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Researching the teaching and learning of the concept "bonding and structure of molecules"

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Abstract

This dissertation consists of a diagnostic study, followed by curricular development and implementation regarding the teaching of the *bonding* concept. Chemical *bonding* theory is central to understanding general chemistry. The diagnostic study focuses on students' difficulties over two decades regarding this key concept. Several factors leading to these difficulties are presented; more specifically, we focus on how the structure and content of the National Matriculation Examinations conducted in Israel influence the way bonding is taught and assessed. The traditional pedagogical approach for teaching *bonding* is often overly simplistic and not aligned with the most up-to-date scientific ideas. Based on the analysis of this study and supported by studies worldwide, we suggest that the general approach of the bonding curriculum along with the current system of assessment causes students to memorize "rules" and explain facts by using key phrases, resulting in students lacking a fundamental understanding of this concept. Therefore, it was essential to propose a systemic treatment - revising the scientific content, the pedagogical approach, and the assessment methods. According to this study, a reformed approach should provide: (1) a scientific framework that may prevent pedagogical learning impediments, (2) an academic basis, which may result in a much deeper understanding of the fundamental nature of chemical bonds and in credible explanations of certain phenomena, and (3) a new assessment approach. The thesis describes the development of a new conceptual framework that provides an advanced scientific and pedagogical foundation for the teaching and assessing of the bonding concept; this process was conducted with chemistry lead-teachers, senior chemistry educators, and eminent chemists. In general, we aimed at a framework that, on the one hand, is well rooted in formal theory and, on the other hand, can treat all chemical bonds on an equal footing. We suggest adopting a "bottom-up" approach that rationalizes all bonds and structures based on a small set of underlying assumptions. We also suggest that one of the key goals of the proposed framework is to stress that a continuum scale exists between extreme cases of qualitatively different bonding

scenarios. The research includes implementation of the new approach in 11th-grade chemistry classrooms, and the study indicates that both students and teachers acquired a much deeper understanding of the underlying key concepts as well as advanced thinking skills.