
Contents

1	Introduction to the “Pie Chart” for Chemistry Didactics	1
	References	9
2	Student Conceptions	11
2.1	Scientific Focus: Theories from the History of Natural Sciences	13
2.1.1	Primal Matter Theories	13
2.1.2	Transformation Concepts of the Alchemists	14
2.1.3	The Phlogiston Theory	15
2.1.4	“Horror vacui” and Air Pressure	16
2.1.5	Theories on Atomism and the Structure of Matter	17
2.2	Learners: Empirical Evidence of Student Conceptions	19
2.2.1	Substances as Property Carriers	19
2.2.2	Mixture Concept	20
2.2.3	Destruction Concept	21
2.2.4	Energy Concept	22
2.2.5	The Combustion Process	23
2.2.6	Air and Other Gases	26
2.2.7	Structure of Matter	27
2.2.8	Horror vacui	29
2.2.9	Spatial Ability	29
2.2.10	Homemade Misconceptions	32
2.3	Teaching Processes: Consideration of Student Conceptions	32
2.4	Social Reference Fields: Student Conceptions and Colloquial Language	38
2.5	Exercise Tasks	39
2.6	Experiments	40
	References	54
3	Motivation	57
3.1	Learners: Developmental Status, Attitudes and Original Ideas	58
3.1.1	Developmental Stage	59
3.1.2	Attitudes	60
3.1.3	Original Student Conceptions	61

3.2	Teaching Processes: Opportunities for Building Subject-Related Motivation.	61
3.2.1	Comprehensible Teaching	62
3.2.2	Introduction According to Wagenschein	63
3.2.3	References to Everyday Life and Living Environment.	64
3.2.4	Generation of Cognitive Conflicts	65
3.2.5	Striking Experimental Effects	67
3.2.6	Active Handling of Experimental or Model Building Materials	69
3.3	Scientific Focus: Experimental Skills for Demonstration Experiments	70
3.4	Social Reference Fields: Motivation through Everyday Language and Media	70
3.5	Exercise Tasks	73
3.6	Experiments	74
	References.	83
4	Teaching Objectives	85
4.1	General Didactic Introduction	86
4.1.1	Educational Objectives and Their Dimensions	86
4.1.2	Didactic Models.	88
4.1.3	Lesson Planning and Analysis	88
4.2	Social Reference Fields: Educational Standards and Curricula	90
4.3	Learners: Cognitive development, student conceptions, attitudes, interests.	96
4.3.1	Learning Objectives and Developmental Psychology	96
4.3.2	Student Conceptions	97
4.3.3	Attitudes and Interests	98
4.4	Scientific Focus: Chemistry Lessons as a Spiral Curriculum	100
4.5	Teaching Processes—Teaching Methods for Achieving Educational Goals	103
4.5.1	The Research-Developing Teaching:	104
4.5.2	The Historically Problem-Oriented Teaching	106
4.5.3	ChiK – Chemistry in Context	108
4.5.4	choice ² learn	111
4.5.5	The teaching method oriented towards student conceptions	124
4.5.6	choice ² reflect	125
4.5.7	The socio-critical problem-oriented teaching	130
4.5.8	choice ² explore	131
4.5.9	Further Teaching Concepts	137
4.6	Exercise Tasks	142
	References.	142

