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IFIP – The International Federation for Information Processing

IFIP was founded in 1960 under the auspices of UNESCO, following the first World Computer Congress held in Paris the previous year. A federation for societies working in information processing, IFIP's aim is two-fold: to support information processing in the countries of its members and to encourage technology transfer to developing nations. As its mission statement clearly states:

> *IFIP is the global non-profit federation of societies of ICT professionals that aims at achieving a worldwide professional and socially responsible development and application of information and communication technologies.*

IFIP is a non-profit-making organization, run almost solely by 2500 volunteers. It operates through a number of technical committees and working groups, which organize events and publications. IFIP's events range from large international open conferences to working conferences and local seminars.

The flagship event is the IFIP World Computer Congress, at which both invited and contributed papers are presented. Contributed papers are rigorously refereed and the rejection rate is high.

As with the Congress, participation in the open conferences is open to all and papers may be invited or submitted. Again, submitted papers are stringently refereed.

The working conferences are structured differently. They are usually run by a working group and attendance is generally smaller and occasionally by invitation only. Their purpose is to create an atmosphere conducive to innovation and development. Refereeing is also rigorous and papers are subjected to extensive group discussion.

Publications arising from IFIP events vary. The papers presented at the IFIP World Computer Congress and at open conferences are published as conference proceedings, while the results of the working conferences are often published as collections of selected and edited papers.

IFIP distinguishes three types of institutional membership: Country Representative Members, Members at Large, and Associate Members. The type of organization that can apply for membership is a wide variety and includes national or international societies of individual computer scientists/ICT professionals, associations or federations of such societies, government institutions/government related organizations, national or international research institutes or consortia, universities, academies of sciences, companies, national or international associations or federations of companies.

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Arthur Tatnall · Mary Webb (Eds.)

Tomorrow's Learning: Involving Everyone

Learning with and about Technologies and Computing

11th IFIP TC 3 World Conference
on Computers in Education, WCCE 2017
Dublin, Ireland, July 3–6, 2017
Revised Selected Papers

Springer

Editors
Arthur Tatnall
Victoria University
Melbourne, VIC
Australia

Mary Webb
King's College London
London
UK

ISSN 1868-4238 ISSN 1868-422X (electronic)
IFIP Advances in Information and Communication Technology
ISBN 978-3-319-74309-7 ISBN 978-3-319-74310-3 (eBook)
https://doi.org/10.1007/978-3-319-74310-3

Library of Congress Control Number: 2018930742

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Every four years, Technical Committee 3 (Education) of the International Federation for Information Processing (IFIP) presents a major international conference: the World Conference on Computers and Education (WCCE). WCCE 2017 was held at Dublin Castle in Dublin, Republic of Ireland.

This book contains research papers relating to education and information technologies from authors around the world. It contains research papers from Greece, Germany, Denmark, Portugal, Ireland, The Netherlands, Austria, Canada, Malaysia, Australia, UK, Kenya, Finland, South Africa, France, Italy, Japan, USA, Slovakia, Czech Republic, Croatia, New Zealand, Israel, Poland, Cyprus, Morocco, and Slovenia.

The papers in the book were selected from those accepted for presentation at WCCE 2017. All papers submitted to the conference were double-blind peer reviewed and only the best were accepted. Of these, a further selection was made after the conference for publication. Based on conference feedback, each author was given the opportunity to improve their paper, and these papers were again peer reviewed before inclusion in this book.

The book is organized into the following sections:

1. Futures of Technology for Learning and Education
2. Innovative Practices with Learning Technologies
3. Computer Science Education and Its Future Focus and Development

Futures of Technology for Learning and Education

What is the future of education and ICT? Papers in this section attempt to offer some possible suggestions and answers for this question. The first paper by Kennewell compares presentations from the WCCE 1995 and WCCE 2017 conferences and suggests that a shift can be seen from "liberation" to "involvement." Two papers (by Dabner) look at ICT and education in New Zealand in relation to digital safety and to future citizens. Following is a discussion (by Akoh) of mobile learning in Canadian First Nations.

