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Book review of Benedict du Boulay, Antonija Mitrovix, & Kalina Yacef (Eds., 2023). *Handbook of artificial intelligence in education*. Edward Elgar.

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Introduction

Lately, Artificial Intelligence in Education (AIED) has gained significant attention due to what the editors perceive as "the impressive achievements of artificial intelligence in general, the much greater public awareness of the subject (both positive and negative) and the effects of COVID on educational practice" (p. 4). Even prior to the recent upsurge in the appeal of generative AI – a topic not addressed in the book due to its 2023 publication date – intelligent tutors engaged in listening and verbal interaction with learners, simulated student proficiency and understanding, examined learning theories, and facilitated classroom management, scalable learning, evaluation, and human-machine interaction.

The *Handbook of artificial intelligence in education* seeks to provide a comprehensive overview of the field by tracing its development from the 1970s to the present. Well-known authors in the field of AIED evaluate various AI techniques that are used to create systems that support learners, teachers, and administrators. Du Boulay et al.'s Handbook covers theories, foundational aspects, collaborative learning, games, and psychomotor learning. It concludes with a discussion of the wider context, commercialisation, social and political role, ethics, and future challenges and opportunities for AIED. It provides both broad and detailed accounts of the field. The target audience of the Handbook is researchers and (advanced) students in computer science, education, and AI.

The editors are well-known AI researchers and computer scientists. The lead editor, Benedict du Boulay, is one of the pioneers in AIED. He is a past president of the International Society for Artificial Intelligence in Education, an emeritus professor of Artificial Intelligence at the University of Sussex, and a visiting professor at University College London. Antonija Mitrovic is a Professor of Computer Science and Software Engineering at the University of Canterbury (New Zealand), and Kalina Yacef is a Professor at the School of Computer Science at the University of Sydney.

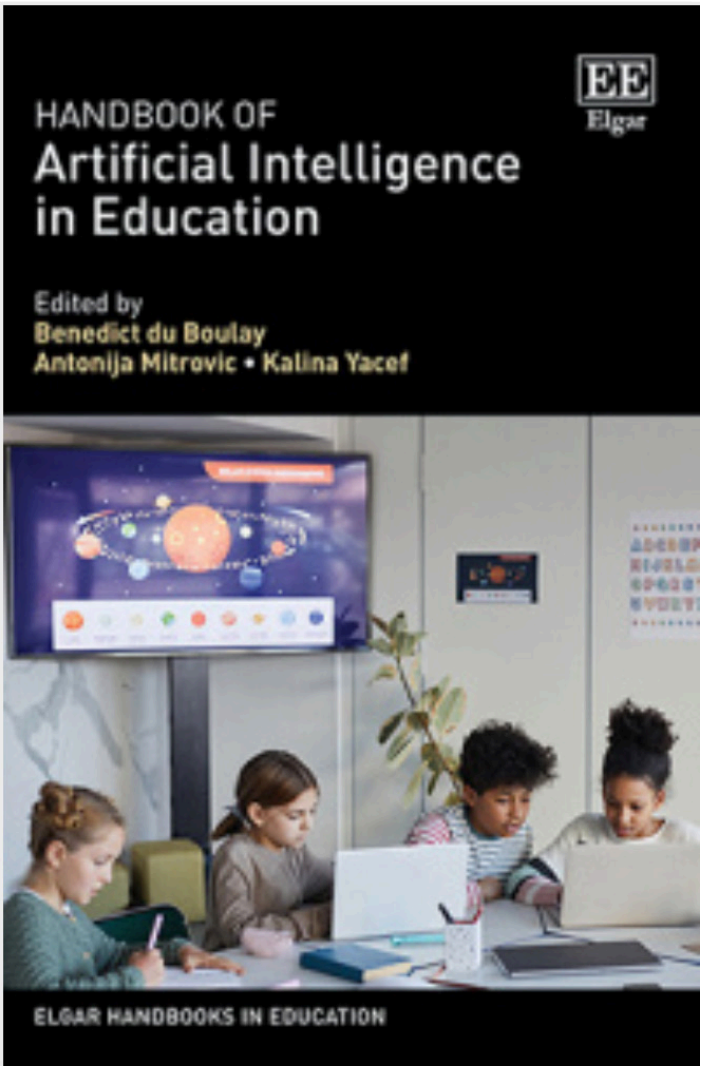

Figure 1: Book cover of du Boulay et al. (Eds., 2023).

