laboratory course in order to elucidate differences in the influence of the course on students' scientific attitudes, as well as their creative thinking abilities and self-regulated learning skills.
- Liu and Huang introduce the concept of affection and categorize the affective dimensions in chemistry education. They also discuss the potential application of cognitive neuroscience methods—such as electroencephalograms (EEGs), event-related potentials (ERPs), and functional magnetic resonance imaging (fMRI)—to chemistry education research about the affective dimensions.
- Markic and Eilks discuss the use of drawings of classroom situations for exploring, researching, and assessing the pedagogical attitudes of chemistry teachers and teacher trainees.
- Markic examines the attitudes and perceptions that chemistry teachers hold when it comes to dealing with linguistic heterogeneity in the classroom.
- M. Kahveci reports a study examining chemistry majors' attitudes toward learning physical chemistry from a gender perspective.

Peer Review

Manuscripts were evaluated by the editors to determine if they matched the scope of the book and then sent for a full cycle of review by two peers. We gratefully acknowledge the essential contributions of these reviewers, as their rigorous attention to detail and to scholarship has improved the quality of this volume.

1. Simone Abels, University of Vienna
2. Sevil Akaygun, Bosphorus University
3. Michelle Dean, Kennesaw State University
4. Ayla Cetin Dindar, Middle East Technical University
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23. Daniel Southam, Curtin University
24. David Treagust, Curtin University
25. Ellen Yezierski, Miami University

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