



Intelligent Textbooks: The Fifth International Workshop

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Abstract. Textbooks have evolved over the last several decades in many aspects. Most textbooks can be accessed online, many of them freely. They often come with libraries of supplementary educational resources or online educational services built on top of them. As a result of these enrichments, new research challenges and opportunities emerge that call for the application of AIED methods to enhance digital textbooks and learners' interaction with them. Therefore, we ask: How can we use intelligent and adaptive technologies to facilitate the access to digital textbooks and improve the learning process? What new insights about knowledge and learning can be extracted from textbook content and data-mined from the logs of students interacting with it? How can these insights be leveraged to develop improved intelligent texts? How can we leverage new language technology to manage and augment textbooks? The Fifth International Workshop on Intelligent Textbooks features research contributions addressing these and other research questions related to intelligent textbooks. It brings together researchers working on different aspects of learning technologies to establish intelligent textbooks as a new, interdisciplinary research field.

Keywords: intelligent textbooks · digital and online textbooks · open educational resources (OER) · modelling and representation of textbook content · assessment generation · adaptive presentation and navigation · content curation and enrichment

1 Introduction

Textbooks remain one of the main methods of instruction, but – just like other educational tools – they have been evolving over the last several decades in many aspects (how they are created, published, formatted, accessed, and maintained). Most textbooks these days have digital versions and can be accessed online. Plenty of textbooks (and similar instructional texts, such as tutorials) are freely available as open educational resources (OERs). Many commercial textbooks

come with libraries of supplementary educational resources or even distributed as parts of online educational services built on top of them. The transition of textbooks from printed copies to digital and online formats has facilitated numerous attempts to enrich them with various kinds of interactive functionalities including search and annotation, interactive content modules, automated assessments, chatbots and question answering, etc.

As a result of these enrichments, new research challenges and opportunities emerge that call for the application of artificial intelligence (AI) methods to enhance digital textbooks and learners' interaction with them. There are many research questions associated with this new area of research; examples include:

- How can one facilitate the access to textbooks and improve the reading process?
- How can one process textbook content to infer knowledge underlying the text and use it to improve learning support?
- How can one process increasingly more detailed logs of students interacting with digital textbooks and extract insights on learning?
- How can one find and retrieve relevant content “in the wild”, i.e., on the web, that can enrich the textbooks?
- How can one leverage advanced language technology, such as chatbots, to make textbooks more interactive?
- How can one better understand both textbooks and student behaviors as they learn within the textbook and create personalized learner experiences?

The Fifth International Workshop on Intelligent Textbooks invited research contributions addressing these and other research questions related to the idea of intelligent textbooks. While the pioneer work on various kinds of intelligent textbook technologies has already begun, research in this area is still rare and spread over several different fields, including AI, human-computer interaction, natural language processing, information retrieval, intelligent tutoring systems, educational data mining, and user modeling. This workshop brings together researchers working on different aspects of intelligent textbook technologies in these fields and beyond to establish intelligent textbooks as a new, interdisciplinary research field.

2 Workshop Background and Topics

This workshop will build upon the success of the four previous workshops on Intelligent Textbooks that we organized in conjunction with AIED'2019 [1], AIED'2020 [2], AIED'2021 [3], and AIED'2022 [4]. Altogether, the four previous workshops featured 45 papers and brought together more than a hundred researchers exploring various aspects of intelligent textbooks. An analysis of topics presented at these workshops [5] revealed seven prominent areas (Table 1), which to some extent represent prospects of researchers coming from different fields and applying knowledge and approaches from these fields to the research on intelligent textbooks [6].

Table 1. Categories of intelligent textbook papers over the years.

Topic/Year	2019	2020	2021	2022	Special Issue
Intelligent interfaces	5	2	1	0	0
Smart content	1	1	2	2	0
Knowledge extraction	1	2	0	1	1
Learning content construction	0	1	3	3	3
Intelligent textbook generation	1	2	0	1	1
Interaction mining and crowdsourcing	1	1	3	1	4
Domain-focused textbooks and prototypes	1	0	2	0	0
Miscellaneous	4	0	2	1	0