From Greece, Nikolopoulou reports on a study of adolescent Internet attitudes, which found that almost all adolescents believe that the Internet allows for more interesting and imaginative work.

Several papers then discuss computer-based gaming. Holvikivi and Toivanen-Labiad investigate health-game development, while Alghamdi and Holland report on how online gaming effects the dispositions, abilities, and behaviors of primary school students. Economides looks at alternate reality gaming as it relates to higher education.

Fluck, Ranmuthugala, Chin, Penesis, Chong, and Yang discuss two computer-based interventions in Year 6 classrooms that used sophisticated software alongside multimedia learning materials to teach topics from curriculum objectives many years ahead of these students' chronological ages. Grandbastien describes e-Fran, an on-going French initiative for linking academics from various disciplines and practitioners to design and test innovative ways of using digital technologies to improve learning outcomes.

Four papers then consider the use of mobile technologies. Firstly, Symons, Redman, and Blannin report on how these technologies can support pre-service teacher STEM education. Lopez-Fernandez and Nikolopoulou discuss mobile phone dependence in Spanish and Greek high school students. Learning in vocational training for mechanical engineering involves theoretical knowledge and practical activities, and how mobile technologies can assist is described by Wilke. Tablets have become very popular and Drossel and Eickelmann look at the how these relate to computer literacy.

From Africa, Maina (Kenya), Mavengere (Finland), Manzira (South Afrrica), Kihoro (Kenya), and Ruohonen (Finland) describe a multicultural remote collaborative learning environment. Manzira and Munyoka then present a South African case study of higher education collaborative postgraduate education.

MOOCS have become an important aspect of education and Butler, Leahy, Hallissy, and Brown look at how they can be used in teacher professional learning to recreate deep learning conversations. Investigating how teachers can be supported and guided in the planning of Web-based learning scenarios, Hofmann offers a connection of didactical aspects and ontological structures.

In the last three papers in this section, Jugo, Balaban, Pezelj, and Redjep discuss the development of a model to assess digitally mature schools in Croatia. Frankl, Schartner, and Jost look at a secure exam environment and Brites-Pereira, João Almeida and Osório investigate acceptance of motion detection devices by the elderly.

Innovative Practices with Learning Technologies

New technologies of all types offer novel innovative learning practices. This was true of the movie projector, video-tape recorder, DVD player, and other multimedia devices, and of course ICT. This section examines the wide range of some of these innovative practices.

We begin with an article by Masters on a project on Tasmania's King Island for extending children's literacies through developing digital stories. This is followed by Tosato and Banzato's discussion of gender difference in handmade robotics for children.

Blended learning is an important concept and Webb, Hatzipanagos, San Diego, Khan, and Goral offer a decision support tool to assist with assessment design. Sen, Chuen, Harn Liew, and Zay Hta next offer the concept of using augmented reality as a tool for learning of clinical skills in the early years of medical training. Soonja Yeom, Fluck, and Sale describe use of the technology acceptance model (TAM) to investigate

students' acceptance of a haptic learning resource in anatomy education. Holmes, Latham, Crockett, and O'Shea then present a conversational intelligent tutoring system.

In terms of professional education, Lecomber and Tatnall describe how project management education can be of great value to IT professionals. Andresen then deals with teacher-driven learning analytics in primary and secondary education. It is seen as challenging for teachers to select the most suitable educational app to support students' learning, and Bano, Zowghi, and Kearne offer an innovative technique for evaluating educational mobile apps. Jakab and Redman address science concepts for young children with the use of ICT interactives.

Kolbæk and Nortvi describe student interactions with online problem-based learning. Selcuk investigates student perceptions of peer affective factors during a Facebook-based collaborative writing activity, while Araújo, Osório, and Martins discuss writing opinion essays using ICT. Donkor and Toplis investigate virtual learning environments in relation to the importance of emotional intelligence. Virtual environments and different learning modes is the topic of a paper by Mavengere, Ruohonen, and Vartiainen.

