



# Half a century of Instructional Science: a bibliometric analysis

Betzabe Ruiz-Morales<sup>1</sup> · Víctor G. Alfaro-García<sup>1</sup> · José M. Merigó<sup>2</sup>  · Amara Atif<sup>2</sup> · Eleni A. Kyza<sup>3</sup>

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## Abstract

*Instructional Science* is a prominent international journal of learning sciences. This article provides a comprehensive bibliometric overview of the major trends within the journal from 1972 to 2023. The study focuses on assessing the journal's impact, identifying the most productive and influential authors, institutions, and countries, as well as analysing the evolution of key topics over time. The primary source of bibliometric data for this analysis is the Scopus scientific database. Some information of the Web of Science Core Collection database is retrieved in specific instances to enhance the analysis. Additionally, the paper includes a graphical mapping of the bibliographic data using VOS viewer software, which provides more in-depth analysis through co-citation, bibliographic coupling, and co-occurrence of author keywords. The findings highlight the journal's significant growth and impact over the years, and it is anticipated that it will continue to expand its international reach.

**Keywords** Bibliometrics · Web of science · Scopus · Keyword analysis · VOS viewer

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✉ José M. Merigó  
Jose.Merigo@uts.edu.au

Betzabe Ruiz-Morales  
betzabe.ruiz@umich.mx

Víctor G. Alfaro-García  
victor.alfaro@umich.mx

Amara Atif  
Amara.Atif@uts.edu.au

<sup>1</sup> Facultad de Contaduría y Ciencias Administrativas, Universidad Michoacana de San Nicolás de Hidalgo, Gral. Francisco J. Mugica S/N, 58030 Morelia, Michoacan, Mexico

<sup>2</sup> School of Computer Science, Faculty of Engineering and Information Technology, University of Technology Sydney, 81 Broadway, Ultimo, NSW 2007, Australia

<sup>3</sup> Department of Communication and Internet Studies, Cyprus University of Technology, Lemesnos, Cyprus

## Introduction

*Instructional Science – An International Journal of the Learning Sciences* aims to enhance understanding of the nature, theory, and practice of learning, as well as the environments in which it takes place. The journal publishes papers that explore a wide range of perspectives within the learning sciences, addressing learning processes across all age groups, various curriculum areas, and settings that range from technology-rich to technology-limited, and from informal to formal educational contexts. The journal prioritizes original empirical research, offering a platform for comprehensive reporting on significant studies. Regardless of their specific focus, all articles in the journal contribute to the field of learning and instruction by highlighting insights that inform the development and implementation of effective learning environments.

The journal consistently ranks highly in its field across various metrics, such as the five-year impact factor, article influence score, and CiteScore. In celebration of the journal's 50th anniversary, this paper presents a bibliometric analysis to highlight the leading trends within the journal. The goal is to identify key aspects such as the most cited papers, prominent authors, institutions, and countries, the author keyword analysis, the leading topics and topic clusters, and temporal evolutions. To achieve this, the study examines all documents published in the journal from 1972 to 2023, utilizing the Web of Science (WoS) Core Collection. Additionally, the Visualization of Similarities (VOS) viewer software (Van Eck & Waltman, 2010) is employed to visually map the bibliographic data, using methods like bibliographic coupling (Kessler, 1693) and co-citation analysis (Small, 1973). It is noteworthy that significant anniversaries of journals often prompt special activities such as editorials (Barley, 2016; Shugan, 2006) reviews (Van Fleet et al., 2006), and special issues (Kozlowski et al., 2017).

Bibliometrics is a research field within library and information sciences that focuses on the quantitative analysis of bibliographic data (Broadus, 1987; Pritchard, 1969). It involves the application of statistical methods to analyse units of publication and citation, thereby providing a representative overview and classification of a set of bibliographic documents (Ding et al., 2014; Donthu et al., 2021a, 2021b). This field helps in understanding patterns and trends in research outputs, such as publication productivity, citation impact, and the development of scientific fields (Glanzel et al., 2019; Hicks et al., 2015).

There are many bibliometric overviews in the field of educational research and learning sciences. For example, Hung, (2012) provided a bibliometric overview of e-learning research. Cheng et al. (2014) studied e-learning in the workplace. Jing et al. (2024) performed a bibliometric analysis of studies on technology-supported learning environments. Widowati and Tyas (2024) developed a bibliometric review of the field of mobile-based learning. Hernández-Torrano and Ibrayeva (2020) focused on creativity and education. Several authors have studied the impact of artificial intelligence in education (Ahmad et al., 2024; Chen et al., 2022; Durak et al., 2024). Some other authors have focused on virtual reality and education (Rojas-Sánchez et al., 2023).

