

Empowering Open Education Methodologies with AI-based Strategies for the Customization of Education

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ABSTRACT

The amount and heterogeneity of data generated allied to the rapid progress of scientific research and technological development have created vast amounts of data, much of it open data, but significant challenges to gathering, filtering and making sense of this information. In this paper, we will be discussing the research outcomes of three complementary projects monitoring and enhancing Open Education. First, the initial results obtained from the construction of Open Education Resources (OERs) Observatory, contributing to implement 2019 UNESCO OER Recommendation. Improving upon existing projects developed by some of the coauthors focused on data observatories, this project identified data sources, while gathering, enriching and treating data in order to display meaningful information on a dashboard focused on OERs using AI-based solutions to advance the Sustainable Development Goals. The collaboration focused on existing partnerships within IRCAI, the UNESCO Chair in Distance Education and the UNESCO Chair on Open Technologies for Open Educational Resources and Open Learning, mobilizing researchers to collaborate on key AI research challenges relating to generating knowledge about OER. Secondly, we will discuss the recent development of an Educational Recommender System (ERS) that integrates Conversational Analysis (CA) to assess and enhance collaborative learning (CL) in Virtual Learning Environments (VLEs). The system was designed to identify collaboration among students and provide tailored recommendations to promote participation and interaction within discussion forums. Finally, we will discuss the development and implementation of OERs in alignment with Sustainable Development Goals (SDGs), addressing topics of significant social impact over an international online mentoring initiative.

CCS CONCEPTS

- Real-time systems
- Data management systems
- Education
- Document management and text processing

KEYWORDS

Open Education, Machine Learning, Educational Recommender System, Conversational Analysis, Virtual Learning Environment

1 Introduction

The centralizing piece of the discussions in this paper is an AI-based observatory that allows to explore OER-related topics, particularly those mentioned in the OER Recommendation: promoting OER and acknowledging its contribution to advancing quality education while providing information on advances focused on the equity and inclusion qualities of OER, as well as on research, activities, projects and news related to OER development, including new initiatives and projects while also promoting public infrastructures for education. The OER Observatory builds on the content made available in UNESCO's OER Dynamic Coalition Portal¹ providing the user with access to any of the four proposed views: media; science; policies and training. In each of the views, the user can access interactive data visualisation summarising the sourced data configured to observe the UNESCO OER recommendations. As it is fully based on open data, it allows the user to click on the resources collected and summarized, being taken directly to the media house, journal, policy source or to the location in Videolectures.

Embracing the intersection of AI and education, which has led to the development of various tools that personalize and enhance learning experiences, we discuss a complementary research based on Conversational Analysis (CA) much aligned with the objective of empowering Community interaction at the SDG 4 (Education) Observatory [2]. AI applications in education often focus on providing adaptive feedback, facilitating personalized learning paths, and analyzing student data to improve outcomes. CA is a method that examines the understanding generated through interactions, offering a framework for analyzing how students collaboratively build knowledge. By combining CA with AI, this research aims to develop a system that not only assesses but also actively promotes collaboration in Virtual Learning Environments (VLEs) [8]. The ERS discussed later in this paper, is an example of how IRCAI's SDG4 Observatory gains a complex capability towards the engagement with communities such as in Education. This discussion then expands towards the appropriate mentorship of the professionals that will change the domain's landscape. While initiatives in this context are

¹ See <https://oerdynamiccoalition.org>

diverse and disperse, the authors are not aware of existing similar approaches [3].



Figure 1: The ERS forum analysis screen

2 AI-based strategies for the moderation of online forums on education

Entering the age of Big Data, Artificial Intelligence (AI) is feeding the data-driven digital transformation across industries including Education. Collaborative Learning (CL) emphasizes the importance of group tasks and joint participation, wherein students learn by actively engaging in dialogues that facilitate the sharing of ideas and information. Even in remote settings, CL enables students to learn together through virtual platforms. AI offers new opportunities as a pedagogical tool, providing adaptive and personalized environments that can support CL. This research explores the integration of AI into educational contexts, particularly through the development of an Educational Recommender System (ERS) that uses CA to identify and promote collaboration among students in VLEs [1]. See Figure 1.

The research methodology is divided into three key stages: *Conversational Analysis*, applying CA to monitor discussion forums within the Moodle platform, focusing on interactions among students, identifying collaborative behaviors and interaction patterns; *Collaboration Assessment*, evaluating the level of collaboration among students based on identified interaction patterns; and *Development of ERS*, building a mechanism that provides recommendations to students, teachers, and tutors. These recommendations are aimed at enhancing collaboration and are based on the analysis of forum interactions [10].

