

Evaluation of questions in general chemistry textbooks according to the form of the questions and the Question-Answer Relationship (QAR): the case of intra- and intermolecular chemical bonding

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Supplementary Material: The case of other topics

Here, we treat what happens with the questions that cover other topics in the selected ten general chemistry books of which we analyzed in the main paper the questions on intra- and on intermolecular bonding. To answer this would require a lengthy analysis, which was beyond the scope of this work. As a substitute, we took one particular book, that of Silberberg (its 2006, 4th edition) and carried out an analysis of its chapters on stoichiometry, gases, and chemical equilibrium. Tables S1 and S2 show the results of the analysis of the form and the content of the corresponding questions. For direct comparison, the results of the analysis for the chapter on intramolecular bonding are also included in these tables.

Table S1 Evaluation of questions (n = 298) according to type/form, for four chapters of the book by Silberberg (2006)

Book Chapter no. *		3	5	9	17
<i>Objective/closed</i>	<i>Multiple choice</i>	3	0	5	0
<i>type questions</i>	<i>Disjunction answer</i>	1	2	0	0
<i>(Type A)</i>	<i>Coupling/pairing</i>	0	1	10	0
<i>(n = 294)</i>	<i>Ordinance</i>	2	0	15	0
	<i>Completion space</i>	4	0	2	0
	<i>Short answer</i>	89	59	34	67
<i>Open questions</i>	<i>Acceptance</i>	0	0	0	0
<i>(Type B)</i>	<i>Logical</i>	0	0	4	0
<i>(n = 4)</i>	<i>substantiation</i>				
	<i>View and aspect</i>	0	0	0	0
	<i>Entailment;</i>	0	0	0	0
	<i>Evaluation</i>	0	0	0	0
TOTAL		99	62	70	67

*Chapter 3 (Stoichiometry); Chapter 5 (Gases); Chapter 9 (Chemical bonds); Chapter 17 (Chemical equilibrium)

Table S2 Evaluation of questions (n = 298) according to content, for four chapters of the book by Silberberg (2006)

Book Chapter no.*		3	5	9	17
<i>Declarative</i>	<i>Precisely there</i>	4	8	13	9
<i>knowledge</i>	<i>Think and search</i>	5	3	10	3
<i>Basic level</i>	<i>You and the Author</i>	6	8	26	18
<i>(n = 113)</i>	<i>On your own</i>	0	0	0	0
<i>Declarative</i>	<i>Precisely there</i>	-	-	-	-
<i>knowledge</i>	<i>Think and search</i>	2	3	5	1
<i>Higher level</i>	<i>You and the Author</i>	21	10	8	4
<i>(n = 54)</i>	<i>On your own</i>	0	0	0	0
<i>Procedural</i>	<i>Precisely there</i>	9	8	1	30
<i>knowledge</i>	<i>Think and search</i>	52	22	7	2
<i>Basic level</i>	<i>You and the Author</i>	-	-	-	-
<i>(n = 131)</i>	<i>On your own</i>	-	-	-	-
TOTAL		99	62	70	67

*Chapter 3 (Stoichiometry); Chapter 5 (Gases); Chapter 9 (Chemical bonds); Chapter 17 (Chemical equilibrium)

The number of questions is about the same for gases, bonds, and equilibrium, but it is higher for stoichiometry. Regarding their form, in all chapters most of the questions are of the short answer type. Only in the chapter on intramolecular bonding, were a few open type questions found.

In the chapter on stoichiometry, most of the questions were categorized at procedural level. Actually, they constitute applications of algorithmic procedures that are described in the text by means of worked examples. Several questions were categorized at declarative knowledge of higher level, without the answers existing in the text. For their answer, students need conceptual understating and not just knowledge.

In the chapter on gases, almost half of the questions are at procedural level. Most of these questions deal with unit transformation, application of formulas, and calculations of masses and of number of moles.

In the chapter on chemical equilibrium almost half of the questions are at procedural level, and about the same at the basic level of declarative knowledge. The questions require the following of algorithmic procedures and knowledge of the theory, without necessarily involving conceptual understanding. Conceptual understanding questions are very few.

In contrast, in the chapter on chemical bonding the questions that deal with the knowledge of theoretical topics are much more numerous than the questions that check for conceptual understanding. Questions at procedural level are minimal.