



23 Ahmed Tlili · Maiga Chang
24 Editors

25 Data Analytics Approaches
26 in Educational Games
27 and Gamification Systems
28
30

Editor Proof





33 *Editors*
39 Ahmed Tlili
40 Smart Learning Institute
47 Beijing Normal University
48 Beijing, China
43
44
45
47

Maiga Chang
School of Computing
and Information Systems
Athabasca University
Edmonton, AB, Canada

Editor Proof

48

49 ISSN 2522-0888 ISSN 2522-0896 (electronic)
51 Smart Computing and Intelligence
53 ISBN 978-981-32-9334-2 ISBN 978-981-32-9335-9 (eBook)
54 <https://doi.org/10.1007/978-981-32-9335-9>
55

56 © Springer Nature Singapore Pte Ltd. 2019

57 This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part
58 of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations,
59 recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission
60 or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar
61 methodology now known or hereafter developed.

62 The use of general descriptive names, registered names, trademarks, service marks, etc. in this
63 publication does not imply, even in the absence of a specific statement, that such names are exempt from
64 the relevant protective laws and regulations and therefore free for general use.

65 The publisher, the authors and the editors are safe to assume that the advice and information in this
66 book are believed to be true and accurate at the date of publication. Neither the publisher nor the
67 authors or the editors give a warranty, expressed or implied, with respect to the material contained
68 herein or for any errors or omissions that may have been made. The publisher remains neutral with regard
69 to jurisdictional claims in published maps and institutional affiliations.

70 This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
71 The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721,
72 Singapore



265

Preface

Editor Proof

266 Educational games, gamification learning systems and learning analytics are
267 gaining an increasing attention from researchers and educators. The educational
268 games and gamification system can get learners engaged and motivated in the
269 learning process; at meanwhile, learning analytics grants a system the capability of
270 understanding the learners' needs, assessing learners' skills and knowledge silently,
271 providing teachers detailed information about their students and warning teachers
272 and administrative personnel to pay attention on the at-risk students. This book
273 covers applications of data analytics approaches and research on human behavior
274 analysis in educational games and gamification systems. In particular, this book
275 discusses the purposes, advantages and limitations of using data analytics approa-
276 ches in game-based learning environments and applications.

277 This book talks about the data analytics methods, systems/tools and research for
278 analyzing learners' actions, profiles, records and behaviors stored or happened in
279 educational games and gamified learning systems. As the research progress rapidly,
280 this book can be an up-to-date textbook and reference book for not only
281 post-secondary and academic, but also can be a handbook for educational tech-
282 nology relevant companies and industry.

283 This book arranges research based on three themes: learning analytics, academic
284 analytics and learning assessment, and learner modeling and individual differences.
285 Each theme covers three to four latest research results related to the data analytics in
286 educational games and gamification systems. The aim is to provide readers with
287 methodologies, evidences and experiments through these researches and help
288 readers get clear picture of how data analytics approaches can help not only stu-
289 dents and teachers but everyone in the world.

290 First, this book starts with Moon and Kang's introduction chapter that helps
291 readers get familiar with the subject areas and leads readers to know the importance
292 of data analytics in educational games and gamification research area.

293 In the second part, four chapters talk about learning analytics in educational
294 games and gamification systems. Moon and Liu in Chap. 2 explore the use of
295 sequential data analytics in game-based learning and major issues while doing so
296 via a systematic literature review. At the end of the chapter, they propose guidelines



297 for readers to use sequential data analytics properly. Ifenthaler and Gibson then in
298 Chap. 3 bring the concept of challenge-based learning up. They study 8951
299 students' transaction data and find the learning engagement is positively related to
300 learning performance. Their finding in fact implies the importance of making a
301 learning system like educational game or gamification system capable of catering
302 for the individual learner's needs. Shute, Rahimi and Smith, on the other hand, in
303 Chap. 4 discuss the learning supports and their influences in educational game and
304 present a usability study's of designing and developing stealth assessment in an
305 educational game named Physics Playground. At the end of the chapter, they
306 provide insights of the future of using learning analytics in the games for stealth
307 assessment. In the end of this part in Chap. 5, Montaña, Mondragón, Tobar-Muñoz
308 and Orozco create a gamified platform called HERA. In HERA, students participate
309 in gamified activities that are part of assessment and teachers can know their
310 students via learning traces analysis.

311 The third part of the book is about the academic analytics and learning assess-
312 ment in educational games and gamifications. This part also has four chapters.
313 Denden and colleagues in Chap. 6 present an iMoodle that is an intelligent gamified
314 Moodle. iMoodle has a built-in learning analytics plug-in that can provide teachers
315 dashboard for teachers to control the learning process and an early warning system
316 for predicting at-risk students. Their finding shows that iMoodle has a high accu-
317 racy rate which is almost 90%. Seaton, Chang and Graf also propose the use of
318 dashboard in an educational game called OMEGA (Online Metacognitive
319 Educational Game with Analytics) in Chap. 7. The dashboard can help players see
320 how their performance and skills change over time and what are their weakness and
321 strengths. With the dashboard, players can see their gameplay performance and
322 habits and find the clues and strategies to improve their in-game performance. As
323 the goal of educational games is to allow players to learn unconsciously while
324 playing and playing educational games more and frequently players should learn
325 more or have their skill better, the dashboard can avoid the players quitting from the
326 gameplay due to stuck in the game and cannot get further progress. In Chap. 8,
327 Chadli, Tranvouez and Bendella are also putting their focus on metacognitive skill,
328 in particularly, problem-solving skill. They not only investigate the improvements
329 of second-grade students' word problem-solving skills with educational game's
330 help, but also propose a competency model to measure student's knowledge levels.
331 At the end of this part, Zheng, Cheng, Chew and Chen in Chap. 9 try to improve
332 game-playing process with additional software and sensors. The game collects
333 students' interaction data and provides instantaneous feedbacks for the students.