The initial dataset comprises 20,976 messages of Moodle discussion forums, with 15,703 posted by students from a vocational education school. The analysis focuses on these messages to develop and validate the ERS's recommendations. The quality of collaboration is measured through various indicators, which are extracted during different stages of CA. *Preprocessing* applies techniques of Natural Language Processing (NLP) to ensure the accuracy of the analysis, preparing data for the *Resource Processing* stage using Social Network Analysis (SNA) to characterize social dynamics and

interactions among students. Moreover, the *Message Attribute Identification* is the CA stage that allows identifying characteristics of students' messages, specifically their questions, and then *Topic Modeling* is employed to identify key terms discussed in the forums [9], using the Tomotopy library². The ERS was tested across five experimental cycles in different classes at two Brazilian Federal Institutes, in a Portuguese language context. The results indicated a positive impact on student learning, with 82% of participants acknowledging the relevance of the recommendations. The system motivated increased participation and collaboration, with a notable trend of students writing more and systematically organizing their ideas in forum posts. Additionally, 90% of students engaged in other activities proposed by their teachers, demonstrating the effectiveness of the recommendations. The results also demonstrate the system's effectiveness in fostering collaboration, with positive feedback from students and educators (see Figure 2).

The development of the ERS represents a significant advancement in promoting collaborative learning in educational settings [4,5]. By integrating CA into the system, the ERS effectively identifies and enhances collaboration among students. The current implementation of this ERS aims to provide personalized recommendations to students, teachers, and tutors, fostering a more interactive and collaborative learning environment [6]. Future work will explore the integration of additional features, such as *wikification* and visualization tools, to further enhance the system's capabilities.

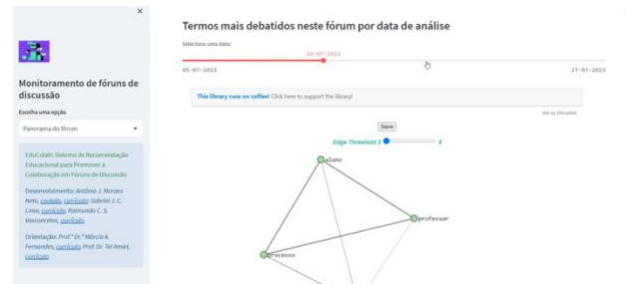


Figure 2: Visual analysis of students' collaboration in a discussion forum.

3 An AI-based Observatory to Assess the Impact of OER Worldwide

Although the abundance of information available online, some of which is labeled as education-related, it is harder and harder to find the appropriate resources that can serve education either at an undergraduate or a professional training level. IRCAI's Open Education Observatory is an initiative dedicated to monitoring, analyzing, and promoting the use of OERs globally. It serves as a hub for research insight and fomenting

² See <https://bab2min.github.io/tomotopy>

collaboration, providing valuable insights and data on the adoption, impact, and trends of OER in education systems worldwide. The observatory supports educators, policymakers, and institutions in leveraging open resources to enhance teaching and learning. It is designed to support government and institutional decision-makers dedicated to promoting the goals of the 2019 UNESCO OER Recommendation, which is centred on OER but generally promotes the ideals of Open Education (see Figure 3).

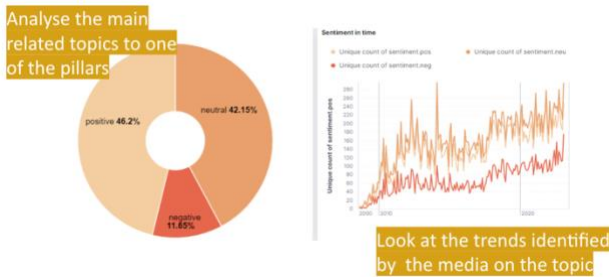


Figure 3: Dashboard of visual modules to analyse the most relevant topics under a certain domain or SDG, and the trends that can direct the education actors preparedness

The Open Education Observatory ingests a range of different data sources with heterogeneous nature and different frequency: (i) worldwide news in almost real-time providing information from a vast catalogue of multilingual world news, captured in more than 60 languages and based on a variety of wikidata concepts; (ii) published scientific articles, including journal and conference papers, mostly peer-reviewed, covering over more than 126 million articles with yearly updates; (iii) OER policies from the OER Policy Hub (www.oepolicyhub.org) that needs to be input into the OER DC Portal; subsequent extraction and enrichment of metadata; preparation of dashboard related to dashboard based on filters over the metadata, as well as OECD policies data and metadata on AI and Education with yearly updates; (iv) lectures and videos selected and filtered on content from Videolectures.net resources related to OER; (v) a snippet of worldwide public and private initiatives related to AI and SDG 4 captured by IRCAI's Top100 and related actions; and (vi) a range of worldwide indices with yearly updates on Education-related topics such as the percentage of children out of school, or the literacy rate in youth and adults (see Figure 4).

To ensure that content is readily available for each focus area, materials from the mentioned sources are categorized by relevant keywords and concepts closely associated with the five key areas of the Recommendation. This organization allows users to easily filter and access content based on their specific interests within these areas. By doing so, users can tailor their exploration of resources to match their focus, whether it's capacity building, supportive policy development,

leveraging equitable access provided by OER, sustainability models, or international cooperation.