The first of three more papers relating to teacher education comes from Niess, who presents a case study on the design of online learning educational environments. McLeod and Carabot next look at the best way to embed ICT in teacher education, and Černochová, Jeřábek, and Vaňková offer a paper dealing with use of a DIYLab to understand a learning process.

A discussion on the effectiveness of using haptic simulators in higher education for dental students and other health-care disciplines is presented by from Cox, Quinn, San Diego, Patel, Gawali, and Woolford, who describe how innovations in teaching and learning strategies can improve their effectiveness. Okabe, Umezawa, and Yamaguchi then offer discussion of a backward learning support system that uses ontology to suggest prerequisites for understanding an item of which students may not have knowledge.

The last paper in this section, from Fluck and Hillier, examines the growing number of emerging eExam systems that allow students to demonstrate academic achievement using computers in schools and universities.

Computer Science Education and Its Future Focus and Development

The papers in this section are focused on research into the learning and teaching of computing, computer science, or informatics as a specialist subject in the curriculum. Different terms are used in different countries and contexts for this specialist subject but they all incorporate the study and design of computational systems. This focus separates these papers from the use of computer-based technologies for teaching and learning across a range of curriculum subjects, which is covered in the previous two sections.

Recently, concern was expressed in many countries about the position and nature of computer science in the curriculum, predominantly because a lack of computer science

education has led to a dearth of computer scientists, which is a threat to economic well-being. In the first paper, which introduced a symposium incorporating eight papers focusing on curriculum issues, Webb et al. summarize the current situation of curriculum change and discuss the issues and challenges facing computer science education in schools. Micheuz's paper examines the situation in Austria as a specific example of how a country has responded to challenges of computer science in the school curriculum. Several subsequent papers consider issues for future curriculum design: Two papers (Haque; Przybylla and Romeike) consider curriculum needs in relation to industry and social needs, while another two papers focus on the changing curriculum at university level, with an analysis of change in an Australian university (Tatnall and Burgess) and an investigation of the changing capabilities of undergraduates (Strong et al.). The next five papers examine the issue of encouraging students into computer science and pedagogical approaches for retaining their interest (Brinda et al.; McInerney et al.; Shelton; Saito; Weigend).

The following three papers report on investigations of learners' and teachers' knowledge and beliefs in relation to computer science. Specifically, Hildebrandt reports on teachers' self-efficacy, while Pancratz and Diethelm focus on understanding of computer science concepts by learners, and Grillenberger and Romeike report more specifically on understanding of data management by both teachers and learners.

The remaining papers focus on learning programming, which has always been one of the most challenging aspects of learning computer science. These papers start with research in early years and primary education (Kalas and Benton; Keane; Tohyama). The next group of papers deal with learning programming and software engineering at university level (Higgins et al.; Holvikivi and Hjort; Matsuzawa et al.; Kramer et al.).

The Dublin Declaration

Finally the book presents "The Dublin Declaration," which is a distillation of evidence, identifying key aspects of innovation, development, successes, concerns, and interests in relation of ICT and education, but also showing where less success than expected has been achieved. It aims to offer recommendations and to support researchers, policymakers, and practitioners.

December 2017

Arthur Tatnall
Mary Webb

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The IFIP TC3 Dublin Declaration

Introduction

Every four years, the International Federation for Information Processing (IFIP) Technical Committee on Education (TC3) holds a World Conference on Computers in Education (WCCE). This significant event brings together researchers, policy makers and practitioners from across the world, to share the most recent research findings, policy concerns and focus, and examples of practitioners' interventions and needs. This event provides an important platform, both for gaining a view of the current situation and its contexts with regard to how digital technologies are being used across education (in primary, secondary, vocational, further, higher and adult education), and as a springboard for viewing possible futures based on the most up-to-date perspectives from research, policy and practice disciplines. This year, to support researchers, policy makers and practitioners, a Dublin Declaration has been created; a distillation of evidence, identifying key aspects of innovation, development, successes, concerns and interests, but also showing where less success has been achieved. Consequently, it offers recommendations for researchers, policy makers, developers and practitioners.

