Intelligent Learning Environments: Design, Usage and Analytics for Future Schools

Manolis Mavrikis, UCL Knowledge Lab
Wayne Holmes, Institute of Educational Technology, Open University, UK

Abstract

This chapter reviews the field broadly referred to as Intelligent Learning Environments (ILEs), capturing the state-of-the-art in both Intelligent Tutoring Systems (ITS) and Artificial Intelligence in Education (AIED). After a brief historical account, we report design architectures and implementation approaches exemplified by a recent example. We then shift our attention to classroom implementation and blended learning strategies that take into account the challenges of using ILEs in the classroom. We present Learning Analytics tools as a way to support teachers addressing these challenges, to increase their awareness and ultimately to support students directly. We conclude with a summary of efficacy studies and open issues while advocating that these systems should not be seen as displacing teachers but augmenting the human aspects of teaching.

Keywords: intelligent learning environments, learning analytics, design, blended learning

Introduction

With the recognition of education as a pilar for a sustainable future (e.g. UNESCO, 2014), educators, policy makers and parents are in search of ways to provide cost-effective and at the same time quality teaching and learning opportunities for students. Technology has been promoted as a solution to this challenge for decades. The emergence of artificial intelligence techniques and advancements in the analysis and visualisation of data are transforming learning technologies and introducing a genre of tools that can support students directly and provide information about their learning to teachers and parents.

There are several terms and ways to refer to this technology. This chapter will refer to **Intelligent Learning Environments** (ILEs) as a broad category of digital educational interactive applications equipped with features that enable the provision of personalized, adaptive support to students (either by means of task selection or adaptation, or dynamic assistance while students are undertaking a task). This expands on older definitions that centre on student assistance during problem solving (Dillenbourg et al., 1994) or student-driven learning (Brusilovsky, 2004). Depending on the subject matter that these systems are designed to target, and the type of learning that they are promoting, the system-student interaction is characterized differently. For example, the system-student interaction may be referred to as *tutoring* (hence Intelligent Tutoring Systems), when the interaction is designed around the steps that students take when solving a problem (Van Lehn, 2011). At other times, it may be referred to more generally as *intelligent support* when the interaction is more open-ended or exploratory (Gutierrez-Santos et al. 2012).

Mathematical Intelligent Learning Environments

Christine Keitel-Kreidt,Kenneth Ruthven

Mathematical Intelligent Learning Environments:

Mathematical Intelligent Learning Environments Hyacinth Sama Nwana,1993 The Mathematical Intelligent Educational Environments considered here provide methods on how ILE systems are developed The book looks at the most recent developments in Intelligent Learning Environments for the domain and groups together the most recent work

Intelligent Learning Environments: The Case of Geometry Jean-Marie Laborde,2012-12-06 This book is a thoroughly revised result updated to mid 1995 of the NATO Advanced Research Workshop on Intelligent Learning Environments the case of geometry held in Grenoble France November 13 16 1989 The main aim of the workshop was to foster exchanges among researchers who were concerned with the design of intelligent learning environments for geometry The problem of student modelling was chosen as a central theme of the workshop insofar as geometry cannot be reduced to procedural knowledge and because the significance of its complexity makes it of interest for intelligent tutoring system ITS development The workshop centred around the following themes modelling the knowledge domain modelling student knowledge design ing didactic interaction and learner control This book contains revised versions of the papers presented at the workshop All of the chapters that follow have been written by participants at the workshop Each formed the basis for a scheduled presentation and discussion Many are suggestive of research directions that will be carried out in the future There are four main issues running through the papers presented in this book knowledge about geometry is not knowledge about the real world and materialization of geometrical objects implies a reification of geometry which is amplified in the case of its implementation in a computer since objects can be manipulated directly and relations are the results of actions Laborde Schumann This aspect is well exemplified by research projects focusing on the design of geometric microworlds Guin Laborde   Smart Learning Environments in the Post Pandemic Era Demetrios G. Sampson,Dirk Ifenthaler,Pedro Isaías,2024-03-25 This edited volume presents the latest research focussing on current challenges on the deployment of smart technologies and pedagogies for supporting teaching and learning in the post covid19 era This is at the core of studying the evolution of the learning process the role of technology supported pedagogical approaches and the progress of educational technology innovations in the context of digital transformation in education and professional training A selection of the best papers from the Cognition and Exploratory Learning in the Digital Age CELDA Conference 2022 are included in this volume bringing together high quality research on Smart Pedagogies in the Post Pandemic Era Smart Learning Technologies in the Post Pandemic Era and Case Studies of Smart Learning Environments The volume contributes to the discussion of current issues in digital education between researchers practitioners and policymakers   Cases on Smart Learning Environments Darshan Singh, Abtar,Raghunathan, Shriram,Robeck, Edward,Sharma, Bibhya,2018-12-28 At a time when ICTs are proliferating various facets of society and human interactivity optimizing the use of these tools and technologies not only enhances learning but also transforms learning experiences all together resulting in an increase of

