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# Bibliometric Analysis of the Last Ten Years of the European Conference on Technology-enhanced Learning

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**Abstract.** Over the last decade, we have seen a large amount of research being performed in technology-enhanced learning. The European Conference on Technology-enhanced Learning (EC-TEL) is one of the conferences with the most extended trajectory in this area. The goal of this paper is to provide an overview of the last ten years of the conference. We collected all papers from the last ten years of the conference, along with the metadata, and used their keywords to find the most important ones across the papers. We also parsed papers' full text automatically, and used it to extract information about this year's conference topic. These results will shed some light on the latest trends and evolution of EC-TEL.

**Keywords:** Technology-enhanced learning, bibliometrics, natural language processing, education

## 1 Introduction

The term technology-enhanced learning (TEL) is used to describe the application of information and communication technologies to teaching and learning [5]. Nowadays, technology is changing and improving year after year, and this development is also making a significant impact on educational environments. Despite there are still some limitations that contribute to the still-limited application of technology in education [2] (such as economic ones), research and interest in this area have been growing over the years. This increase is an excellent motivation to analyze the current trends in educational technology (EdTech) and see changes and new emerging patterns.

There are several approaches to do this type of analysis [6, 9]: systematic reviews, scoping reviews, or even meta-reviews of multiple review papers, among others. Unfortunately, analyzing a large collection of papers is often very time-consuming, specially when we find a large number of them as we do in this area. We propose a methodology to discover trends quickly and easily, and since the European Conference on Technology-enhanced Learning (EC-TEL) has become the primary educational technology conference in Europe and one of the world's

leading conferences, we consider that this venue is very representative of the trends in this area.

Specifically, our analysis has focused on the following three main objectives: 1) Discover which are the main topics of the conference using paper keywords. 2) Discover the evolution of said topics over the last ten years of the conference. 3) Discover how many papers have tackled this year’s conference theme on “Free, Safe and Sustainable World.” The rest of the paper is organized as follows. Section 2 describes the methodology followed to conduct the research and Section 3 presents the results of the synthesis and analysis. Then, we finalize the paper with conclusions and future work in Section 4.

## 2 Methodology

To conduct the research, we divided our work in different stages. Next, we explain each part of the methodology in detail:

- **Data extraction.** The first step in our analysis was to get all the data necessary to begin the research. To download each paper in PDF, we used the Springer Link database [11]. On the other hand, we used two different databases to get each paper’s metadata: Scopus [1] and Web of Science [10]. Although we did not find the metadata corresponding to the papers of the EC-TEL 2015 edition, we included these papers’ metadata that we needed for our analysis manually. The final data collection contains a total of 447 documents and 1 905 keywords (4.26 average keywords).
- **PDF parsing.** In this stage, we parsed every PDF file into a plain text (TXT) file. To make that possible, we used *PdfToText* library, which parsed 100% of the papers with high fidelity.
- **Data cleaning & lemmatization.** We cleaned each paper’s full text, along with the keywords, by removing, for example, unnecessary URLs, numbers, or additional space characters. Once the text is cleaned, we applied lemmatization (i.e., the process of converting a word to its base form) to every document and keyword using *pywsd* library.
- **NLP & keyword analysis.** To discover the main topics based on the papers’ keywords, we inspected the data manually to merge similar keywords into a single one. That way, if we find, for example, “technology-enhanced learning” and “technology enhanced learning,” both keywords are merged and their number of appearances are aggregated.

## 3 Results

### 3.1 Main topics of EC-TEL based on keywords

After applying the proposed methodology in the previous Section, we calculated the top ten keywords proportion across the last ten years of EC-TEL. As we see in Figure 1, the most frequent keywords appearing are “learn analytics” (2.99%), “collaborative learning” (2.67%) and “massive open online course” (2.36%).

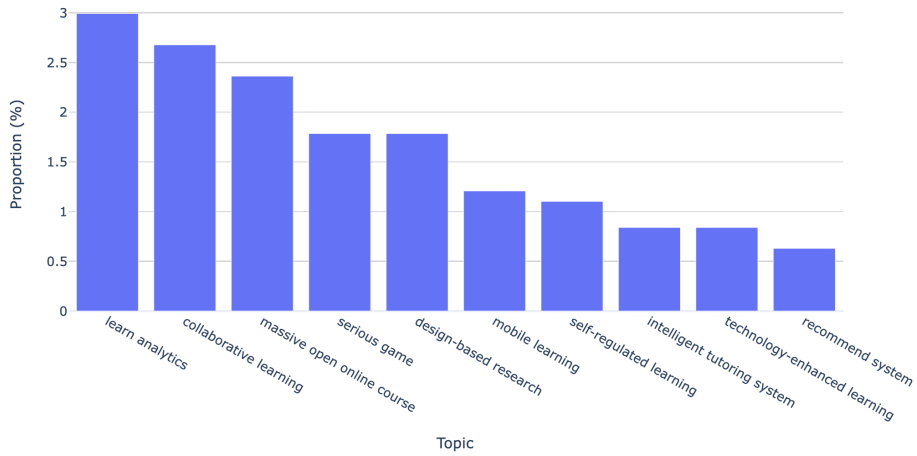


Fig. 1: Keyword distribution across all papers.