This Dublin Declaration is an important source for all those concerned with the development, deployment and uses of educational technologies. For researchers, the Dublin Declaration provides a view across current studies while also identifying gaps in our knowledge base. For policy makers, the Dublin Declaration shows the current focus of national and international concerns but also highlights those developments that are important for the future acquisition of digital capabilities and long-term skills. For developers, the Dublin Declaration highlights those innovations that are breaking new ground but also points to areas where gaps are evident. For practitioners, the Dublin Declaration provides examples of successful and effective practice while also offering ways to consider and develop new practices and pedagogies.

We hope that this Dublin Declaration will help with your endeavours, no matter what disciplinary area you are concerned with, and that you will look to take up the challenges presented here, in order to most effectively support the prospects of our learners, across the lifespan, and across society.

Don Passey
Chair of the IFIP TC3 WCCE2017 International Programme Committee

IFIP TC3 Dublin Declaration

Tomorrow's Learning: Involving Everyone

Background

The IFIP WCCE 2017, organised by TC3 and hosted by the Irish Computer Society (ICS), took place in Dublin from the 3rd to 6th July 2017, with a doctoral consortium held on 2nd July 2017.

The identification of key themes and trends from previous WCCEs led to the production of a series of recommendations, actions and visions. In 2005, the Stellenbosch Declaration called for actions to support digital solidarity, learners and lifelong learning, teachers and decision-making strategies, networking, and research. In 2009, the Bento Gonçalves Declaration called for actions to support the learner and teacher through curriculum initiatives, to develop research, learning environments, professionalism, and collaborative communities. In 2013, the Torun Vision set out two key challenges for the future. The first was to move from consuming to innovating; to creating, conceptualising and producing using programming and computer science (CS), as well as using information and communication technology (ICT) applications. The second was to deploy digital technologies to better support different interactions with different stakeholders, according to technologies selected and used (such as those with online or haptic features), accommodating institutional diversities, gender, cultural, native language, cognitive and social backgrounds.

This Dublin Declaration from the IFIP WCCE 2017 is informed by the many presentations, discussions and interactions during the Conference from across the entire group of delegates. These researchers, policy-makers, educators, and ICT practitioners in education, from five continents, met and worked together in Dublin, Ireland.

Chairs of all sessions were asked to provide summaries, stating up to three key ideas for the future that were raised in their sessions (keynote presentations, paper presentations, symposia, and discussion sessions). Following the Conference, members of the International Programme Committee (IPC) collated these summary points. Key themes were drawn out, and contents were analysed and distilled within those themes. Draft versions were further shared with members of the IPC, with chairs of Conference sessions, and with all members of the four working groups of TC3. The resultant final version, this Declaration, provides an informed view from the width of conference delegates as to how they perceive the focus for necessary future action in this field of technologies supporting learning and education for all.

The Current and the Future

Participants in the Conference shared the belief that in terms of computing, computer education and uses of technologies for teaching and learning we are, in 2017, at a pivotal point of change. It is clear that international, national and local computer and educational technology strategies, policies and curricula are shifting. Earlier and ongoing outcomes from the activities of important initiatives such as the European Computer Driving Licence (ECDL) have clearly contributed to this current state of play with regard to user practices and uses of ICT. The current status of computer access and uses across countries and the identification of key underlying development needs are clearly shown from the monitoring of international and national comparison data. For example, from the Programme for International Student Assessment (PISA) results run by the Organisation for Economic Cooperation and Development (OECD) and presented in the Conference; and from the International Association for the Evaluation of Educational Achievement's (IEA's) International Computer and Information Literacy Study (ICILS) focusing on computer and information literacy presented in previous IFIP TC3 conferences. Given the wide evidence base from a wealth of research studies and the outcomes presented throughout the Conference, learners of all ages and levels can benefit from, and should be enabled to develop opportunities that such technologies offer, not only for their individual futures but also for the future of our wider communities and society as a whole. However, young people need to have sufficient opportunities to be creators and not just consumers of ICT. The theme of the Conference was Tomorrow's Learning: Involving Everyone, which reflected a focal objective - to seek ways to assure the inclusiveness of technologies to support education, teaching and learning for all social groups. From the variety of opportunities presented, it is critical that teaching about computing does not replace the use of ICT to enhance learning across the curriculum, as ways in which ICT impacts on society and other aspects of digital literacy and digital agency (such as how to manage one's online presence) are fundamental knowledge for the current and the future. The balance between computing and ICT to enhance learning across the curriculum must be fully considered and accommodated. Importantly also, the balance between educational activities that involve non-computer use as well as computer use is an issue that needs wider consideration, as we move towards increased digital ubiquity in this digital era.

