

# Research on Development Trend in Interdisciplinarity of Educational Technology based on Web of Science-covered Data

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**Abstract.** The purpose of this study is to provide references for researchers in the fields of educational technology (ET) and other sciences such as natural science, humanities and social sciences in their cross-integration research, and then promote interdisciplinary research and development of ET. To this end, this paper, based on the literature on Web of Science and related data in different subject category, applies the literature metrology and visualization technology of mapping knowledge domains, and then deeply reveals the interdisciplinary development of international ET from a multi-dimensional perspective. The study found that “computer science in interdisciplinary applications” are most closely related to the ET, with the longest interdisciplinary time. In addition, the knowledge source of ET is extensively covered, and its knowledge source discipline is far more than its own application field. Thus, it is necessary for ET to discover the characteristics of computer-related disciplines in terms of application methods and application fields and further improve its application range.

**Keywords:** Educational technology (ET); Interdisciplinary; Citation analysis.

## 1. Introduction

In the process of disciplinary development, educational technology has continuously integrated the disciplines of pedagogy, psychology, systems science, and sociology, as well as the theories and methods of audio-visual media, computer and network technology, and emerging technologies etc. Many scholars have conducted in-depth research on the discipline connotation, development trend, hotspot changes, and research frontiers of ET, e.g., used co-word analysis to interpret the hotspots and trends of ET research in China since the 21st century[1]; carried out the qualitative analysis for the development of Japanese ET from the aspects of research content and theory, and obtained the development trend of Japanese ET research[2]; Tian Lin et al. conducted analysis for the high-frequency keywords etc., and concluded the research hotspots, trends and subject classification of international ET for the past ten years; concluded the research hotspots, trends and subject classification of international ET for nearly ten years[3]; Zhou Jing et al. analyses the scientific output competitiveness of Chinese ET research institutions [4]. In the existing research, there has been relatively few studies on the cross-disciplinary situation of ET, and a lack of quantitative research to reveal the trend of cross-disciplinary changes in ET. Yang Zongkai et al. pointed out that a series of problems involved in the practice of educational informatization must be solved by integrating with the knowledge resources of multidisciplinary fields such as information science, education, computer science, psychology, cognitive science, neuroscience, brain science, political science, management science, economics and even philosophy etc [5]. The task of scientists has shifted to interdisciplinary issues rather than a single discipline [6]. At present, it is urgent to grasp the development law of educational informatization through the multi-disciplinary basic and comprehensive scientific research, understand its scientific connotation, and further reveal its basic mechanism, typical characteristics and dynamic mechanism. In the “13th Five-Year” development plan, the National Natural Science Foundation of China clearly states that it is necessary to encourage the intersection of natural sciences and humanities and social sciences, explore the basic research of education science, and add new projects in the field of “educational information science and technology” in 2018.

This paper, based on the literature on Web of Science and related data in different subject category, applies the literature metrology and visualization technology of mapping knowledge domains, and then deeply reveals the interdisciplinary development of international ET from a multi-dimensional perspective. The purpose of this study is to provide references for researchers in the fields of ET and other sciences such as natural science, humanities and social sciences in their cross-integration research, and then promote interdisciplinary research and development of ET.

## **2. Research Content and Methods**

Interdisciplinary situation analysis can be studied from two aspects: the academic articles and the subject knowledge flow. On the one hand, the disciplines and research fields of the article itself are the direct source for understanding the inter-disciplines; on the other hand, the citations of the articles in the subject area can express the knowledge and information input in its field [7]. The citing articles are not only cited in the same field, but also cited and disseminated in similar fields and other different fields, so as to promote the generation of new knowledge [8]. Besides, the knowledge absorption and diffusion of the science can help to well measure the cross-integration of the knowledge in this field with other knowledge.

This paper analyses and studies the interdisciplinary development of ET from multiple perspectives by applying the scientific metrology theory. The research content includes according to the literature data of ET itself, the development characteristics of the subject, its cross-correlation history and cross-development trend with related disciplines are analysed from different angles.