Numerous journals have also published bibliometric overviews focused on their own publications motivated by some specific anniversary or event (Baker et al., 2020; Laengle et al., 2017; Monastersky & Van Noorden, 2019). For example, in the field of educational research and learning sciences, the following journals have already prepared a bibliometric review of their publications:

- *Australasian Journal of Educational Technology* (López-Belmonte et al., 2021).
- *British Journal of Educational Technology* (Chen et al., 2020).
- *Educational Administration Quarterly* (Hallinger, 2023).
- *Educational Management Administration & Leadership* (Hallinger & Kovačević, 2021).
- *European Journal of Engineering Education* (de Graaff, 2014).
- *IEEE Transactions on Learning Technologies* (Zurita et al., 2022).
- *Journal of Computer Assisted Learning* (Akturk, 2022).
- *Journal of Engineering Education* (Pawley et al., 2016; Qiu & Natarajarathinam, 2023).
- *Journal of Marketing Education* (Donthu et al., 2021a).
- *Journal of Public Affairs Education* (Raadschelders et al., 2018).
- *Journal of Research on Technology in Education* (Wilson, 2022).
- *Journal of Teaching in International Business* (Sureka et al., 2020).
- *Reading Research Quarterly* (Reutzel & Mohr, 2015).

The structure of this paper is as follows. Sect. "Methods" provides a concise overview of the bibliometric methodology applied in this study. Sect. "Results" outlines the results, covering aspects such as the publication and citation patterns, the most frequently cited papers, highly cited documents within the journal, and the top contributing authors, institutions, and countries, as well as the articles that cite them. Sect. "Mapping Instructional Science with VOS viewer software" offers a graphical representation of the journal's bibliographic data using VOS viewer software. Finally, Sect. "Conclusions, implications and limitations" highlights the conclusions of the paper.

## Methods

This study employs bibliometric methods to perform a specific analysis of *Instructional Science* publications (Donthu et al., 2021b; Merigó et al., 2015). This approach enables a retrospective evaluation of the journal by examining various aspects such as publication and citation structures, authorship, contributing institutions, countries or territories, keywords, and temporal trends, among other factors (Ng & Tamer, 2023). Note that since the work of leading pioneers (Bensman, 2007; Garfield, 1955), bibliometrics has grown a lot during the last decades thanks to the development of computers and internet (Bar-Ilan, 2008).

The study utilizes a range of bibliometric indicators (Garfield, 1955; Liao et al., 2019; Podsakoff et al., 2008) to present the relevant bibliographic data, including metrics such as the total number of publications, total citations, citations per paper, and the *h*-index (Alonso et al., 2009; Hirsch, 2005; Martínez et al., 2014). Typically, research is assessed from two main perspectives: productivity and influence. Productivity is commonly measured by the number of publications, while influence is gauged by citation counts. Notably, citations per paper and the *h*-index serve as indicators that integrate both productivity and influence. The *h*-index specifically measures the number of documents *X* that have received at least *X* citations.

This study highlights that the Impact Factor (IF) is calculated using data from the WoS Core Collection database, while the CiteScore (CS) is derived from the Scopus database. The IF assesses a journal's performance by dividing the number of citations in year *n* to publications from years *n*-1 and *n*-2 by the total number of publications in those years. The

CS in year  $n$  represents the average number of citations per publication over the preceding four years (from year  $n-3$  to  $n$ ). Additional bibliometric indicators, such as the journal impact factor percentile, journal impact factor quartile, article influence score, and immediacy index, are also used to evaluate the journal's performance. The study also considers several other bibliometric metrics to better represent the analyzed documents, including citations per year, citation thresholds, citing articles, and temporal trends. For the institutional analysis, the university rankings from the Academic Ranking of World Universities (ARWU) and the Quacquarelli and Symonds (QS) University Ranking are included. In the country analysis, indicators such as publications and citations per million inhabitants are used to provide a clearer understanding of the data.

The study also employs VOS viewer software (Van Eck & Waltman, 2010) to visually map the bibliographic data. VOS viewer compiles the data and generates maps based on bibliographic coupling, citation, co-citation, co-authorship, and the co-occurrence of author keywords. Bibliographic coupling measures how many documents cite the same third document (Kessler, 1963), helping to identify similar research profiles. Citation analysis examines how documents cite each other, counting instances where document A cites document B and vice versa. Co-citation occurs when two documents are cited by the same third source (Small, 1973). Co-authorship identifies connections between documents authored by multiple authors, institutions, or countries. Note that in the literature different software is available for building graphical analysis of the bibliometric information (Aria & Cuccurullo, 2017; Cobo et al., 2011).