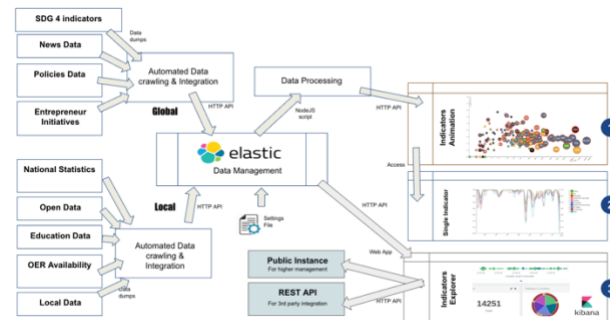


Figure 4: The architecture of the OER Observatory as an Elasticsearch-based system that enables the visualization of heterogeneous data on OERs

For each area, users can filter and find content specific to their domain of interest: up-to-date news and research on OER developments, academic studies related to professional development, and relevant lectures for capacity building; information on OER policy development; resources and research focused on effective, inclusive, and equitable access to quality OER; strategies for developing sustainable OER models; and opportunities for fostering international cooperation through potential new partnerships and shared goals. This organized approach enhances the ability to pinpoint and utilize the most relevant information in each domain.

Information generated by the Observatory can be used to aid in the resolution of problems related to the promotion of OER, by identifying trends and major areas of discussion, and to explore successful scenarios through similar challenges and cases. The OE Observatory can properly address the challenges of decision makers, using machine learning techniques, extracting insights and best practices from text-based documents. The Observatory provide benefits, more specifically, to the following target stakeholders: (i) National Governments – providing access to a variety of perspectives (including trend and comparative) on a data driven dashboard with information on OER trends for decision-making; (ii) Educational Institutions – to access to information on current trends on OER research and development; (iii) Research Institutions – providing access to data over interactive visualisation and research; (iv) Civil Society – allowing access to information and training materials that explore the knowledge available towards the implementation of the UNESCO recommendations; (v) NGO community – enabling access to information directly linked to the community priorities if intersecting the five UNESCO OER pillars mentioned above; and (vi) General Population – empowering overall open education to access to local progress on OER. The OE Observatory is being built by the AI research centre under the auspices of UNESCO (IRCAI)

through the Institute Jozef Stefan Institute, in collaboration with both UNESCO Chairs.

4 Open Education for a Better World

The Open Education for a Better World (OE4BW) program is an international online mentoring initiative aimed at advancing the development and implementation of open educational resources (OER) that address topics of significant social impact, in alignment with the United Nations Sustainable Development Goals (SDG). As part of the Slo2Svet project, the program received 70 project applications and 87 mentor applications from six continents and 25 different countries (see Figure 5). The program's activities are structured into thematic clusters, focusing on areas such as Artificial Intelligence, Displaced Persons, Sustainability, Health and Well-being, Renewable Energy, Education, and Youth (specifically targeting developers aged 12-24). Throughout the project development process, progress was closely monitored by a network of mentors and hub coordinators, providing essential guidance and support to OER developers. Additionally, within the scope of the Slo2Svet project, evaluation rubrics for the OER projects were developed and will be utilized during the final conference, where developers will be required to present their completed work.

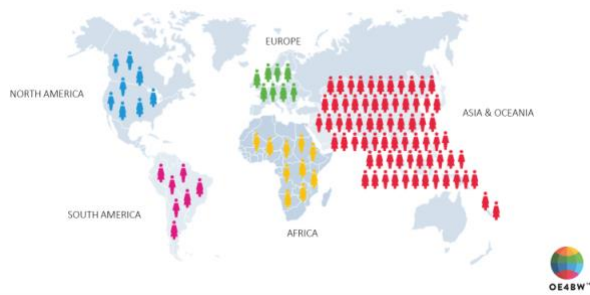


Figure 5: Participants of the OE4BW mentorship in 2023/24.

5 Conclusions and further work

In this paper we discussed the research results and opportunities in Open Education, building on an overall perspective over the OER landscape, the AI-enhanced student-educator interaction, and the mentorship for further progress. We will be exploring further the potential of the OER observatory, particularly in what regards the use of LLMs in analyzing the compliance to AI policies in Education. In what regards the future developments of the ERS addressed, in alignment with IRCAI's SDG Observatory research agenda and the potential for institutional collaboration, we will focus on the following aspects: (i) *wikification*, incorporating suggestions for Wikipedia links related to the main discussion topics; (ii) visualization tools, presenting graphical representations of collaboration trajectories, topic evolution, and other key indicators; (iii) extending the system, applying the ERS to other datasets, including public and private message exchange logs, to validate and enhance its applicability; and (iv)

personalized recommendations, developing a user-based collaborative filtering technique to tailor recommendations more specifically to individual student groups.

In the context of the Slo2Svet project, we are conducting a comprehensive analysis of the Open Education for a Better World (OE4BW) mentoring program since its inception. Additionally, we will develop an evaluation framework to assess the impact of the projects produced through the program, mapping project outputs to the five action areas of the 2019 UNESCO OER Recommendation, using insights provided by automatic text analysis and other AI tools. This will allow us to connect the projects produced by OE4BW to the concrete objectives of the Recommendation, providing examples of practice that can be leveraged to advance its goals.

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