## **3. Analysis for the Cross-disciplinary Situation of Educational Technology**

### **3.1 Data Preparation**

The core collection of the Web of Science (WOS) database was selected, namely, SCI-EXPANDED, SSCI, A&HCI database, with the time range of 1971-2016, document type of “Article” or “Review”, and the search date of December 2017. The JCR (Journal Citation Report) in WOS divides the discipline into 242 categories, among which the education-related subject category is Education & Education Research, and ET is a subcategory of the education discipline. But considering no further classification in the “Education & Educational Research” category, this paper selects 21 journals related to ET according to the journal orientation from 238 journals in the “Education & Educational Research” category, and make searching in terms of the publication name. Thus, a total of 14,325 records were obtained.

For the 21 journals, the impact factors in 2017 are ranked from high to low, as shown in Table 1.

### **3.2 Trend Analysis for Article Outputs**

The twenty-one ET-related journals were searched by publication name, to obtain a total of 14,325 records. The publication year of the documents included in this data set began in 1971 with a total of 46 years. Based on the statistics for the 14,325 records according to the publication year, the number of articles per year was obtained, as shown in Figure 1.

By analysing the literature of the dataset, it's found that the development of this discipline can be divided into four periods. The first is the initial period of the first 10 years (1971-1980), in which the number of articles was small and it developed slowly; the second is the stable growth period of about 20 years (1981-2000) at the slow growth rate, and the annual literature volume reached nearly 200 articles; the third is the rapid development period in the following 10 years (2001-2010), at the fast growth rate is very fast, and the number of annual literatures exceeded 1,000; the fourth is the relative stability period of nearly 5 years (2011-2016), and the annual literature volume has exceeded 1,000 articles, showing more mature situation.

Table 1. 21 journal titles and impact factors

Publication Name	Journal Impact Factor
Internet and Higher Education	5.847
Computers & Education	4.538
International Journal of Computer-Supported Collaborative Learning	3.273
British Journal of Educational Technology	2.729
Language Learning & Technology	2.113
IEEE Transactions on Learning Technologies	1.869
Computer Assisted Language Learning	1.928
Learning Media and Technology	3.175
International Review of Research in Open and Distributed Learning	1.826
Interactive Learning Environments	1.604
Distance Education	1.314
Educational Technology & Society	1.767
Journal of Computing in Higher Education	1.517
Journal of Computer Assisted Learning	1.859
Journal of Science Education and Technology	1.375
Technology Pedagogy and Education	1.580
Australasian Journal of Educational Technology	1.396
Etr&D-Educational Technology Research and Development	1.728
Journal of Educational Computing Research	1.234
Research in Science & Technological Education	0.513
Egitim ve Bilim-Education and Science	0.352

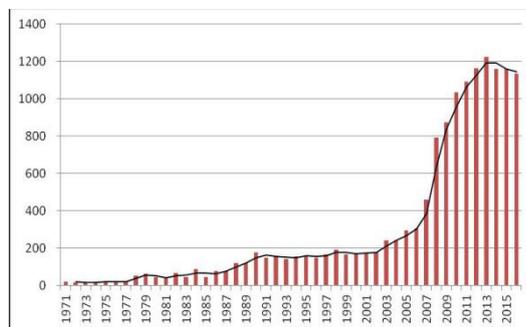


Figure 1. Variation trends in the number of WOS articles on educational technology from 1971 to 2016

### 3.3 Interdisciplinary Category

Each article in WOS has its own specific subject category of WOS, and interdisciplinary literatures are labelled in the relevant categories. Based on this, these datasets involve five WOS categories except for the “education and education research”, and they have a certain crossing relationship with ET. Compared with the discipline classification of the 2011 China Academic Office, it covers the fields such as education, engineering, literature, management, etc., and specifically the five first-level disciplines: education, psychology, foreign language and literature, computer science and technology, libraries, intelligence and archives management. Table 2 lists the top 5 WOS categories and their record number. These disciplines are closely related to ET.

Table 2. Interdisciplinary categories of educational technology (1971-2016)

Web of Science Categories	Number of papers
Computer Science, Interdisciplinary Applications	3895
Education Scientific Disciplines	546
Linguistics	522
Language Linguistics	274
Information Science Library Science	213

It can be seen from Table 2, the five categories most closely related to ET include interdisciplinary application of computer science, educational sciences, linguistics, language and linguistics, information science, and library science.

