Perspectives on an integrated computer learning environment

Heck, A.J.P.

Publication date
2012

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.
Contents

1 Introduction 1
   1.1 Educational Context ........................................... 2
   1.2 R&D at AMTDEL .................................................. 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 37
       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
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3.2</td>
<td>ICT-Supported Study of Acid-Base Titration Curves</td>
<td>136</td>
</tr>
<tr>
<td>3.3.3</td>
<td>Modeling of Tidal Movement</td>
<td>142</td>
</tr>
<tr>
<td>3.4</td>
<td>Data Logging, Control, and Video Combined</td>
<td>150</td>
</tr>
<tr>
<td>3.4.1</td>
<td>Gait Analysis via Electromyography</td>
<td>151</td>
</tr>
<tr>
<td>3.4.2</td>
<td>Exploring Standing Vertical Jumps</td>
<td>153</td>
</tr>
<tr>
<td>3.4.3</td>
<td>Measuring the Pupil Light Reflex</td>
<td>160</td>
</tr>
<tr>
<td>3.5</td>
<td>Video Analysis and Modeling Combined</td>
<td>161</td>
</tr>
<tr>
<td>3.5.1</td>
<td>Modeling the Motion of a Yoyo</td>
<td>162</td>
</tr>
<tr>
<td>3.5.2</td>
<td>High Speed Video Analysis of a Falling Shuttlecock</td>
<td>165</td>
</tr>
<tr>
<td>3.5.3</td>
<td>Modeling the Decay of Beer Foam in a Glass</td>
<td>169</td>
</tr>
<tr>
<td>3.5.4</td>
<td>Understanding the Motion of a Falling Chain</td>
<td>173</td>
</tr>
<tr>
<td>3.5.5</td>
<td>Models of Sprinting</td>
<td>178</td>
</tr>
<tr>
<td>3.5.6</td>
<td>Modeling Bouncing Gaits</td>
<td>187</td>
</tr>
<tr>
<td>3.5.7</td>
<td>Exploring the Giant Circle on the High Bar</td>
<td>194</td>
</tr>
</tbody>
</table>

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