Following success of the first four workshops, we proposed a special issue of the Journal of Artificial Intelligence in Education on Intelligent Textbooks. The proposal has been approved. The Call for Papers brought 19 submission proposals out of which guest editors approved 9 for further consideration. Currently, the submissions are undergoing a peer review. The categorisation of submissions according to the topics identified in our earlier analysis is presented in Table 1 as well. It is important to notice that (1) these numbers are projections, as the submissions are still under review; (2) papers submitted to a journal typically present more comprehensive projects that can cover multiple topics and belong to several categories at once. Nevertheless, the data shows, that the key research directions keep attracting considerable interest of researchers year by year, however, the focus of attention gradually shifts following the development of the field. We could acknowledge the gradual increase of interest in research on learner interaction mining, which is promoted by the increased number of available digital textbooks and rapid accumulation of data [7]. This topic is explored in grater details by a related series of workshops on the Analysis of Reading Behavior organized at Learning Analytics and Knowledge Conference series¹. Similarly, we can observe a gradually increasing research in learning content construction based on the material of intelligent textbooks [8,9], which corresponds to the rapid progress in the natural language processing techniques. We expect the shift of focus will continue as new AI technologies become available. In particular, it is natural to expect the rise of research on interactive question-answering and other forms of dialogue in context of digital textbooks. While pioneer research on this topic started more than 10 years ago [10], the capabilities of large language models like ChatGPT remarkably expanded research opportunities in this area.

To reflect the recurrent and emergent research directions, the topics discussed at the 5th workshop include but are not limited to:

1. Modelling and representation of textbooks: examining the prerequisite and semantic structure of textbooks to enhance their readability; b) Analysis and

¹ <https://sites.google.com/view/lak23datachallenge/home>.

- mining of textbook usage logs: analyzing the patterns of learners' use of textbooks to obtain insights on learning and the pedagogical value of textbook content;
2. Collaborative technologies: building and deploying social components of digital textbooks that enable learners to interact with not only content but other learners;
 3. Generation, manipulation, and presentation: exploring and testing different formats and forms of textbook content to find the most effective means of presenting different knowledge;
 4. Assessment and personalization: developing methods that can generate assessments and enhance textbooks with adaptive support to meet the needs of every learner using the textbook;
 5. Content curation and enrichment: sorting through external resources on the web and finding the relevant resources to augment the textbook and provide additional information for learners.
 6. Dialog-assisted textbooks: leveraging chatbot technology to support and facilitate learner-textbook dialogues.

3 Workshop Organizers

3.1 Chairs

Sergey Sosnovsky is an Associate Professor of Software Technology for Learning and Teaching at the Department of Information and Computing Sciences, Utrecht University. His research interests include various aspects of designing, developing and evaluating adaptive educational systems and personalized information systems in general. Dr. Sosnovsky holds a PhD degree in Information Sciences from University of Pittsburgh (Pittsburgh, PA, USA). Before joining Utrecht University, Dr. Sosnovsky worked as the head of the e-Learning lab at German Center for Artificial Intelligence (DFKI) and as a senior researcher at Saarland University (Saarbrücken, Germany).

Peter Brusilovsky is a Professor of Information Science and Intelligent Systems at the University of Pittsburgh, where he directs Personalized Adaptive Web Systems (PAWS) lab. Peter Brusilovsky has been working in the field of adaptive educational systems, user modeling, and intelligent user interfaces for more than 30 years. He published numerous papers and edited several books on adaptive hypermedia, adaptive educational systems, user modeling, and the adaptive Web. Peter is the past Editor-in-Chief of IEEE Transactions on Learning Technologies and a board member of several journals including User Modeling and User Adapted Interaction and ACM Transactions on Interactive Intelligent Systems. Peter has been exploring the topic of intelligent textbooks for over 20 years. Together with G. Weber he developed one of the first online intelligent textbooks ELM-ART [11], which received the 1998 European Academic Software award.

Andrew S. Lan is an Assistant Professor in the College of Information and Computer Sciences, University of Massachusetts Amherst. His research focuses on the development of human-in-the-loop machine learning methods to enable scalable, effective, and fail-safe personalized learning in education, by collecting and analyzing massive and multi-modal learner and content data. Prior to joining UMass, Andrew was a postdoctoral research associate in the EDGE Lab at Princeton University. He received his M.S. and Ph.D. degrees in Electrical and Computer Engineering from Rice University in 2014 and 2016, respectively. He has also co-organized a series of workshops on machine learning for education; see <http://ml4ed.cc/> for details.

3.2 Program Committee

- Isaac Alpizar Chacon, Utrecht University
- Debshila Basu Mallick OpenStax, Rice University
- Paulo Carvalho, Carnegie Mellon University
- Vinay Chaudhri, SRI International
- Brendan Flanagan, Kyoto University
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- Andrew Olney, University of Memphis
- Philip Pavlic Jr., University of Memphis
- Cliff Shaffer, Virginia Tech
- Khushboo Thaker, University of Pittsburgh
- Ilaria Torre, University of Genoa

4 Workshop Format and Materials

We plan a full-day hybrid workshop that will combine regular presentations with more interactive formats such as a demonstration of working prototypes. The workshop program and other information is available on the workshop website (<https://intextbooks.science.uu.nl/workshop2023/>) where we publish the call for contributions, the final program, and the first version of the proceedings. The final version of the proceedings will be published at <http://ceur-ws.org/>. Slides of workshop presentations will be made available at <https://www.slideshare.net/>.

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