5	Media	147
5.1	Teaching Processes: Media and their Functions in Teaching.	149
5.1.1	Textbook.	151
5.1.2	School Board	152
5.1.3	Presentation Slides (via Overhead Projector or Computer/Tablet and Projector).	154
5.1.4	Newspaper Report	155
5.1.5	Videos, Films, Online Appearances.	156
5.1.6	Computer, Tablet	156
5.1.7	Multimedia.	158
5.1.8	Interactive Whiteboard.	159
5.1.9	Experiments	160
5.1.10	Backgrounds and Light Wall	160
5.1.11	Camera Use	161
5.1.12	Projections	161
5.1.13	Magnetic Whiteboards.	161
5.1.14	Computer Use	162
5.1.15	Data Acquisition Systems, Handheld Devices.	162
5.1.16	Models	163
5.1.17	Experiment Kits	163
5.2	Scientific Focus: Objective Adequacy Appropriateness of Media	163
5.3	Learners: Media Competence and Media Production	166
5.4	Social Reference Fields: Mass Media	168
5.4.1	Webquest	169
5.4.2	Movie Scenes.	170
5.5	Exercise Tasks	171
5.6	Experiments	171
	References.	177
6	Experiments	181
6.1	Scientific focus: Experiment, Experimental Skills, Safety	184
6.1.1	Experiment and Process of Knowledge Acquisition	184
6.1.2	Data Acquisition.	186
6.1.3	Synthesis of New Substances.	188
6.1.4	Experimental Skills and Abilities.	188
6.1.5	Safety and Disposal	191
6.1.6	Disposal	193
6.2	Teaching Processes: Functions, Selection Criteria and Forms of Experiments	194
6.2.1	Functions of the Experiment	195
6.2.2	Selection Criteria for Experiments.	200
6.2.3	Implementations of the Experiment.	201
6.2.4	Organizational Procedure of Experimental Teaching.	202

6.3	Learners: Playfulness and Curiosity, Experimental Skills	203
6.4	Social Reference Fields: Experiments on Everyday Life and Environment	204
6.5	Exercise Tasks	206
6.6	Examples of Experiments	207
	References	226
7	Models and Model Representations	227
7.1	Scientific Focus: Models and their Functions	229
7.1.1	Model concept and knowledge in the natural sciences	229
7.1.2	Thought Models in Chemistry	233
7.1.3	Visual Models in Chemistry	235
7.2	Teaching Processes: Models and their Didactic Functions	237
7.2.1	Conveying Chemical Facts through Model Ideas	240
7.2.2	Adaptation and Extension of Models in Chemistry Education	248
7.2.3	Further Functions of Models and Model Ideas	250
7.3	Learners: Experiences with Models	252
7.3.1	Toys	252
7.3.2	Fun with Models	253
7.3.3	Models from Other School Subjects	253
7.4	Social Reference Fields: Interdisciplinary Model Ideas	255
7.5	Exercise Tasks	255
7.6	Model Building Workshop: Structures of Metals and Salts	256
7.6.1	Tasks and Construction Instructions	257
7.6.2	Solutions and Drawings for the Tasks	261
	References	264
8	Scientific Language and Symbols	267
8.1	Scientific Focus: Terms, Symbols, Quantities, Units	268
8.1.1	Système Internationale and derived units	268
8.1.2	School-Relevant Sizes and Units	269
8.1.3	School-Relevant Terms	277
8.2	Teaching Processes: Everyday Language → Scientific Language → Symbolic Language	288
8.2.1	Linking Everyday Language and Scientific Language	288
8.2.2	The Chemical Symbol Language	292
8.2.3	Derivation of First Chemical Symbols in Teaching	297
8.3	Learners: Student Conceptions of Chemical Structures and Symbols	300
8.3.1	Conceptions of Combustion	300
8.3.2	Concepts of the Ion Idea	300
8.3.3	Concepts of Stoichiometry	301
8.3.4	Laboratory Jargon and Misconceptions	303

8.4	Social Reference Fields: Laypeople and Chemical Jargon	309
8.5	Exercise Tasks	309
	References.	312
9	Everyday Life and Chemistry	315
9.1	Learners: Curiosity and Interest.	316
9.1.1	Student Interests.	318
9.1.2	Household Chemicals and Interest.	320
9.1.3	Attitudes towards Chemistry and Chemistry Education	320
9.2	Scientific Focus: Subject Systematics versus Everyday Chemistry.	322
9.2.1	Everyday Phenomena and Chemistry	324
9.2.2	Technical Interpretations, Experiments	324
9.3	Teaching Processes: Subject Systematics plus Everyday Chemistry.	332
9.3.1	Methods for Mediation Processes	332
9.3.2	Complete Curricula Based on Everyday Chemistry	333
9.3.3	Chemistry in Context.	337
9.3.4	Chemistry for Life	338
9.3.5	NRW Curricula and New Textbooks	339
9.4	Social Reference Fields: Role-Playing and Environmental Education	342
9.5	Exercise Tasks	344
9.6	Experiments	345
	References.	351
10	History of Chemistry for Student Teachers	353