The search process uses the WoS Core Collection to collect the bibliographic information. The initial search selects the option of "Publication Titles" and the keyword "Instructional Science". In June-July 2024, this search retrieves 1,467 documents. Selecting the option of "Show Final Publication Year" we exclude "2024" to consider all documents published between 1972 and 2023. Additionally, in "Document Types" we select only "Articles" and "Reviews" to focus on research contributions and excluding editorial material and other related documents. These refinements produce a result of 1,275 documents. Finally, the work also excludes "Document Types" classified as "Early Access" since these documents will be published in 2024 or later. The final result retrieves 1,262 documents that will be used in all the analyses of this article.

To summarize the bibliometric methodology of this article, Fig. 1 presents the scientific procedures and rationales following the SPAR-4-SLR protocol for systematic literature reviews (Alaminos et al., 2024; Donthu et al., 2021b; Paul et al., 2021).

## Results

The analysis in this study uses data from the WoS Core Collection, managed by Clarivate Analytics. The initial search was conducted using the keyword "Instructional Science" under the "publication name" filter, taking place in July 2024. The study includes all documents published in the journal from 1972 to 2023, 1,467 documents. This number reduces to 1,262 when only articles and reviews, are considered. As of July 2024, the journal had received 39,169 citations from other documents in the WoS database, averaging 26.5 citations per paper. The  $h$ -index of the journal is 86.

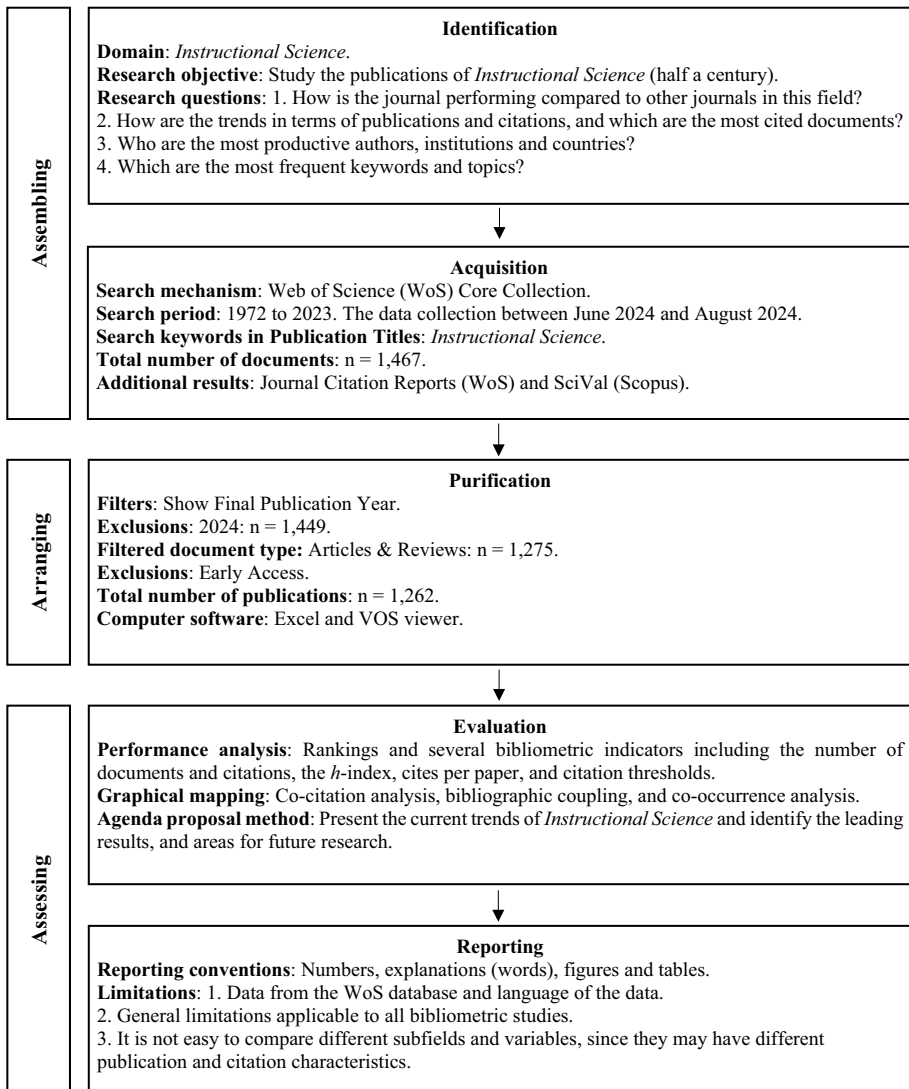
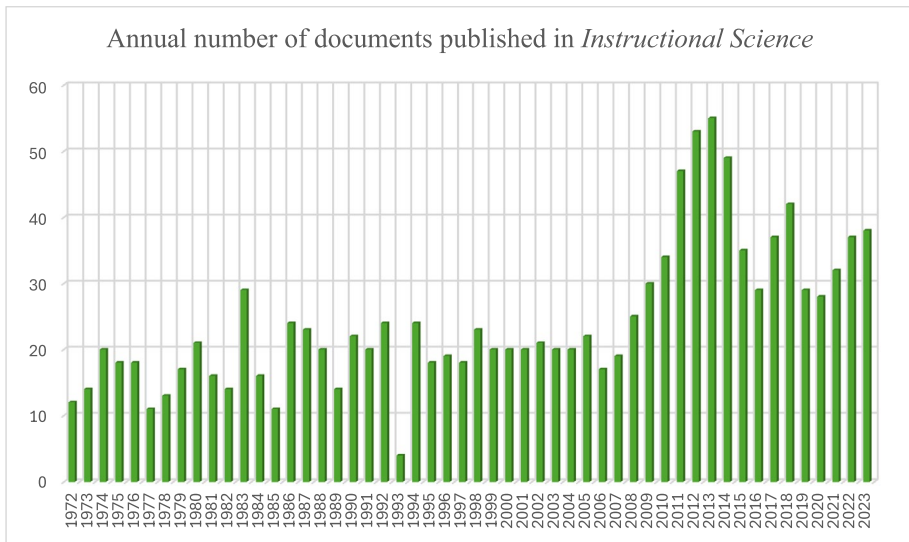