During the Conference, a large range of relevant contributions presented examples of practice of major importance and relevance, showing how improvement of education can be achieved through effective uses of technologies. Reviewing the entirety of evidence presented, we strongly recommend that stakeholders and decision-makers in education consider and invest in areas that Conference topics highlighted (detailed further in sections following), all of deep importance to the improvement of education through a consistent support of ICT. Following evidence supported by keynote presentations from policy perspectives, it is recommended that national investment is needed at a level of 7% of Gross Domestic Product (GDP) for education, compared to the current 5.2% as the OECD average. In addition, it was commonly agreed that for any strategy or policy in the educational arena to succeed, we must bring together contributions of researchers, policymakers and practitioners.

Computer Science Education

This was recognised widely as an area of growing and upmost importance. As we increasingly depend on well-educated professionals and digitally literate citizens, able to use computing and ICT in a broad set of circumstances and able to adapt in a flexible manner to a continuously changing technological environment, there are clearly implications for the social and economic sectors. Concerns were raised in this area; that we need far more research on aspects of inclusive curriculum, pedagogies and attitudes to computing, the need for more and well-trained computer science teachers, as well as the need for more professional educational support. In terms of economic drivers, there is need for any society to promote active producers rather than a society of passive consumers of technology, to create a wide set of computer scientists to sustain a competitive edge, and to have computer science-enabled professionals in all industries to support innovation. From a social point of view, computer science awareness provides opportunities to lead, create and innovate within society; and from a cultural perspective, it can be a powerful driver of cultural change. However, concerns have to be considered also; there is a trend towards starting computer science in the curriculum at a younger age, and this needs to be adequately supported by new programming environments that remove obstacles to learning, such as complex syntax. There is a need to look carefully at the conceptual basis of these approaches in order to develop important concepts for young learners through, for example, building procedures within Scratch (a widely-used programming environment for children) or through robotics (humanoid or handmade), as notions of procedural abstraction need to be integrated within curricular content, accommodating educational research in this field.

Our recommendations are:

- For an entitlement for young people to be educated in computing, incorporating computer science and computational thinking as the underlying academic discipline, as well as digital literacy - all young people have a right to become creators and not only consumers of ICT for their future.
- To enable more research into inclusive curriculum, pedagogies and attitudes to computing.
- To create more and well-trained computer science teachers.
- For more teacher professional educational support in integrating technology into lesson plans, and teaching across the curriculum, developing teachers as researchers in appropriate selection, design, implementation, reflection and dissemination of practice.
- To clarify use of terminology in this field, to ensure there is clear understanding whatever and wherever the audience is. Terms such as informatics, ICT, digitalisation, computers, etc., are often used indistinctly, although they are not interchangeable. A first pedagogical step should be to agree a common frame of terminology to avoid ambiguity or overlapping between different concepts.

Developing Countries

The gap between developing and developed countries in the use of ICT in education has not closed sufficiently to allow students from different parts of the globe to have the same opportunities to develop digital skills, competences and agency. The problem is becoming wider in some respects, because different groups of populations inside developing countries can have quite imbalanced access to technology. The differences between rural and city areas and, within the latter, between inner city and the rest, means that an appropriate development of specific technology learning according to economic capacity of the different groups must be adequately considered.