effectiveness and quality of education around the globe As such teachers are being challenged to implement a wide range of tools such as mobile learning and augmented reality to create smarter learning environments inside and outside of the classroom Cases on Smart Learning Environments explores the potential of SLE tools for enhanced learning outcomes as experienced by educators learners and administrators from various learning institutions around the world This publication presents cases on the real world implementation of SLEs in 11 countries that span the continents of Asia Africa Europe and North and South America Featuring coverage on a broad range of topics such as learner engagement teacher training and intelligent agent technology this book is ideally designed for academicians instructors instructional designers librarians educational stakeholders and curriculum developers **Smart Learning Environments** Maiga Chang,Yanyan Li,2014-09-05 This book addresses main issues concerned with the future learning learning and academic analytics virtual world and smart user interface and mobile learning This book gathers the newest research results of smart learning environments from the aspects of learning pedagogies and technologies in learning It examines the advances in technology development and changes in the field of education that has been affecting and reshaping the learning environment Then it proposes that under the changed technological situations smart learning systems no matter what platforms i e personal computers smart phones and tablets they are running at should be aware of the preferences and needs that their users i e the learners and teachers have be capable of providing their users with the most appropriate services helps to enhance the users learning experiences and to make the learning efficient *International Handbook of Mathematics Education* Alan Bishop,M.A. (Ken) Clements,Christine Keitel-Kreidt,Jeremy Kilpatrick,Colette Laborde,2012-12-06 ALAN J BISHOP Monash University Clayton Victoria Australia RATIONALE Mathematics Education is becoming a well documented field with many books journals and international conferences focusing on a variety of aspects relating to theory research and practice That documentation also reflects the fact that the field has expanded enormously in the last twenty years At the 8th International Congress on Mathematics Education ICME in Seville Spain for example there were 26 specialist Working Groups and 26 special ist Topic Groups as well as a host of other group activities In 1950 the Commission Internationale pour I Etude et l Amelioration de l Enseignement des Mathematiques CIEAEM was formed and twenty years ago another active group the International Group for the Psychology of Mathematics Education PME began at the third ICME at Karlsruhe in 1976 Since then several other specialist groups have been formed and are also active through regular conferences and publications as documented in Edward Jacobsen s Chapter 34 in this volume *Learning from Computers: Mathematics Education and Technology* Christine Keitel-Kreidt,Kenneth Ruthven,2012-12-06 The NATO Advanced Research Workshop on Mathematics Education and Technology was held in Villard de Lans France between May 6 and 11 1993 Organised on the initiative of the BaCoMET Basic Components of Mathematics Education for Teachers group Christiansen Howson and Otte 1986 Bishop Mellin Olsen and van Dormolen 1991 the workshop formed part of a larger NATO programme on Advanced Educational

