Perspectives on an Integrated Computer Learning Environment

Heck, A.J.P.

Citation for published version (APA):

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: https://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

UvA-DARE is a service provided by the library of the University of Amsterdam (http://dare.uva.nl)
# Contents

1 Introduction .......................................................... 1
   1.1 Educational Context ........................................... 2
   1.2 R&D at AMSTEL ............................................. 13
   1.3 Multiformity of ICT Tools .................................. 15
   1.4 Aims and Set-Up of the Study ............................... 18
   1.5 Structure of the Thesis ...................................... 24

2 Classroom Studies .................................................... 25
   2.1 Introduction .................................................. 26
   2.2 Student Work with Real Data about Human Growth .......... 30
   2.3 Computer-Based Investigations of Mathematical Shapes of Real Objects
       2.3.1 Image Analysis of Bridges and Hanging Chains ............ 37
       2.3.2 Modeling Shapes of Bridges and Hanging Chains .......... 41
   2.4 Video Analysis of Human Locomotion .......................... 44
       2.4.1 Gait Analysis in the Classroom .......................... 45
       2.4.2 Gait Analysis in a Masterclass .......................... 51
   2.5 Video-Based Practical Work at Pre-Vocational Secondary School Level 56
   2.6 Spreadsheet-Based Data Handling ............................ 62
       2.6.1 Survival Analysis of Censored Clinical Data by Students .... 62
       2.6.2 Handling Weather Data ................................ 67
   2.7 Computer-Based Modeling in Quantitative Pharmacology ......... 74
   2.8 Video Analysis and Modeling of Bouncing Balls ................. 83

3 Computer Tools for Cross-Disciplinary Work with Real Data ........... 99
   3.1 Overview of Activity Types .................................. 100
       3.1.1 Data Logging ........................................... 102
       3.1.2 Control ............................................... 103
       3.1.3 Digital Image and Video Analysis ........................ 104
       3.1.4 Modeling and Simulation ................................ 108
       3.1.5 Animation ............................................. 111
   3.2 Digital Image and Video Analysis ............................. 114
       3.2.1 Image Analysis of a Hanging Slinky ...................... 115
       3.2.2 Perspective Correction Applied in Crime Scene Photography .... 118
       3.2.3 Using High Speed Video to Study Moving Coins ............ 122
   3.3 Modeling ................................................... 127
       3.3.1 Modeling Chemical Kinetics Graphically ................. 127
3.3.2 ICT-Supported Study of Acid-Base Titration Curves  ........... 136
3.3.3 Modeling of Tidal Movement ..................................... 142
3.4 Data Logging, Control, and Video Combined .......................... 150
3.4.1 Gait Analysis via Electromyography ................................. 151
3.4.2 Exploring Standing Vertical Jumps ................................ 153
3.4.3 Measuring the Pupil Light Reflex .................................. 160
3.5 Video Analysis and Modeling Combined ................................ 161
3.5.1 Modeling the Motion of a Yoyo ..................................... 162
3.5.2 High Speed Video Analysis of a Falling Shuttlecock ............... 165
3.5.3 Modeling the Decay of Beer Foam in a Glass ....................... 169
3.5.4 Understanding the Motion of a Falling Chain ..................... 173
3.5.5 Models of Sprinting .................................................. 178
3.5.6 Modeling Bouncing Gaits ............................................ 187
3.5.7 Exploring the Giant Circle on the High Bar ....................... 194

4 Findings and Conclusions ................................................. 203
4.1 Analysis Framework ................................................... 203
4.2 Aspects of Scientific Inquiry and Authenticity ....................... 205
4.2.1 Quantitative Mathematical Modeling Competency ................. 205
4.2.2 Design and Conduct of Experiments, and Basic Data Handling .. 211
4.2.3 Graph Sense ....................................................... 216
4.2.4 Data Sense ....................................................... 227
4.2.5 Symbol Sense ..................................................... 232
4.2.6 Representational Fluency .......................................... 238
4.2.7 Instructional Design ............................................... 241
4.2.8 Authenticity ....................................................... 247
4.3 Aspects of Tool Design ............................................... 250
4.3.1 The Role of ICT in Quantitative Mathematical Modeling ........ 251
4.3.2 ICT-supported Mathematical Representations ...................... 261
4.3.3 Tables and Graphs .................................................. 264
4.3.4 Data Manipulation, Processing, and Analysis ..................... 274
4.3.5 Video Analysis ..................................................... 281
4.3.6 Graphical System Dynamics-Based Modeling ...................... 288
4.4 Concluding Remarks ................................................... 294
4.4.1 Main Outcomes .................................................... 294
4.4.2 Answers to the Driving Questions ................................ 303
4.4.3 Reflection on the Presented and Future Work .................... 307

References ................................................................. 311

Contents of the CD-ROM .................................................. 339

Summary ................................................................. 345

Samenvatting ............................................................. 349

Acknowledgments ......................................................... 353

Curriculum Vitae .......................................................... 357