### 3.2 Evolution of topics across the previous ten years

After reviewing keywords taking into account all ten years, we analyzed each year separately, calculating the proportion of each keyword in each year individually.

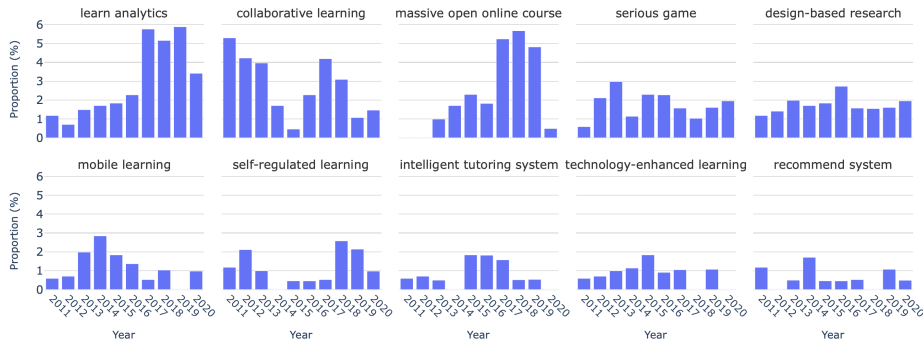


Fig. 2: Keyword distribution by year.

Figure 2 shows the evolution of each keyword’s distribution over time. We see some keywords that have never been as trendy as others, but they keep appearing year after year. This is the case of “design-based research,” which has a stable distribution almost every year. Moreover, we also see other keywords that have increased their frequency significantly, such as “learn analytics” (increasing from 1.17% in 2011 to a maximum of 5.88% in 2019). What we discover looking at Figure 2 is that almost every keyword has lost frequency from 2019 to 2020,

which possibly means that 2020 was a year with new trends, or maybe papers' topics are more diverse.

### 3.3 Evolution of this year's conference topic on "Free, Safe and Sustainable World"

We searched the appearance of certain quotes: using the papers' full text, we searched for the quotes: "free world," "safe world," "sustainable world," and "sustainability"; then, we made a manual review of those papers found to check if they are really addressing any related area to this year's theme. All papers (a total of ten) resulting from our search matched the quote "sustainability", and none of them matched any other quote. We identified that all these papers addressed four main topics:

- **Economical sustainability.** We found one paper matching this topic, dealing with the economical issues of implementing technology in the classroom. Specifically, [4] created a multi-user simulation environment for LEGO robots, which are expensive and typically could not be used by students at home.
- **Technological sustainability.** We found a total of three papers in this topic, addressing some existing technological challenges in the area. For example, the work in [8] describes multi-tier architecture and data model to support the deployment of learning designs, which is sustainable and scalable.
- **Pedagogical sustainability.** We found two papers matching this topic. These papers propose new approaches to content generation issues over time. For example, the focus in [7] is on the construction, use, pedagogical potential, and long-term sustainability of certain web-based tools designed for teaching logic.
- **EdTech about sustainability.** We found four papers in this topic, including EdTech research where the tool developed (e.g., games, MOOCs) includes sustainability concepts. For example, authors in [3] discuss the design, implementation and evaluation of a pilot project that integrated inquiry-based learning with mobile game design, addressing topics such as energy consumption or sustainable development.

## 4 Conclusions and future work

This student presents a methodology to discover the latest trends in the last 10 years of the EC-TEL conference. Some of the most frequent keywords that we found are "learning analytics," and "massive open online course," which have gained popularity over time. Other keywords, like "collaborative learning," have also been very popular, but their popularity is decreasing over the years. We also analyzed how papers have addressed this year's conference theme on "Free, Safe and Sustainable World," finding that not many papers have tackled it in

the past. However, we consider that this is an emergent topic that should be addressed in a world of ever-increasing technology development. It is important to adapt the future of learning to address the current global challenges and continue growing in a safe, free, and sustainable world.

This work has some limitations. First of all, we did not use the complete proceedings of EC-TEL since we excluded demo and poster papers from our analysis. With respect to the keyword analysis, we are limited by authors' keywords, expecting they cover all the possible topics addressed in each paper. However, usually, it is not like that. As part of our future work, we will be expanding this analysis to the conference's entire trajectory, including the 15 years of manuscripts. As we have also collected all the papers' metadata, including authors and also citations available in the full manuscript, we are working on a network analysis to establish relations between the different papers and authors across the conference trajectory. We expect our study to shed some light on the latest trends and evolution of EC-TEL.

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