Technology Some workshop members had already participated in earlier events in this series and were able to contribute insights from them similarly some members were to take part in later events The problematic for the workshop drew attention to important speculative developments in the applications of advanced information technology in mathematics education over the last decade notably intelligent tutoring geometric construction symbolic algebra and statistical analysis Over the same period more elementary forms of information technology had started to have a significant influence on teaching approaches and curriculum content notably arithmetic and graphic calculators standard computer tools such as spreadsheets and databases and computer assisted learning packages and computer microworlds specially designed for educational purposes **Information and Communications Technologies in School Mathematics** David Tinsley,David B. Johnson,2013-06-05 The International Federation for Information Processing IFIP is a multinational federation of professional technical organisations concerned with information processing IFIP is dedicated to improving communication and increased understanding among practitioners of all nations about the role information processing can play in all walks of life This Working Conference Secondary School Mathematics in the World of Communication Technologies Learning Teaching and the Curriculum was organised by Working Group 3 1 Informatics in Secondary Education ofiFIP Technical Committee for Education TC3 This is the third conference on this theme organised by WG 3 1 the previous two were held in Varna Bulgaria 1977 and Sofia Bulgaria 1987 proceedings published by North Holland Elsevier The aim of the conference was to take a forward look at the issue of the relationships between mathematics and the new technologies of information and communication in the context of the increased availability of interactive and dynamic information processing tools The main focus was on the mathematics education of students in the age range of about ll to 18 years and the following themes were addressed Curriculum curriculum evolution relationships with informatics Teachers professional development methodology and practice Learners tools and techniques concept development research and theory Human and social issues culture and policy personal impact Exploiting Mental Imagery with Computers in Mathematics Education Rosamund Sutherland,John Mason,2012-12-06 The advent of fast and sophisticated computer graphics has brought dynamic and interactive images under the control of professional mathematicians and mathematics teachers This volume in the NATO Special Programme on Advanced Educational Technology takes a comprehensive and critical look at how the computer can support the use of visual images in mathematical problem solving The contributions are written by researchers and teachers from a variety of disciplines including computer science mathematics mathematics education psychology and design Some focus on the use of external visual images and others on the development of individual mental imagery The book is the first collected volume in a research area that is developing rapidly and the authors pose some challenging new questions

Advanced Educational Technology: Research Issues and Future Potential Thomas T. Liao,2012-12-06 As we approach the 21st century the need to better link research findings and practical applications of advanced educational technologies AET

continues to be a priority During the five year NATO Special Programme on AET many advanced study institutes and research workshops focused on building bridges between researchers in and users of educational technology The organizing committee of the final capstone workshop which took place in September 1993 also chose to focus on this theme Three position papers written by members of the AET advisory committee provided the background and platform for the two day workshop that was designed to provide guidelines for future AET research and implementation projects Nicolas Balacheff kicked off the workshop with a philosophical review of the research issues and future research agendas Herman Bouma and his colleagues at the Institute for Perception Research discussed implementation issues and problems of technology transfer from research laboratories to educational product development *Blended Learning. Education in a Smart Learning Environment* Simon K. S. Cheung,Richard Li,Kongkiti Phusavat,Naraphorn Paoprasert,Lam-For Kwok,2020-07-17 This book constitutes the refereed proceedings of the 13th International Conference on Blended Learning ICBL 2020 held in Bangkok in August 2020 The 33 papers presented were carefully reviewed and selected from 70 submissions The conference theme of ICBL 2020 is Blended Learning Education in a Smart Learning Environment The papers are organized in topical sections named Blended Learning Hybrid Learning Online Learning Enriched and Smart Learning Learning Management System and Content and Instructional Design **Smart Education and e-Learning 2019** Vladimir L. Uskov,Robert J. Howlett,Lakhmi C. Jain,2019-05-31 This book contains the contributions presented at the 6th international KES conference on Smart Education and e Learning KES SEEL 2019 which took place at St Julian s Malta June 17 19 2019 It contains fifty five high quality peer reviewed papers that are grouped into several interconnected parts Part 1 Smart Education Part 2 Smart e Learning Part 3 Smart Pedagogy Part 4 Smart Education Systems and Technology Part 5 Smart Education Case Studies and Research Part 6 Students with Disabilities and Smart Education University and Part 7 Mathematical Modelling of Smart Education and Economics of Smart University Smart education and smart e learning are emerging and rapidly growing areas with the potential to transform existing teaching strategies learning environments and educational activities and technology in the classroom Smart education and smart e learning focus on enabling instructors to develop new ways of achieving excellence in teaching in highly technological smart classrooms and providing students with new opportunities to maximize their success and select the best options for their education location and learning style as well as the mode of content delivery This book serves as a useful source of research data and valuable information on current research projects best practices and case studies for faculty scholars Ph D students administrators and practitioners all those who are interested in smart education and smart e learning *Artificial Intelligence and Speech Technology* Amita Dev,Arun Sharma,S.S. Agrawal,2021-06-29 The 2nd International Conference on Artificial Intelligence and Speech Technology AIST2020 was organized by Indira Gandhi Delhi Technical University for Women Delhi India on November 19 20 2020 AIST2020 is dedicated to cutting edge research that addresses the scientific needs of academic researchers and industrial professionals