Our recommendations are:

- To focus on new pedagogical opportunities offered by mobile learning applications and their adoption in the education field.
- To consider infrastructure challenges neither as a matter of funding nor as a technocratic approach; school administrators and parents should be included in developing creative support and maintenance, as part of a wider holistic approach to development.
- There should be co-operation with countries with a high degree of ICT development in education, to share their experience in IT usage/skills in the educational domain.
- Approaches implemented when using digital technologies to enhance learning in multicultural environments into developing countries should be considered for wider potential adoption, but with full consideration given to contextual differences and implications arising for adoption.

Inclusiveness and Student Engagement

Evidence shows that not enough didactic ICT-based resources have been developed for those with disabilities. This huge void should be more actively covered, enabling all to directly contribute to wider social welfare. Reducing the gender gap also constitutes an important concern for wider social development; there is a need to develop innovative and imaginative ways to attract more girls into computing. Technologies, in their varied applications, can show themselves as a powerful means to facilitate skills through activities that could be initially thought of as highly complex and demanding. In this way, innovative technologies should be used to facilitate more inclusive learning, reducing the gender gap and promoting student engagement.

Our recommendations are:

- To encourage schools to implement problems and ideas from real life and from students' out-of-school interests, activities and hobbies, to allow children to enjoy solving them in a challenging way, even in their free time.

- To focus curriculum design on the needs of all learners and not to over-emphasise the needs of those who will enter the computing profession; the key ideas and concepts of computer science should be made accessible to all students.
- To develop digital stories into the curriculum as a tool to engage young learners in active uses of ICT from early ages.
- To develop emotional intelligence of our students, as this is often a missing component of all virtual learning environments and other digital resources. The goal is to pay closer attention to implementing this aspect into pedagogies that involve educational software.
- To develop strategies to encourage the use of handheld devices in education to boost computer literacy.
- To commission research to understand why the gender gap is being reduced, according to some recent research studies.

Teacher Education and Continuing Professional Development

Experiences of how teaching staff in all educational sectors are currently teaching computing, and using and teaching ICT, emphasise the need to foster greater involvement of schoolteachers in the use of ICT as part of their regular teaching activities. Teachers should be aware that ICT can be more than a mere tool for superficial engagement of learners; they can aid the development of deeper engagement and thinking. This can be achieved by starting from a requirement to develop ICT-based resources themselves, rather than having them provided or modelled. Such uses will need to be adequately balanced with uses of ICT as pedagogical tools across the curriculum. There is a critical need to call the attention of policymakers as well as teacher educators and teachers to engage positively with the design and development of computing curricula in this changing world. Introducing ICT effectively into teaching and learning is often challenging because change will be necessary. It is, therefore, essential that all stakeholders are engaged in agreeing change - parents, governors, teaching staff and local and regional bodies as appropriate. In developing appropriate practices, where educators in ICT need to work with educational technology companies, practice-based research shows examples of how some companies have supported projects to meet educational agendas. Involving teachers in using ICT purposefully may be developed through communities of teachers within schools and in wider communities, where they can engage in well-organised practice-based research, sharing their results and aiming at a wider analysis of the evidence rather than being isolated in the classroom. Multimodal web publication can be an effective way of sharing evidence in a form that teachers are willing to access.

Our recommendations are:

- To develop educators who can teach computational thinking rather than just teaching programming from standard lesson plans and textbooks.
- To build further capacity in digitally-literate teachers in every discipline.

