

Contents

Introduction	xi
Catherine HOUEMENT, Cécile DE HOSSON and Christophe HACHE	
Part 1. A Study of the Dynamics of the Development of Scientific Knowledge: Semiotic Opportunities	1
Introduction to Part 1.	3
Catherine HOUEMENT, Cécile DE HOSSON and Christophe HACHE	
Chapter 1. A Walk in Semiotics and Mathematics.	5
Catherine HOUEMENT	
1.1. A glance at semiotics	6
1.1.1. Ferdinand de Saussure	7
1.1.2. Charles Sanders Peirce.	8
1.2. At the heart of mathematics, the symbolic.	11
1.2.1. The epistemological life of the mathematical signs + and =	12
1.2.2. The evolution of signs, a driver for the invention of mathematics	15
1.3. The life of a basic sign in contexts	19
1.3.1. The = sign in a teaching context	19
1.3.2. The = sign in society	21

1.4. Semiotics and questions of teaching	22
1.4.1. Duval's approach on semiotics and mathematics	23
1.4.2. Semiotics and geometry	24
1.4.3. Semiotics and numbers.	26
1.4.4. And language in all this?.	35
1.5. Conclusion	37
1.6. Appendix: the mystery writing in Figure 1.1	39
1.7. References	40

Chapter 2. Semiotic Systems Specific to Chemistry and Their Learning 45

Isabelle KERMEN

2.1. Introduction.	45
2.2. The specific signs of chemistry	48
2.2.1. Diversity of chemical signs presented to students	49
2.2.2. A consideration of chemical signs using the “chemistry triplet”	50
2.2.3. Beyond the chemistry triplet	51
2.3. Didactical analysis framework: domains of knowledge in chemistry	52
2.3.1. The empirical register	53
2.3.2. The register of models	54
2.3.3. The communication of knowledge	54
2.4. Semiotic supports	55
2.4.1. Triadic semiotic relationship	56
2.4.2. Relation between the sign and the represented object.	57
2.4.3. The meaning of a semiotic representation through the prism of its belonging to a semiotic system	58
2.4.4. Semiotic systems and cognitive activities.	60
2.5. The challenges of learning some chemical signs	61
2.5.1. Chemical formulae and names	62
2.5.2. Spatial representations of molecules.	64
2.5.3. Summary	67
2.6. Students' understanding of names and formulae	67
2.6.1. A single sign for two objects: students' difficulties	68
2.6.2. Interpretation by students of a molecular formula depending on the context	71
2.6.3. Summary	73

2.7. Students' understanding of stereochemical formulae	73
2.7.1. Exploration of the cognitive function behind processing.	74
2.7.2. Exploration of the cognitive function used in conversion between systems	77
2.7.3. Summary	78
2.8. Conclusion	79
2.9. References	81
Part 2. The Semiotic Approach: Toward the Invention of New Forms of Didactic Intervention	87
Introduction to Part 2.	89
Catherine HOUEMENT, Cécile DE HOSSON and Christophe HACHE	
Chapter 3. Scientific Knowledge at the Mercy of the "BD" Comic Strip	93
Laurence BORDENAVE and Cécile DE HOSSON	
3.1. Introduction.	93
3.2. Science in comic strips: semiotic analysis of some strips by apprentice-authors.	97
3.2.1. A device for scientific mediation: "BD-sciences" workshops . . .	97
3.2.2. Science in the apprentice-authors' strips: where? how? why? . . .	99
3.3. Science in science comics for the "wider public": some narrative-visual invariants	110
3.3.1. The text: a favorable space for scholarly pronouncements.	111
3.3.2. The supernatural for micro-macro-scales	113
3.3.3. The unavoidability of personification	116
3.3.4. Metaphorical universes.	116
3.3.5. Humor: a link between popularization and comics	119
3.4. Science comics at the mercy of the reader.	125
3.4.1. Graphic and verbal signals to decode	125
3.4.2. Scientific fiction at work.	127
3.4.3. Scientific knowledge is not always integrated	127
3.4.4. . . . but reading requires help.	131
3.5. Conclusion	133
3.6. References	135