to explore new horizons of knowledge related to Artificial Intelligence and Speech Technologies AIST2020 includes high quality paper presentation sessions revealing the latest research findings and engaging participant discussions The main focus is on novel contributions which would open new opportunities for providing better and low cost solutions for the betterment of society These include the use of new AI based approaches like Deep Learning CNN RNN GAN and others in various Speech related issues like speech synthesis speech recognition etc **Innovations in Science and Mathematics Education** Michael J. Jacobson,Robert B. Kozma,2012-12-06 The uses of technology in education have kindled great interest in recent years Currently considerable resources are being expended to connect schools to the Internet to purchase powerful and increasingly affordable computers and on other implementations of educational technologies However the mere availability of powerful globally connected computers is not sufficient to insure that students will learn particularly in subjects that pose considerable conceptual difficulties such as in science and mathematics The true challenge is not just to put the newest technologies in our schools but to identify advanced ways to design and use these new technologies to advance learning This book offers a snapshot of current work that is attempting to address this challenge It provides valuable and timely information to science and mathematics educators educational and cognitive researchers instructional technologists and educational software developers educational policymakers and to scholars and students in these fields **Semiotics in Mathematics Education** ,2008-01-01 Current interest in semiotics is undoubtedly related to our increasing awareness that our manners of thinking and acting in our world are deeply indebted to a variety of signs and sign systems language included that surround us Since mathematics is something that we accomplish through written oral bodily and other signs semiotics appears well suited to furthering our understanding of the mathematical processes of thinking symbolizing and communicating Resorting to different semiotic perspectives e g Peirce s Vygotsky s Saussure s the authors of this book deal with questions about the teaching and learning of mathematics as well as the history and epistemology of the discipline Mathematics discourse and thinking and the technologically mediated self of mathematical cultural practices are examined through key concepts such as metaphor intentionality gestures interaction sign use and meaning The cover picture comes from Jacob Leupold s 1727 Theatrum Arithmetico Geometrico It conveys the cultural historical and embodied aspects of mathematical thinking variously emphasized by the contributors of this book **Intelligent Learning Environments: The Case of Geometry** Jean-Marie Laborde,1996 Proceedings originating from the NATO Advanced Research Workshop on Intelligent Learning Environments the Case of Geometry held in Grenoble France November 13 16 1989 **Intelligent Learning Environments and Knowledge Acquisition in Physics** Andree Tiberghien,Heinz Mandl,2012-12-06 The NATO workshop Knowledge acquisition in the domain of physics and intelligent learning environments was held in Lyon France July 8 12 1990 A total of 31 researchers from Europe France Germany Greece Italy Portugal and the U K the U S A and Japan worked together This proceedings volume contains most of the contributions to the

