

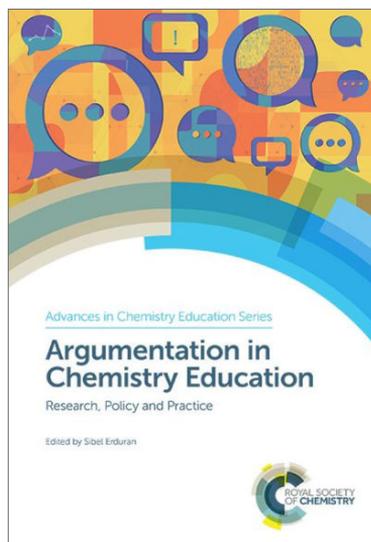
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Sibel Erduran (Ed.), *Argumentation in Chemistry Education: Research, Policy and Practice*, Advances in Chemistry Education Series (Vol. 2), Royal Society of Chemistry: London, UK, 2019; 295 pp.: ISBN: 9781788012126

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Johnstone's triangle and the role of arguments in the chemistry class

Multilevel thinking is an essential feature of talking about chemistry. When chemists and chemistry teachers talk to each other about chemistry, they switch from a description of observed phenomena (macroscopic level) to explanations on the molecular level (submicroscopic level) and merge this with symbolic representations in the language of chemical equations and the 'alphabet' of the periodic table of elements (symbolic level). This complexity challenges both teachers and learners of chemistry, as Johnstone (1991) pointed out almost 30 years ago. Students have to make sense of communication in chemistry, in which the three aforementioned levels are often difficult to distinguish. Furthermore, for constructing their own arguments in the chemistry class, they have to build connections between the different levels of communication in chemistry. Chemistry teachers, on the other hand, need to guide their students in these processes: in the development of an understanding of these levels and in the students' construction of scientifically sound arguments from the perspective of chemistry.



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The book *Argumentation in Chemistry Education*, edited by Sibel Erduran, is positioned in this context. Erduran points out that building connections between the different levels of the triangle (macroscopic, symbolic, submicroscopic; see Johnstone) requires arguments. Chemistry teachers can show an observable phenomenon and present an explanation for it on the symbolic or the submicroscopic level, but the connections between the two levels are made with arguments, as Erduran argues in the first chapter of the book. This is the framework in which Erduran's book provides insights into one of the central aspects of chemistry education: argumentation. Chemistry education seeks to empower students to construct chemical arguments and to provide evidence for the claims they make, instead of merely believing the teacher. This is a highly complex issue in the chemistry class.

A combination of theoretical perspectives and concrete teaching resources

The book *Argumentation in Chemistry Education* approaches the topic with an interesting mixture of articles about argumentation in the chemistry class. It contains chapters that present the theory of argumentation in chemistry education, providing an overview of the field today. This is done, for instance, in a literature review by Aydeniz covering advances in research about argumentation in chemistry education (Chapter 2). In addition, insights into the integration of argumentation in pre- and in-service teacher training are presented by Zembal-Zaul and Vaishampayan (Chapter 7). However, the book's great strength is its strong focus on application to chemistry teaching practice. Chapter 6, by Ng, constitutes a bridge between theory and practice. The author presents an analysis of the place of argumentation skills in the school curricula of the UK and Australia. In an exemplary fashion, she shows the divide between curricula that demand the teaching of argumentation skills in the chemistry class and the assessment of such skills, which remains only partially resolved. Rather than measuring argumentation skills, assessment tools often measure factual knowledge, and thus lag behind the demands of the curricula. For chemistry teachers and teacher educators, this shows the place of argumentation in education policy.

The most interesting chapters for teachers are probably those that provide practical resources. Many chapters contain a box with a 'practical digest'. Here, the authors show the impact of their research on teaching practice in chemistry, in some cases using concrete examples with teaching material. Moreover, Cullinane and O'Dwyer (Chapter 4) give an overview of teaching approaches that can support teaching argumentation in school, for instance,

evidence-based reasoning. They review established tools, such as concept cartoons or frameworks that support students linguistically in the construction of arguments. Henderson and Osborne (Chapter 5) concentrate on the potential of online applications in teaching argumentation. In both chapters, teachers find a multitude of very helpful references to concrete teaching material, in some cases as open educational resources that can be easily accessed. Hofstein, Katevitch and Mamlok-Naaman (Chapter 8) propose inquiry-based learning as a means to develop students' argumentation skills in laboratory work. Christodolou and Grace (Chapter 9) expand the notion of argumentation from scientific reasoning to the more comprehensive way of reasoning that is necessary in socio-scientific argumentation. Integrating ethical, socioeconomic and scientific reasoning in nuanced argumentation is a task that differs from the basic model of linking the macroscopic, submicroscopic and symbolic levels. The authors show that argumentation in the chemistry class can reach beyond chemistry itself, an argument underlying Chapter 3 by Crujeiras-Pérez and Jiménez-Aleixandre about interdisciplinarity, as well.