The structure of du Boulay et al.'s exceptionally well-referenced Handbook represents their sense of the scope of AIED in six parts: (1) scene setting, (2) theories underpinning AIED, (3) the architecture and design of AIED systems, (4) analytics, (5) AIED systems in use and (6) the future. The first five parts of the 696-page Handbook consist of 26 chapters. The final part manifests the editors' creative idea

of combining 11 brief visions of the future in the 27th multi-authored chapter. I undertake my best efforts to avoid writing a lengthy book review and hence limit myself to a cursory overview of the book before I provide some concluding remarks.

Overview

In addition to the editors' helpful introduction, the initial section, "Scene setting", presents a comprehensive overview of AIED's young history. This journey began with the early adoption of computers in education, initially referred to as Computer-Assisted Learning (CAL) or Computer-Assisted Instruction (CAI). The field has grown exponentially in the past 30 years. Exploring AIED's history provides insights into how the discipline has evolved and the reasons behind the existence of certain research directions today. The saying, 'Those who are unaware of history may be destined to repeat it', highlights the critical role of historical awareness in preventing the recurrence of past errors and steering the course of future developments.

Part 2 discusses the foundational theories of AIED across four chapters, each focusing on different aspects: cognitive and knowledge theories; metacognition (an individual's awareness and understanding of their own thought processes); the realms of emotion and meta-emotion (how we think and feel about our emotional experiences); and the principle of scrutability. Ohlson's Chapter 3 examines the significance of psychological, instructional design, and AI theories in the development of AIED systems. Azevedo and Wiedbusch, in Chapter 4, detail six systems designed to enhance learners' metacognitive skills. Chapter 5, authored by Arroyo et al., examines the roles of emotions and motivation in learning. Kay et al., in Chapter 6, focus on the concept of "Scrutable AIED". Scrutability pertains to creating AIED systems that are accountable, transparent, explainable, and ethical. Scrutable AIED can be fully understood and evaluated through careful analysis.

Part 3 encompasses the foundational aspects of AIED system design, spread over six chapters. It starts with an exploration of three crucial elements for adaptive and personalised learning: domain modelling (structuring the subject content), student modelling (assessing learners' needs and knowledge), and instructional strategies (learning from problem-solving practice, learning from examples, exploratory learning, collaborative learning, game-based learning and learning by teaching). Following this, the discussion shifts to enhancing learner engagement through design and natural language communication, concluding with an analysis of the tools for AIED system development.

Part 4 encompasses five chapters dedicated to exploring analytics and data-driven approaches within AIED systems. Two of the chapters (Chapters 14 and 15) concentrate on aiding educators. Holstein and Olsen's chapter (14) explores how AI can collaborate with teachers in learning settings like classrooms, emphasising a partnership where AI assists through a human-in-the-loop and co-agency approach. Pozdniakov et al.'s chapter (15) examines various types of teacher-facing analytics and details their utility in sense-making, decision-making, and pedagogical actions. Rosé et al.'s chapter (17) focuses on social analytics and foundational theories aimed at enhancing learning experiences in Massive Open Online Courses (MOOCs).

