# Contents

**Foreword** . . . . . ix

**Preface** . . . . . xiii

**Introduction** . . . . . xix

**Chapter 1. Learning Robotics: Users' Representation of Robots** . . . . . 1

1.1. Introduction: the ontological and pedagogical status of robots . . . . . 1
1.2. What do we mean by robot representation? . . . . . 3
1.2.1. The place of robots in our common-sense ontology . . . . . 3
1.2.2. Categories: essentialist versus graded . . . . . 4
1.2.3. The NOC hypothesis . . . . . 6
1.2.4. Shifting between the different pedagogical roles of a robot . . . . . 7
1.2.5. How do we investigate robot representations and the impact of learning robotics on these representations? . . . 8
1.3. Study 1: Robot representation . . . . . 9
1.3.1. Aims and rationale . . . . . 9
1.3.2. Hypotheses . . . . . 10
1.3.3. Method . . . . . 12
1.4. Results . . . . . 17
1.4.1. Which representation of robots for familiar and unfamiliar students? . . . . . 17

1.4.2. The living and non-living items most frequently associated with robots (pre-questionnaire) . . . . . 18
1.4.3. Gradation in robot categorization: essentialist versus non-essentialist stance (pre-questionnaire). . . . . 19
1.4.4. The educational roles most frequently envisaged for robots (pre-questionnaire) . . . . . 20
1.4.5. Gradation in the educational roles envisaged for a robot (pre-questionnaire). . . . . 20
1.4.6. The impact of building and programming a robot on students' judgment about the ontological status of robots . . . . . 21
1.4.7. The impact of robot making on graded versus all-or-nothing categorization . . . . . 23
1.4.8. Does familiarity with robots influence their categorization? . . . . . 26
1.4.9. Dichotomous versus multiple categorization of robots . . . . . 28
1.4.10. The impact of robot making on the educational roles envisaged for robots . . . . . 29
1.4.11. The impact of robot making on shift between the educational roles envisaged for robots. . . . . 31
1.4.12. Does previous experience influence the educational role attributed to robots? . . . . . 32
1.5. Discussion. . . . . 34
1.6. Conclusions, limits and perspectives . . . . . 38

**Chapter 2. Learning with Robotics: Functional and Social Acceptance of Robots** . . . . . 43

2.1. Functional and social acceptance of robots . . . . . 43
2.2. Trust as a fundamental indicator of acceptance. . . . . 49
2.2.1. Commonly used measures of human–robot trust . . . . . 49
2.2.2. Conformation as an innovative measure of human–robot trust . . . . . 51
2.2.3. Factors influencing robot trust . . . . . 52
2.3. Study 2: robot acceptance . . . . . 56
2.3.1. Aims and rationale . . . . . 56
2.3.2. Method . . . . . 59

2.4. Results . . . . . 69
2.4.1. Do participants conform their answer more to iCub's answer in the functional task than in the social task? (H1) . . . . . 69
2.4.2. Do participants who conform to iCub in the social task also conform in the functional task? (H2) . . . . . 71
2.4.3. Does the imagined HRI scenario influence trust in iCub? (H3) . . . . . 71
2.4.4. Is there a correlation between negative attitudes to the robot's social influence and the trust in the robot's social savvy? (H4) . . . . . 74
2.4.5. Is there a correlation between the human DFC and the trust in the robot's functional and social savvy? . . . . . 74
2.5. Discussion . . . . . 76
2.6. Conclusions . . . . . 83

**Chapter 3. Learning by Robotics: The Impact of Educational Robots on Learning** . . . . . 87

3.1. Combining RBI and inquiry-based science . . . . . 87
3.2. IBSE and the four dimensions of learning . . . . . 93
3.2.1. The cognitive dimension . . . . . 95
3.2.2. The affective dimension . . . . . 97
3.2.3. The social dimension . . . . . 98
3.2.4. The meta-cognitive dimension . . . . . 99
3.2.5. Self-regulation . . . . . 101
3.2.6. RBI and inquiry-based learning . . . . . 105
3.3. Study 3: impacts of ER on learning . . . . . 114
3.3.1. Aims and rationale . . . . . 114
3.3.2. The RObeeZ project . . . . . 115
3.3.3. Hypotheses . . . . . 122
3.3.4. Experimental design . . . . . 123
3.4. Results . . . . . 128
3.4.1. Are the subject-specific knowledge and competencies of pupils enhanced at the end of RObeeZ project? . . . . . 128
3.4.2. Are pupils' transversal competencies enhanced at the end of the project? . . . . . 129

3.4.3. Does the combination of RBI and IBSE have an impact on the four dimensions of learning? . . . . . 130
3.5. Discussion. . . . . 136

**Conclusion and Perspectives** . . . . . 143

**Appendices** . . . . . 153

**Appendix 1** . . . . . 155

**Appendix 2** . . . . . 159

**Appendix 3** . . . . . 163

**Appendix 4** . . . . . 169

**Appendix 5** . . . . . 177

**Bibliography** . . . . . 181

**Index** . . . . . 223