Research about argumentation in concrete contexts is presented in Chapters 10–12. Pabuccu (Chapter 10) shows how argumentation tasks can lead to conceptual learning in organic chemistry, instead of simply memorising reaction mechanisms, as is very common in organic chemistry in higher education. Concrete examples of teaching practice in higher education, accompanied by a report on the experiences gained by the author using them, make this chapter very useful for teacher educators. Chapter 11, by Towns, Cole, Moon and Stanford, covers argumentation in physical chemistry. It is more research-focused than Chapter 10 and presents a method for analysing argumentation in chemistry classrooms in higher education. It is, therefore, more interesting for researchers working in the field of argumentation, and less germane for chemistry teachers and teacher educators. Chapter 11 shifts the focus to the socioeconomic and socio-cultural context in which argumentation occurs in chemistry education. The authors, Msimanga and Mudadigwa, present the results of research conducted in South African classrooms. In this context, many students learn chemistry in English despite speaking other languages at home. Integrating other languages is crucial for the students to develop arguments in chemistry.

A valuable resource for teacher educators

The book covers a broad range of perspectives on argumentation in chemistry education. Different groups of science educators can profit from this wealth: some chapters are interesting mostly from a chemistry education

research perspective (e.g., Chapters 2 and 11), while others are very application-focused and could therefore be interesting for chemistry teachers, as well (e.g., Chapters 4, 5 and 8). The audience for other chapters could be researchers in chemistry who would like to improve their courses in organic chemistry at the university level (Chapter 10). This diversity in the collection of articles constitutes an honest account of what has been achieved and what still needs to be done in the field of argumentation in chemistry education. The book therefore provides a high-quality overview of the research field.

Chemistry teachers could, of course, learn from the book via self-study. However, working with the chapters in a group of chemistry teachers, possibly under the supervision of a chemistry teacher educator, could increase the learning output even more. Since the book is based on educational resources from the English-speaking world, application of the material is easy only for teachers working in English-speaking countries or in bilingual chemistry classes. These teachers will certainly profit from the open educational resources and the teaching material referenced or included in the book, which they will be able to use in their chemistry classes. For those chemistry teachers who teach in other languages, however, the application is not as straightforward, as the material would need to be translated. Working in a group of teachers could facilitate the process of translation and ensure that the intended content is captured. Moreover, the teaching material can probably unfold its full potential if teachers know the theoretical basis of argumentation (which is provided in the book), and if they have the craft knowledge of putting the theory into practice. Working in a group of chemistry educators could be a great opportunity for developing this craft knowledge, as this setting allows for discussions about adequate applications of the theory to the design of practical teaching material and sequences. In the sense of continuous professional development, chemistry teachers could benefit greatly from the resources presented in Erduran's book.

Chemistry teacher educators could profit from the book, as well. For those who already teach argumentation in classes for pre- and in-service teachers, the book provides knowledge about the latest advances on the topic and can be used to stay up to date in the field. On the other hand, for those who have not yet taught argumentation to chemistry teachers and who wish to introduce the topic into their teaching, the book can serve as a basis for the construction of a specific course for pre- and in-service teachers. It is interesting in this context because it unites theoretical, practical and policy-oriented perspectives on argumentation in chemistry education.

Using Erduran's book, teacher educators could, for instance, (i) first cover some fundamental knowledge about the status of argumentation in the

chemistry class. This can be done to sensitise teachers to the challenges posed by argumentation in chemistry education, especially if Johnstone's concept is covered in the course, as well. In the next step, (ii) teacher educators could, together with chemistry teachers, analyse the place that local policy allocates to argumentation in the school curricula. In the last phase, (iii) the teachers could be guided in the development of concrete teaching materials that help students in the acquisition of argumentation skills. Existing material that can be found in the book or its references could be adapted, as well. This third phase is crucial for the development of the teachers' craft knowledge about argumentation in chemistry. Here, discussions with the other teachers in the course, as well as supervision by the teacher educator, will be necessary in order to introduce the theory into teaching practice in chemistry education in local school settings. Erduran's book represents an excellent resource for designing this type of course.

References

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