workshop The papers show clearly the main directions of research in intelligent learning environments They display a variety of points of view depending on the researcher s own background even when a single domain of teaching namely physics is considered We acknowledge the assistance of Michael Baker who was responsible for reviewing the English of the contributions February 1992 Andree TIberghien Heinz Mandl Table of Contents Introduction 1 1 Teaching Situations and Physics Knowledge Introductory University Courses and Open Environment Approaches The Computer as a Multi role Mediator in Teaching Learning Physics 5 E Balzano P Guidoni M Moretti E Sassi G Sgueglia Practical Work Aid Knowledge Representation in a Model Based AI System 21 J Courtois Simultaneous Processing of Different Problem Aspects in Expert Problem Solving An Analysis in the Domain of Physics on the Basis of Formal Theories of Commonsense Knowledge 35 A Hron Modelis An Artificial Intelligence System Which Models Thermodynamics Textbook Problems 47 G Tisseau 2 Different Approaches to Student Modelling Steps Towards the Formalisation of a Psycho logic of Motion 65 J Bliss J **Digital Technologies in Designing Mathematics Education Tasks** Allen Leung,Anna Baccaglini-Frank,2016-10-12 This book is about the role and potential of using digital technology in designing teaching and learning tasks in the mathematics classroom Digital technology has opened up different new educational spaces for the mathematics classroom in the past few decades and as technology is constantly evolving novel ideas and approaches are brewing to enrich these spaces with diverse didactical flavors A key issue is always how technology can or cannot play epistemic and pedagogic roles in the mathematics classroom The main purpose of this book is to explore mathematics task design when digital technology is part of the teaching and learning environment What features of the technology used can be capitalized upon to design tasks that transform learners experiential knowledge gained from using the technology into conceptual mathematical knowledge When do digital environments actually bring an essential educationally speaking new dimension to classroom activities What are some pragmatic and semiotic values of the technology used These are some of the concerns addressed in the book by expert scholars in this area of research in mathematics education This volume is the first devoted entirely to issues on designing mathematical tasks in digital teaching and learning environments outlining different current research scenarios

Discourse, Tools and Reasoning Lauren B. Resnick,Roger Säljö,Clotilde Pontecorvo,Barbara Burge,2013-06-29 Not long ago projections of how office technologies would revolutionize the production of documents in a high tech future carriedmany promises The paper less office and the seamless and problem free sharing of texts and other work materials among co workers werejust around the corner we were told To anyone who has been involved in putting together a volume of the present kind such forecasts will be met with considerable skepticism if not outright distrust The diskette the email the fax the net and all the other forms of communication that are now around are powerful assets but they do not in any way reduce the flow of paper or the complexity of coordinating activities involved in producing an artifact such as a book Instead the reverse seems to be true Obviously the use of such tools requires considerable skill at the center of coordination to borrow an

expression from a chapter in this volume As editors we have been fortunate to have Ms Lotta Strand Linkoping University at the center of the distributed activity that producing this volume has required over the last few years With her considerable skill and patience Ms Strand and her work provide a powerful illustration of the main thrust of most of the chapters in this volume Practice is a coordination of thinking and action and many things had to be kept in mind during the production of this volume **Advanced Educational Technologies for Mathematics and Science** David L. Ferguson,2013-04-17 This book is the outgrowth of a NATO Advanced Research Workshop held in Milton Keynes United Kingdom in the summer of 1990 The workshop brought together about 30 world leaders in the use of advanced technologies in the teaching of mathematics and science Many of these participants commented that the workshop was one of the more productive and exciting workshops that they had attended It was not uncommon to see participants engaged in informal discussion far into the evenings and early mornings long after formal sessions had ended It is my hope that this book captures the substance and excitement of many of the ideas that were presented at the workshop Indeed the process by which this book has come about has given every opportunity for the best thinking to get reflected here Participants wrote papers prior to the workshop After the workshop participants revised the papers at least once In a few instances three versions of papers were written Some participants could not resist the urge to incorporate descriptions of some of the newer developments in their projects The papers in this book demonstrate how technology is impacting our view of what should be taught what can be taught and how we should go about teaching in the various disciplines As such they offer great insight into the central issues of teaching and learning in a wide range of disciplines and across many grade levels ranging from elementary school through undergraduate college education

Decoding **Mathematical Intelligent Learning Environments**: Revealing the Captivating Potential of Verbal Expression

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