Chapter 4. The Map at the Heart of Disciplinary Learning	139
Sophie GAUJAL and Caroline LEININGER-FRÉZAL	
4.1. Introduction.	139
4.2. Cartography in the classroom: a complex learning challenge	141
4.2.1. The languages of maps.	141
4.2.2. The map, the favored tool for educational geography.	142
4.3. Toward a renewal of mapping practices?	146
4.3.1. Methodology for analyzing textbooks	147
4.3.2. [Should we use] the cartography of riddles to consider maps?	148
4.4. The sensitive map, a lever for renewing mapping	155
4.5. Conclusion	162
4.6. References	163
Part 3. The Multimodal Semiotic Approach: A Look at Didactic Interactions and Cognitive Processes	167
Introduction to Part 3.	169
Catherine HOUEMENT, Cécile DE HOSSON and Christophe HACHE	
Chapter 5. Semiotic Modes and Models in Physics.	173
Karine BÉCU-ROBINAULT	
5.1. An initial epistemological anchoring: modeling	175
5.1.1. An epistemological approach to physics	175
5.1.2. The constituent elements of modeling activities	179
5.1.3. Example: modeling the functioning of a flashlight	181
5.2. The second anchoring: semiotic representations	182
5.2.1. Definition of semiotic representations.	182
5.2.2. Semiotic representations in physics	184
5.2.3. Example: from drawings to diagrams in electrokinetics	186
5.3. The contribution of gestures	187
5.3.1. Gestures as semiotic modes	187
5.3.2. Gestures for teaching electrokinetics	189
5.4. Articulation of modeling and semiotic representations within the epistemo-semiotic framework	191
5.4.1. Complementary activities	191
5.4.2. Implications for teaching and learning	193

5.5. Solving the problem of the principle of inertia at upper secondary school	194
5.5.1. Context of the study and research questions	194
5.5.2. A priori analysis of the situation	196
5.5.3. Analysis of students' written productions.	198
5.5.4. Analysis of interactions within a group of students	202
5.5.5. Summary of results	204
5.6. Conclusion	204
5.7. References	205
Chapter 6. The Didactic Effects of Semiotic Microphenomena in Mathematics	209
Édith PETITFOUR and Catherine HOUEMENT	
6.1. Some foundations	210
6.1.1. Our vision of learning	210
6.1.2. Theoretical tools for semiotic analysis	211
6.1.3. Semiotic dissonance	212
6.2. Dissonance and interactions in a mainstream class	214
6.2.1. Presentation of the context, the data studied	215
6.2.2. Studying communication and regulation of the task	217
6.2.3. Noting semiotic dissonances on language.	219
6.3. Dissonances and symbols in a class at a medical-education institute	220
6.3.1. Presentation of the context, the data studied	221
6.3.2. Semiotic dissonances and numbers	223
6.3.3. Semiotic dissonances and arithmetical writing.	225
6.4. The table, a support for hidden complexity	232
6.4.1. A table for breaking numbers down into tens	233
6.4.2. A table for breaking down the numbers into hundreds	237
6.4.3. The table, an analytical aide for the researcher?	238
6.4.4. In sum: the table, a sign in itself	238
6.5. Conclusion	239
6.6. References	243
Chapter 7. Body, Matter and Signs in the Constitution of Meaning in Mathematics	247
Luis RADFORD	
7.1. Introduction.	247
7.2. Body, matter and thought.	251
7.2.1. From Antiquity to the Middle Ages	251

7.2.2. Rationalism and empiricism in the 17th and 18th centuries	253
7.2.3. The body and the senses in contemporary research	254
7.3. The body and the historical emergence of algebraic symbolism.	259
7.4. Sight, touch, orality and symbol.	269
7.5. Conclusion	276
7.6. References	278
Conclusion	283
Catherine HOUEMENT, Cécile DE HOSSON and Christophe HACHE	
List of Authors	287
Index	289