### 3.4 Analysis of Interdisciplinary Situation.

This section mainly analyses the trends in the cross-correlation between educational technology and the above-mentioned subject categories. Since the bubble map can simultaneously display three-dimensional data such as category, time, and quantity, it can be used to analyse the intersection characteristics of different subject areas with ET in a specific time period and throughout the time period (Fig.2). The 41 years (1976-2016) was divided into a total of 8 time periods for a period per 5 years (the last period is 6 years), and they're marked as Yi (i = 1 to 8) according to their natural year order.

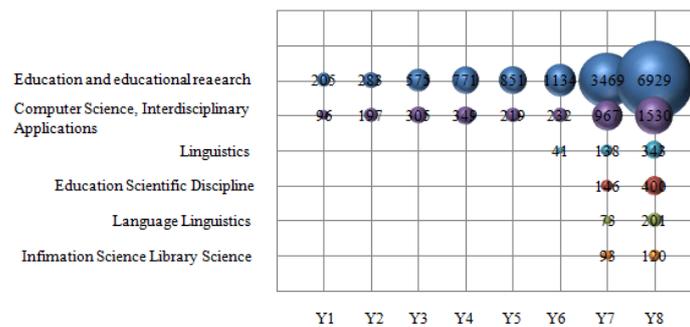


Figure 2. Interdisciplinary situation of educational technology and related disciplines in different periods

Taking ET as a reference, the overall change trend of bubble size in eight time periods indicates that among the five WOS disciplines cross-related to ET, “computer science, interdisciplinary application” are the most closely related. Since 1978, there has been a continuous crossing relationship between them with the largest number of associations, and the correlation with ET has changed from being more closely to gradually weakening and stabilizing. From the proportion of the number of associations, the proportion of “computer science, interdisciplinary application” records reached 46.8% in the Y1 (1976-1980) period, and the highest proportion in the Y2 (1981-1985) period, reaching 69.6%, with the highest degree of association. After that, the proportion of “computer science, interdisciplinary application” records began to decline, and the degree of cross-correlation showed a downward trend, which was related to the rapid development of ET itself. In the Y1-Y5 (1976-2000) period, there had been no other disciplines other than “computer science, interdisciplinary applications.” In the 21st century, the vigorous development of ET has further expanded its integration with more disciplines. Since 2003, linguistics" and ET have had a certain intersection and have continued to this day. Although the number of cross-records is small and the proportion is low, the proportion is gradually increasing. From 2006, ET has been supported by theoretical methods and technical practices from the disciplines of education science, linguistics, language and linguistics. Among them, “education science discipline”, “linguistics”, “language and linguistics” accounted for a relatively small proportion, but the proportion remained relatively stable in Y8 (2011-2016). “Information Science and Library Science” appeared in the Y7 (2006-2010) period, which was relatively low, and had a downward trend during the Y8 (2011-2016) period. Besides, their correlation with ET was slightly diluted in the last period.

## 4. Conclusion

Based on WOS data, this paper applies multi-knowledge map visualization methods and technologies to comprehensively displays and analyses the interdisciplinary situation of ET, which provides reference for its future development, especially the interdisciplinary direction. Then, it's found that the five WOS categories most closely related to ET include the interdisciplinary applications in computer science, educational sciences, linguistics, language and linguistics, informatics, and library science. Among them, "computer science in interdisciplinary application" and education technology are the most closely related, with the longest interdisciplinary time. However, in recent years, the proportion of its cross-correlation has shown a downward trend, which is related to the rapid development of ET itself. Since the data source of this paper is only limited to the WOS database, the diversity of data sources should be considered in the future to improve the comprehensiveness and accuracy of the analysis. Besides, this paper mainly analyses the characteristics of cross-category from a macroscopic point of view. In the follow-up study, more detailed analysis needs to be conducted from the microscopic perspectives such as subject cross-disciplinary topics for better presenting the interdisciplinary characteristics of ET.

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