Fig. 1 Procedure of the study based on the SPAR-4-SLR protocol

### Publication and citation structure of *Instructional Science*

The inaugural issue of *Instructional Science* was published in 1972, and the journal has experienced substantial growth over time. This expansion can be attributed to the significant advancements in the field of learning sciences over recent decades, which have fuelled a considerable increase in research within this discipline see Fig. 2.

Figure 2 shows that the annual number of documents published in *Instructional Science* has exhibited notable changes over the decades. In the initial years, the journal consistently published around 20–30 papers annually, maintaining a relatively steady output. However,



**Fig. 2** Annual number of papers published in *Instructional Science*

starting around 2008, there was a marked increase in the number of publications, reflecting a growing interest and participation in the field. This growth accelerated significantly in the second decade of the millennium, with the journal reaching a peak of approximately 55 documents in the first-2010s. This upward trend indicates an expanding academic engagement and possibly an increase in research funding and interest in instructional methodologies and technologies.

In recent years, however, there has been a slight decline in the number of publications, with the figures stabilizing around 30–40 papers annually. This decline may reflect changes in the journal's editorial policies, such as stricter acceptance criteria or a reduction in special issues. Despite this, the overall trend remains positive, suggesting continued growth in the field. This trajectory is likely influenced by the increasing global submissions and the journal's growing reputation. The sustained interest in publishing in *Instructional Science* underscores the journal's role as a critical platform for disseminating innovative research in the field.

Table 1 presents data on academic production and citations received between 1972 and 2023, detailing the number of publications that have reached various citation thresholds, from more than 500 to at least one citation. The data reveal variability in the number of publications and citations over the years. Also, Fig. 3 shows the annual box-whisker plot structure of the citations of all papers published in *Instructional Science*. Academic production, measured in total publications, has shown fluctuations with notable increases in certain years, such as 1983 and from 2009 to 2018, with 2013 being the most productive year with 55 articles. Conversely, significant decreases are observed in years like 1977, 1985, and especially 1993, which saw only 4 articles published. In terms of total citations, particularly high peaks are observed in 1981, 1989, 1998, and from 2004 to 2005, excluding 2006, indicating years of substantial academic influence. The year with the highest citations

**Table 1** Annual citation structure of *Instructional Science*

Year	TP	TC	C/P	≥500	≥200	≥100	≥50	≥20	≥10	≥5	≥1	T50
1972	12	52	4.33	0	0	0	0	0	2	2	7	0
1973	14	128	9.14	0	0	0	0	2	3	2	5	0
1974	20	115	5.75	0	0	0	0	3	2	6	6	0
1975	18	117	6.50	0	0	0	1	1	5	3	6	0
1976	18	88	4.89	0	0	0	0	1	1	6	6	0
1977	11	213	19.36	0	0	0	2	1	1	3	3	0
1978	13	137	10.54	0	0	0	0	4	1	4	4	0
1979	17	348	20.47	0	0	2	0	0	4	4	5	2
1980	21	177	8.43	0	0	0	0	2	3	5	7	0
1981	16	1836	114.75	1	0	0	2	2	1	5	5	1
1982	14	465	33.21	0	1	1	1	1	0	5	2	1
1983	29	249	8.59	0	0	0	1	2	4	6	14	0
1984	16	420	26.25	0	1	0	2	1	0	6	4	1
1985	11	93	8.45	0	0	0	0	1	3	1	5	0
1986	24	280	11.67	0	0	0	2	2	2	10	5	0
1987	23	302	13.13	0	0	0	1	4	5	4	8	0
1988	20	525	26.25	0	0	0	1	4	5	4	5	0
1989	14	2046	146.14	1	0	1	0	4	0	3	5	2
1990	22	618	28.09	0	1	0	1	4	7	3	6	1
1991	20	224	11.20	0	0	0	1	4	3	5	6	0
1992	24	121	5.04	0	0	0	0	3	0	2	8	0
1993	4	91	22.75	0	0	0	1	0	0	1	2	0
1994	24	432	18.00	0	0	0	1	7	8	6	0	0
1995	18	358	19.89	0	1	0	0	2	2	4	7	1
1996	19	667	35.11	0	1	0	3	4	3	4	4	1
1997	18	857	47.61	0	1	1	4	3	6	0	3	2
1998	23	1714	74.52	1	2	1	3	4	4	3	3	4
1999	20	336	16.80	0	0	1	1	3	3	4	6	0