- To crucially provide professional development for teachers, which should be problem-based and adopt project-based approaches supported by and supplemented with communities of practice, as these provide enormous potential for effective professional development.
- To ensure that all stakeholders are engaged in developments that lead to change through ICT, even at the stage of discussing the evidence.
- To recognise the importance of learning analytics as potential instruments to improve learning processes, but considering the need for such data to provide useful and important feedback to improve educators' work.
- To spread more widely the proof of successful interventions in this domain, taking the context of evidence fully into account when considering relevance for different situations.
- To identify recognised instructional practices in online teacher education to provide effective and accessible professional development, expanding educators' knowledge for teaching with emerging technologies.
- To promote ways of developing communities of research-active teachers to develop and disseminate their own evidence of the impact of ICT on teaching and learning.
- To identify blended learning (online and face-to-face) as professional development opportunities for engaging teachers in practical experiences for teaching with technologies.

Game-Based Learning and Gamification

Games, available in a widening variety of formats and types, all used with different but relevant didactical approaches, promise to be important instructional tools. While this field is still at an embryonic stage, consequently, further theoretical discussions are needed to ensure a common use and understanding of the terminology and scope of these tools. Game-based learning is not just centred on the game and its immediate outcomes, but the challenge is to relate these to other instructional activities to achieve wider and longer-term learning objectives.

Our recommendations are:

- To promote further research to set the basis of a comprehensive framework to support game-based teaching and learning at all levels of education.
- To train pre-service and in-service teachers in the use of game-based learning approaches.

e-Evaluation

To see computers used effectively in education, it is necessary to develop fair, reliable and resilient computer-based assessment methods. Assessment methods must go far beyond imitating paper-based assessment, and prioritise the pedagogical affordances of computers

over administrative convenience. The use of computers in timed, supervised assessments offers the chance to transform curricula in the light of computational thinking.

Our recommendations are:

- To consider stealth assessment as an approach to formative (rather than summative) assessment that is seamless - woven deep into the fabric of the activity such as a game and not taking away the 'fun of learning'.
- To examine how the assessment approach from research can be taken into mainstream learning.
- To study the rapid rise in e-Examinations, for authentic assessment that matches modern workplace practices and many student learning experiences.

In Conclusion

For any of the topics above to be taken forward, they need to be afforded with greater levels of international cooperation and collaboration between researchers and practitioners, through appropriate research processes, from design to dissemination. In addition, research approaches in this field should continue to integrate and combine the expertise of education, psychology, sociology, computer science and economics to provide robust, well-rounded, critical perspectives to ensure the best outcomes to drive the future of education forward. High-quality interdisciplinary research is needed to establish a strong and informative evidence base before adopting large-scale implementation and investments in educational technology initiatives. An evidence base needs to assess the impact and integration of technology in the classroom through a synergy between quantitative and qualitative methods, where studies are framed in appropriate theoretical terms, with consistency between theoretical position, design, methodology, data collection and analysis. Conceptions of research, policy and practice should be revisited in this field. Teachers need to be considered to be producers of knowledge. Maintaining the variety of uses for learners of all ages, identifying outcomes that relate to contexts, and measuring impacts where purpose and future developments are fully considered, are all essential elements that need to be integrated into contemporary and future research, policy, teacher education, teaching and learning practices in this field.

October 2017

The IPC of IFIP WCCE 2017, acknowledging the significant contributions of presenters and chairs of the Conference, and members of the working groups of TC3.

Contents

Futures of Technology for Learning and Education

Intelligent Information Processing supports the most advanced productive tools that are said to be able to change human life and the world itself. However, the path is never a straight one and every new technology brings with it a spate of new research problems to be tackled by researchers. As such, the demand for Information Processing research is ever-increasing. This book presents the proceedings of the 4th IFIP International Conference on Intelligent Information Processing. This conference provides a forum for engineers and scientists in academia, university and industry to present their l IFIP Advances in Information and Communication Technology 356. Researching the Future in Information Systems. ISBN 9783642213632. Preface. Conference Organization. Table of Contents. Researching the Future: The Information Systems Discipline's Futures Infrastructure.Â A Critical View of Emerging Information and Communication Technologies and Their Social Consequences. Introduction. Emerging ICTs. Conceptual Issues. Approach: Principles of Technology Foresight. Methodology, Data Collection, and Analysis. A View of Emerging ICTs.