

Rekha B. Koul
Rachel Sheffield
Leonie McIlvenny

Teaching 21st Century Skills

Using STEM Makerspaces

 Springer

Contents

Part I About Makerspaces

1	The Story of Makerspace	3
1.1	The Beginning of Makerspaces	4
1.2	Makerspace Versus Maker Program	6
1.3	Makerspaces and Maslow's Hierarchy of Needs	8
1.4	Makerspaces in a School Setting	10
1.5	Teacher Reflection	15
1.6	What Do Makerspaces Sound like?	16
1.7	Summary	18
2	Makerspaces and STEM—A Synergistic Partnership	21
2.1	Introduction	22
2.2	What is STEM?	22
2.3	Global Position of STEM	24
2.4	Defining STEM	26
2.5	STEM Concepts versus Skills	26
2.6	STEM Theoretical Framework	27
2.7	Challenges of STEM	29
2.8	STEM Pedagogies	30
2.9	Makerspace: Bridging the STEM Challenges	32
2.10	Summary	33
3	The World of Makerspaces	35
3.1	Introduction	36
3.2	Makerspace Examples	38
3.3	Makerspaces in Libraries	61
3.4	Makerspace at Curtin University, Western Australia	63
3.5	Summary	64

Part II Makerspaces and Pedagogy—Learning in a Makerspace

4	The Essential Twenty-First-Century Skill Set—Transversal Competencies	69
4.1	Introduction	70
4.2	What is in a Name?	71
4.3	Developing Competency Frameworks	71
4.4	The Challenge of Addressing Transversal Competencies within the Curriculum	72
4.5	How Makerspaces Support the Development of Transversal Competencies	75
4.6	Summary	75
5	Higher-Order Thinking in a Makerspace	77
5.1	Introduction	78
5.2	Thinking and Maslow's Hierarchy of Cognitive Needs	79
5.3	Critical and Creative Thinking	79
5.4	Using Blooms' Taxonomy as a Framework for Developing Higher-Order Thinking	82
5.5	Creating a Thinking Classroom/Makerspace	83
5.6	The Power of Questioning	88
5.7	Humour and Higher-Order Thinking	88
5.8	The Problem-Solving Process	92
5.9	Using Makerspace Design Process	92
5.10	Assessing Problem-Solving	93
	Appendix	102
6	Developing Collaboration Skills in a Makerspace	105
6.1	Introduction	106
6.2	Collaboration as a Dynamic Process	107
6.3	Developing a Collaborative Makerspace Culture	109
6.4	Essentials Skills Developed in a Collaborative Makerspace	112
6.5	Operationalising the Collaboration BAR Model in the Classroom	113
6.6	Summary	117
7	Developing Communication Skills in a Makerspace	119
7.1	Introduction	120
7.2	Defining Communication	120
7.3	The Communication Process	120
7.4	Characteristics of Communication	124
7.5	How Makerspaces Can Help Develop Effective Communication in STEM	125
7.6	A Teacher's Role in Developing Communication Skills	125

7.7	Teacher Questions to Support Students Communication	126
7.8	Case Study	126
7.9	Beyond Regular Communication	131
7.10	Summary	134
8	Developing Resilience in a Makerspace	137
8.1	Introduction	138
8.2	Resilience and Maslow's Hierarchy of Needs	139
8.3	Language of Resilience	140
8.4	The Role of Teachers in Developing Resilience in a Makerspace	141
8.5	Reflective Strategies	144
8.6	Developing Resilience Through Effective Questioning	145
8.7	Assessment—Measuring Resilience	146
8.8	Case Study	148
8.9	Summary	152
	Appendix	152

Part III Country Context

9	STEM, TVCs, and Makerspaces in the Indian Curriculum	157
9.1	Introduction	158
9.2	Transitioning Through the National Education Policy	158
9.3	STEM in the Indian Curriculum	159
9.4	Science and Mathematics Learning Outcomes	160
9.5	Activity: Pipeline Challenge—Part 1	160
9.6	Activity: Pipeline Challenge	162
9.7	Pipeline Challenge: Links to Science Curriculum	165
9.8	Pipeline Challenge: Links to Mathematics Curriculum	166
9.9	The NEP 2020 and Makerspaces	166
9.10	Makerspace is not Jugaad	168
9.11	Summary	168
10	STEM, TVCs, and Makerspaces in the Australian Curricula	171
10.1	The Australian Curriculum	172
10.2	STEM in the Australian Curriculum	172
10.3	Makerspace Activities that Link to the Australian Curriculum	176
10.4	Wigglebot Example Part 1	177
10.5	The Place of Transversal Competencies in the Australian Curriculum	179
10.6	Unpacking the General Capabilities	180
10.7	Wigglebot Example Part 2	183
10.8	Summary	184

11 Future-Proofing Makerspaces	189
11.1 Past, Present, and Future	190
11.2 The Evolution from Education 1.0 to Education 4.0	191
11.3 Makerspaces and Education 4.0	194
11.4 Virtual Makerspaces	195
11.5 Summary	197
Appendix	198

References	201
-------------------------	-----