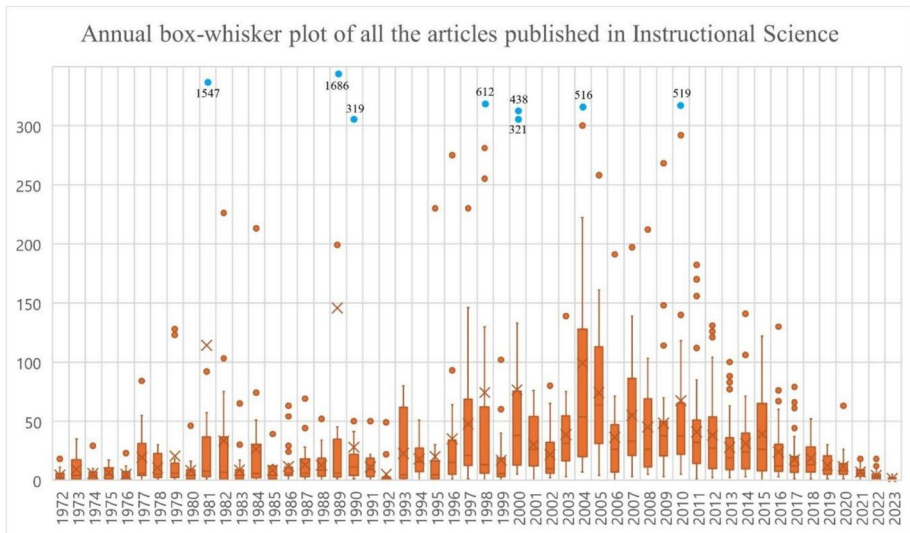
**Table 1** (continued)

Year	TP	TC	C/P	≥500	≥200	≥100	≥50	≥20	≥10	≥5	≥1	T50
2000	20	1535	76.75	0	2	1	6	5	2	4	0	3
2001	20	608	30.40	0	0	0	6	6	4	1	2	0
2002	21	456	21.71	0	0	0	2	8	2	6	3	0
2003	20	773	38.65	0	0	1	4	7	6	1	1	1
2004	20	1990	99.50	1	2	4	3	7	2	1	0	7
2005	22	1633	74.23	0	1	6	6	4	3	1	1	4
2006	17	621	36.53	0	0	1	2	7	3	0	3	1
2007	19	1047	55.11	0	1	2	4	8	2	1	1	2
2008	25	1129	45.16	0	1	1	7	7	4	5	0	1
2009	30	1459	48.63	0	1	2	4	17	5	0	1	2
2010	34	2306	67.82	1	1	3	9	13	5	2	0	3
2011	47	1928	41.02	0	0	4	10	17	9	2	5	3
2012	53	2034	38.38	0	0	5	10	15	10	10	3	4
2013	55	1546	28.11	0	0	1	11	14	15	10	4	0
2014	49	1546	31.55	0	0	3	4	20	10	8	4	1
2015	35	1384	39.54	0	0	2	10	10	4	6	2	1
2016	29	704	24.28	0	0	1	3	7	8	7	3	1
2017	37	662	17.89	0	0	0	3	7	13	9	5	0
2018	42	798	19.00	0	0	0	2	15	10	10	5	0
2019	29	364	12.55	0	0	0	0	9	5	9	6	0
2020	28	332	11.86	0	0	0	1	2	11	9	5	0
2021	32	234	7.31	0	0	0	0	1	6	14	10	0
2022	37	153	4.14	0	0	0	0	0	4	8	22	0
2023	38	62	1.63	0	0	0	0	0	0	3	23	0
Total	1262	38313	4.33	5	17	44	135	275	221	238	256	50

**Table 1** (continued)

Year	TP	TC	C/P	≥500	≥200	≥100	≥50	≥20	≥10	≥5	≥1	T50
%	100%	-	-	0.39%	1.3%	3.5%	10.7%	21.8%	17.5%	18.8%	20.3%	-
C%	-	-	-	0.39%	1.7%	5.2%	15.9%	37.7%	55.2%	74.1%	94.3%	-

TP and TC, total papers and citations; ≥500, ≥200, ≥100, ≥50, ≥20, ≥10, ≥5, ≥1, Number of papers with equal or more than 500, 200, 100, 50, 20, 10, 5 and 1 citations; T50, Number of papers in the Top 50 of Table 6; C%, Cumulative percentages.