334 The fourth part of this book aims to learner modeling and individual difference
335 finding. This part includes three chapters. Manske, Werneburg and Hoppe first in
336 Chap. 10 propose a framework for designing and evaluating game-based compu-
337 tational thinking environment named ctGameStudio. The proposed framework uses
338 learning analytics to provide the learners' dynamic guidance, scaffolds and feed-
339 back properly according to their actual state. Then, Luis Flores, Silverio, Fera and
340 Cariaga in Chap. 11 present a learning analytics model that can measure students'
341 motivation within an educational game, Fraction Hero, based on their in-game data.



342 The model assesses three motivational factors include goal orientation, effort reg-
343 ulation and self-efficacy. They also find that students have higher in-game moti-
344 vation than self-perceived motivation toward solving problems. At the end of this
345 part, Chap. 12 organizes and clarifies gamification concepts according to seven
346 properties: personal, functional, psychological, temporal, playful, implementable
347 and evaluative, through a user-centered approach done by Klock, Gasparini and
348 Pimenta.

349 Finally, the last conclusion chapter is written by Tlili, Chang, Huang and Chang.
350 The chapter summarizes all the presented chapters and also discusses correspondent
351 challenges and future insights while adopting data analytics in educational games
352 and gamification systems.

353 Beijing, China

354

Ahmed Tlili
ahmed.tlili23@yahoo.com

355 Edmonton, Canada

356

Maiga Chang
maiga.chang@gmail.com

UNCORRECTED PROOF



Acknowledgements

359 We would like to first thank all of the authors for their valuable contributions to this
360 book by sharing their developed case studies and research outcomes of applying
361 data analytics approaches in educational games and gamification systems. These
362 studies and their reported findings definitely help readers learn the way of adopting
363 data analytics and also give readers stepping stones for further research and
364 development thoughts and insights.

365 We would also like to thank all of the reviewers who accept to review the
366 submitted chapters and give their constructive comments and suggestions for the
367 authors to further enhance the quality of their book chapters, hence enhancing the
368 overall quality of this book. We really appreciate them for giving their reviews in a
369 timely manner that helps our book to meet the production timeline.

370 Special thanks also go to the series editors, namely Prof. Kinshuk, Prof.
371 Ronghuai Huang and Prof. Chris Dede, for their comments and guidance to prepare
372 this book, as well as all our colleagues in the Smart Learning Institute of Beijing
373 Normal University, China, and Athabasca University, Canada, for their support to
374 finish this book project.

375
376 Dr. Ahmed Tlili
377 Dr. Maiga Chang



379 **Contents**

380 **Part I Introduction**

382 **1 Educational Games and Gamification: From Foundations**

384 **to Applications of Data Analytics 3**

385 Jina Kang, Jewoong Moon and Morgan Diederich

386 **Part II Learning Analytics in Educational Games and Gamification**

388 **Systems**

389 **2 Rich Representations for Analyzing Learning Trajectories:**

390 **Systematic Review on Sequential Data Analytics in Game-Based**

392 **Learning Research 27**

393 Jewoong Moon and Zhichun Liu

394 **3 Opportunities for Analytics in Challenge-Based Learning 55**

396 Dirk Ifenthaler and David Gibson

398 **4 Game-Based Learning Analytics in Physics Playground 69**

399 Valerie Shute, Seyedahmad Rahimi and Ginny Smith

400 **5 Learning Analytics on the Gamified Assessment of**

402 **Computational Thinking 95**

403 Juan Montaña, Cristian Mondragón, Hendrys Tobar-Muñoz

404 and Laura Orozco

405 **Part III Academic Analytics and Learning Assessment**

406 **in Educational Games and Gamification Systems**

408 **6 iMoodle: An Intelligent Gamified Moodle to Predict “at-risk”**

400 **Students Using Learning Analytics Approaches 113**

411 Mouna Denden, Ahmed Tlili, Fathi Essalmi, Mohamed Jemni,

412 Maiga Chang, Kinshuk and Ronghuai Huang

413

Editor Proof



414	7 Integrating a Learning Analytics Dashboard in an Online Educational Game	127
416	J. X. Seaton, Maiga Chang and Sabine Graf	
417		
418	8 Learning Word Problem Solving Process in Primary School Students: An Attempt to Combine Serious Game and Polya’s Problem Solving Model	139
419	Abdelhafid Chadli, Erwan Tranvouez and Fatima Bendella	
420		
422		
423	9 Designing a 3D Board Game on Human Internal Organs for Elementary Students	165
424	Yu-Jie Zheng, I-Ling Cheng, Sie Wai Chew and Nian-Shing Chen	
426		
427	Part IV Modeling Learners and Finding Individual Differences by Educational Games and Gamification Systems	
428		
430	10 Learner Modeling and Learning Analytics in Computational Thinking Games for Education	187
432	Sven Manske, Sören Werneburg and H. Ulrich Hoppe	
433		
434	11 Motivational Factors Through Learning Analytics in Digital Game-Based Learning	213
436	Rafael Luis Flores, Robelle Silverio, Rommel Feria and Ada Angeli Cariaga	
437		
438		
439	12 Designing, Developing and Evaluating Gamification: An Overview and Conceptual Approach	227
440	Ana Carolina Tomé Klock, Isabela Gasparini and Marcelo Soares Pimenta	
442		
443		
444	Part V Conclusion	
445		
446	13 Data Analytics Approaches in Educational Games and Gamification Systems: Summary, Challenges, and Future Insights	249
447	Ahmed Tlili and Maiga Chang	
448		
449		
450		