Part 5 examines the diverse learning modalities enabled by AIED and addresses the evaluative and assessment methodologies pertinent to these systems, their commercial trajectories, and the overarching ethical and bias-related discourse within the sector. The initial trio of chapters (18-20) scrutinises the support AIED provides for distinct learning types: psychomotor development, from assisting individuals with motor challenges to the training of surgeons; the dynamics of online collaborative learning; and the pedagogical potential of gamified learning environments. Subsequently, a pair of methodological chapters (21-22) is dedicated to assessment and evaluation. This is followed by another duo of chapters (23-24) that explore the commercialisation aspects of AIED technologies. The section culminates with two chapters (25-26) that critically engage with the social and ethical implications inherent to the deployment of AIED solutions.

To me, one of the Handbook's highlights is Luckin and Cukurova's chapter (24) on "Small-scale commercialisation: the golden triangle of AI EdTech". Together with two colleagues, I recently interviewed Prof Rose Luckin on her fascinating work, so I may be biased (Luckin et al., 2024). The Golden Triangle Framework outlines a collaborative model for AIED, linking educators, researchers, and EdTech developers to enhance teaching and learning. It underlines the critical role of educators in managing AI tools for personalised student learning experiences. The framework advocates for AI solutions that support teachers. It draws from multidisciplinary research for evidence-based, human-centred design. Luckin and Cukurova stress that ethical considerations, such as transparency and privacy, are essential for trust and learner autonomy. Their approach emphasises AI as a supportive co-pilot in education rather than being on auto-pilot.

Another important chapter (25) in Part 5 is Williamson et al.'s "Critical perspectives on AI in education: political economy, discrimination, commercialization, governance, and ethics". The chapter covers some of the ground of another recently published Handbook by Edward Elgar: Simon Lindgren's (Ed., 2023) *Handbook of critical studies of artificial intelligence*, which I strongly recommend reading (Rudolph, 2024). Williamson et al. provide a sharp focus on educational technology and their chapter ends with the following caution:

> Depoliticized, ahistorical and asocial approaches are a continued problem in many studies of edtech, and enable those with limited expertise but significant (often commercial, economic or political) power to take centre stage in shaping and investing in educational futures (p. 566).

The multi-authored final section casts an eye toward the future. It highlights themes of access, equity, diverse learning modalities, enabling technologies, and the challenges of ubiquity and information overload. It aligns with the

United Nations Sustainable Development Goal #4, which is committed to achieving inclusive and equitable quality education and fostering lifelong learning for everyone. Despite this commitment, the reality remains stark, as highlighted by recent UNESCO statistics: 262 million children were out of school, two-thirds failed to learn basic literacy and numeracy skills after several years of schooling, and 750 million adults were illiterate. In WEIRD (Western, Educated, Industrialised, Rich, and Democratic) countries, the disparity is further exacerbated by the Matthew effect: those with access to advanced educational systems gain increasingly more knowledge, skills, and opportunities. Modern educational software, with its assumptions of readily available resources such as stable electricity, advanced computers, high-speed internet, and expert support, mirrors and magnifies these inequalities, predominantly benefiting those within WEIRD nations.

Conclusion

Du Boulay et al.'s *Handbook of artificial intelligence in education* may well become a major new destination for the tech-savvy, techno-optimistic AI literati. Venturing into its pages as someone whose roots lie far from computer science, I confess the lexicon and prose style demanded a certain acclimatisation. Upon reflection, it became apparent that my intellectual palate found a more satisfying meal within the pages of another Edward Elgar scholarly feast: the *Handbook of critical studies on artificial intelligence* (Lindgren (Ed.), 2023; see Rudolph, 2024). The contributions on AIED – particularly those by Rahm (2023), Connolly (2023), and Schiff & Rosenberg-Kima (2023) – resonated with me more than the bulk of the current volume under scrutiny. However, I urge the esteemed readers of this review not to let my personal idiosyncratic academic inclinations – steeped as they are in the humanities, social sciences, and the realms of business and management – unduly colour their perception. In the final analysis, Du Boulay, Motrovic, and Yacef's encyclopaedic Handbook may well be a timely and much-needed AIED magnum opus.

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