**Fig. 3** Annual box-whisker plot structure of the citations of all papers published in *Instructional Science*

is 2010, reflecting the publication of high-impact papers and a greater interest in the topics investigated during these periods.

The analysis of the citation distribution reveals a concentration of articles in the lower impact categories ( $\geq 1$  to  $\geq 10$  citations), with few articles reaching the thresholds of  $\geq 500$  and  $\geq 200$  citations. Only five years—1981, 1989, 1998, 2004, and 2010—show an article whose citations are above 500. The TC/TP indicator, which measures the average number of citations per article, has fluctuated significantly, reaching notable peaks in years such as 1981 and 1989, reflecting periods of particularly influential publications. As we approach more recent years, a decrease in the average number of citations per publication is observed, particularly evident in 2023, with a TC/TP of 1.63. This trend could indicate a greater number of publications with a lower average impact or a possible saturation of the academic market. Overall, the data suggest that while the journal has maintained a high level of quality, the impact of recent publications may take some time to become fully apparent.

Figure 3 illustrates the annual box-whisker plot structure (Tukey, 1977) of the citations for all publications in *Instructional Science*. The plot presents key statistical measures for each year's citations, including the average, median, first quartile, third quartile, interquartile range (IQR), minimum, and maximum values, as well as outliers. Outliers with more than median citations are marked by orange dots, and blue dots mark exceptionally influential papers with more than 300 citations.

The data reveals significant dispersion in the citation distribution for publications from some years, as indicated by the largest IQR and the widespread extreme values. This suggests that while some papers from that year were highly cited, there was considerable variability in impact. In contrast, the citation distributions for the years 2020 to 2023 are much more concentrated, indicating a narrower range of citations and generally lower citation counts for recent publications. Notably, the papers published in 1998 not only exhibit the highest citation dispersion but also achieve the highest average citations. The highest median citation count occurred in 2000 when half of the publications received at least around 25

citations. The citation patterns from 2012 to 2019 show remarkable consistency, reflecting stable citation behavior during this period.

Table 2 displays a comprehensive analysis of the journal's performance metrics over the years (Clarivate, 2024). The evolution of the number of citable publications and the trend in citations align with the findings from Table 1 based on Scopus data. This journal has shown a consistent upward trajectory in its impact factor (IF), moving from 0.378 in 1997 to 2.7 in 2022. This growth reflects the increasing recognition and influence of the journal's publications. Furthermore, the journal's impact factor percentile and ranking in the Web of Science (WoS) categories, particularly in the Social Sciences Citation Index (SSI), have been very positive, consistently placing the journal in the top quartile (Q1) in recent years.

The 5-year impact factor and article influence score have also demonstrated significant growth, reaching their highest levels recently. This indicates that not only are the journal's articles being cited more frequently, but they are also having a more substantial influence on subsequent research. The journal's immediacy index has notably increased since 2018, suggesting that it is attracting citations more rapidly, highlighting the relevance and timeliness of its publications. The evolution of the quartile rankings for the journal across different categories reflects its growing academic influence and prestige. In the Education & Educational Research category, the journal consistently ranks in the top quartiles, achieving Q1 status in several recent years. This upward trend in quartile ranking is indicative of the journal's strong performance and the increasing recognition of its published research.

The journal's positioning within the Psychology and Educational category also demonstrates a positive trajectory, with movements towards higher quartiles, indicating a broader acceptance and citation of its articles. The consistent presence in the upper quartiles across these categories highlights the journal's expanding impact and its role as a leading publication in its fields. In addition, an analysis of the journal's publication and citation performance compared to other major academic journals in its field shows that it stands out in terms of both the number of high-quality publications and the impact they generate. This sustained growth in key performance metrics underscores the journal's rising prestige and influence within the academic community, particularly in the areas of Education & Educational Research and Psychology, Educational.

Table 3 presents a comprehensive overview of leading journals in the field of education, focusing on key metrics such as total citations, impact factor, and citation per paper ratios. This analysis includes top-tier journals from the Master Journal List of WoS and highly cited publications within educational psychology and related disciplines. Prominent journals such as the *Journal of Educational Psychology* and the *Review of Educational Research* demonstrate high *h*-indices, reflecting their substantial academic influence and the frequency with which their articles are cited. *Educational Psychologist* leads with a notable citation per paper ratio of 126.1. In terms of total citations, the *Journal of Educational Psychology* is the most cited journal, followed by *Computers & Education* and the *Review of Educational Research*. Note that the first two journals have the advantage of being interdisciplinary, receiving a significant number of citations from different fields and not only from educational research.

Focusing on the publications of the last decade (2004–2023), *Computers & Education* gets the most remarkable results, although the *Review of Educational Research* and the *Educational Psychologist* gets higher cites per paper ratio. Looking at the age of the journals, we see that all these journals are very old, indicating that they are very classical and have been

**Table 2** Analysis of *Instructional Science* in the JCR of the WoS

Year	TC	IF	5YIF	ImIn	CI	AIS	AJIF	REER	Q	PEER	RPE	Q	PPE
1997	142	0.378	-	0.056	18	-	43.118	42/102	Q2	59.31	29/39	Q3	26.92
1998	175	0.432	-	0.043	23	-	45.932	42/99	Q2	58.08	25/37	Q3	33.78
1999	148	0.537	-	0.000	20	-	53.811	34/101	Q2	66.83	23/38	Q3	40.79
2000	203	0.651	-	0.050	20	-	63.720	31/96	Q2	68.23	16/38	Q2	59.21
2001	182	0.350	-	0.000	20	-	27.074	56/92	Q3	39.67	33/38	Q4	14.47
2002	239	0.550	-	0.000	21	-	51.584	34/93	Q2	63.98	23/37	Q3	39.19
2003	205	0.366	-	0.550	20	-	31.039	52/92	Q3	44.02	30/36	Q4	18.06
2004	297	0.659	-	0.650	20	-	58.466	27/91	Q2	70.88	21/38	Q3	46.05
2005	271	1.000	-	0.773	22	-	73.228	13/98	Q1	87.24	16/38	Q2	59.21
2006	350	1.810	-	0.059	17	-	90.125	4/100	Q1	96.5	7/40	Q1	83.75
2007	367	0.795	1.300	0.053	19	0.537	60.294	30/105	Q2	71.9	20/38	Q3	48.68
2008	541	0.917	1.816	0.160	25	0.674	54.546	40/113	Q2	65.04	24/42	Q3	44.05
2009	781	1.341	2.311	0.167	30	0.643	75.486	26/139	Q1	81.65	14/44	Q2	69.32
2010	833	1.473	2.044	0.294	34	0.574	73.940	32/184	Q1	82.88	18/50	Q2	65
2011	871	1.828	1.960	0.191	47	0.759	83.003	16/206	Q1	92.48	14/51	Q2	73.53
2012	957	1.568	2.000	0.358	53	0.656	82.608	23/219	Q1	89.73	13/51	Q2	75.49
2013	1,068	1.130	2.016	0.145	55	0.783	64.216	56/219	Q2	74.66	25/53	Q2	53.77
2014	1,145	1.426	1.991	0.633	49	0.852	67.539	38/224	Q1	83.26	27/55	Q2	51.82
2015	1,394	1.462	2.080	0.514	35	0.877	68.000	45/231	Q1	80.74	26/57	Q2	55.26
2016	1,694	1.690	2.305	0.207	29	0.792	72.658	50/235	Q1	78.94	20/58	Q2	66.38
2017	2,022	1.922	2.620	0.405	37	0.828	72.931	59/239	Q1	75.52	18/59	Q2	70.34
2018	2,143	1.576	2.420	0.690	42	0.769	52.263	111/243	Q2	54.53	30/59	Q3	50
2019	2,176	1.734	2.594	0.379	29	0.760	54.292	116/263	Q2	56.08	29/60	Q2	52.5
2020	2,789	2.620	3.360	0.429	28	1.033	54.528	109/265	Q2	59.06	31/61	Q3	50
2021	2,859	2.255	3.282	0.432	37	1.008	45.226	148/270	Q3	45.37	34/61	Q3	45.08
2022	2,760	2.5	2.9	0.8	39	0.790	51.0	123/269	Q2	54.5	32/60	Q3	47.5
2023	2,824	2.6	3.2	0.6	48	0.964	74.9	120/756	Q1	84.2	26/74	Q2	65.5

TC, Total citations; IF, Impact factor; 5YIF, 5-year impact factor; ImIn, Immediacy index; CI, Citable items; AIS, Article Influence Score; AJIF, Average journal impact factor percentile; REER, Ranking in the WoS category of Education & Educational Research; Q, Quartile in CEER; PEER, Journal impact factor percentile in Education & Educational Research; RPE, Ranking in the WoS category of Psychology, Educational; Q, Quartile in PE; PPE, Journal impact factor percentile in Psychology, Educational.

published in this field for a long time. Most of the journals were indexed in WoS a long time ago except for *Educational Researcher*, *Educational Psychologist*, and *Interactive Learning Environments*, which were indexed in 2008, 2007, and 2003, respectively. However, note that these journals started publication in 1972, 1981, and 1990.

Note that all the journals presented in Table 3 are leading journals in the field of learning sciences, educational research and related topics. The table clearly visualizes this by showing the journal impact factor percentile (JIF), where all the journals get a result close to 100. Note that quartile 1 (Q1) journals have a result above 75. *Instructional Science* obtains 84.2, clearly indicating that it is a leading journal in this field. When comparing the results of *Instructional Science* with the rest of the journals in Table 3, it gets a good position although the results are lower than the most cited journals.

The detailed metrics provided for each journal, including total citations, impact factor, and specific citation thresholds, offer a comprehensive view of their standing and impact within the field, making this data invaluable for researchers looking to publish in high-impact journals. Note that the citation thresholds are non-cumulative. Therefore,  $\geq 100$ , indicates the number of documents with equal or more than 100 citations but less than 500, and  $\geq 10$ , the number of articles with equal or more than 10 citations but less than 100.

Next, let us investigate the citing articles (Alfaro-García et al., 2020). Table 4 showcases the top 30 authors, institutions, and countries with the highest number of citing articles to *Instructional Science*. Notably, Chin-Chung Tsai (National Taiwan Normal University) and Fred Paas (Erasmus University of Rotterdam), emerge as the most prolific authors, with 128 and 102 publications, respectively, highlighting their significant contributions to the discipline. Note that citing articles indicate the number of articles where the author has cited *Instructional Science*. However, it does not measure the total number of citations because, in the same article, an author could cite several times the journal.

In terms of institutions, Utrecht University (Netherlands) leads with 335 publications, followed by the Open University Netherlands and Maastricht University (Netherlands) with 297 and 286 publications, respectively. This dominance reflects the robust research culture and resources available at these institutions, which enable them to be at the forefront of educational research. The high publication counts also suggest a strong collaborative network within these universities, contributing to their high productivity and influence. On a global scale, the United States stands out with an impressive 6,921 citing articles, making it the most influential country in the field. Germany and Australia follow with 1,801 and 1,757 publications, respectively. This data highlights the concentration of research activity in these countries, which are known for their strong educational research infrastructures and support for academic publishing. The prominence of the United States in this list indicates a significant level of investment in educational research and a well-established tradition of scholarly output.

These insights provide a comprehensive view of the key players in educational research, emphasizing the roles of prolific authors, leading institutions, and dominant countries in shaping the landscape of this academic field. The data underscores the importance of institutional support and national research policies in driving academic productivity and influence.

The analysis of the citing articles for *Instructional Science* in Table 5 reveals a consistent and growing impact across various research areas. Journals like *Instructional Science* itself, *Computers & Education*, and *ETR&D Educational Technology Research & Development* are among the top citing journals, showcasing the journal's central role in educational tech-

**Table 3** Publication record of leading journals in educational and learning sciences, and other related fields (Rank by C10)

Journal name	P10	C10	C/P10	H10	TP	TC	C/P	H	≥500	≥100	≥10	IF	JIF	CS	Y	YW
Instructional Science	356	6,239	17.53	42	1,262	38,313	30.36	85	5	66	697	2.6	84.2	4.8	1972	1972
Comput Educ	1,930	96,561	50.03	136	4,981	248,507	49.89	209	29	614	2,831	8.9	99.7	27.1	1976	1978
Teaching Teacher Educ	2,102	43,236	20.57	84	4,009	151,374	37.76	153	18	279	2,369	4	95.7	6.5	1985	1987
Stud High Educ	1,505	31,966	21.24	71	2,618	86,105	32.89	124	6	158	1,499	4.2	94.1	8.9	1976	1976
J Educ Psychol	810	29,562	36.50	82	6,857	386,457	56.36	270	89	839	3,389	5.6	96.6	11.4	1910	1910
Brit J Educ Tech	1,109	29,480	26.58	73	2,761	70,987	25.71	101	3	104	1,425	6.7	99.3	15.6	1970	1971
High Educ	1,174	26,007	22.15	65	3,262	94,501	28.97	122	5	168	1,774	3.6	93.7	6.4	1930	1972
Learn Instr	721	23,478	32.56	70	1,329	74,472	56.04	131	9	189	863	4.7	97.6	11.3	1986	1997
Rev Educ Res	246	22,304	90.67	87	2,799	194,067	69.33	217	77	456	1,111	8.3	99.4	24.1	1931	1931
Interactive Learn Env	1,156	22,301	19.29	64	1,383	27,558	19.93	69	0	31	758	3.7	94.1	12.1	1990	2003
Educ Psychol Rev	518	22,267	42.99	78	963	82,159	85.32	141	22	185	503	10.1	98	13	1989	1989
Contemp Educ Psychol	653	20,059	30.72	68	1,780	89,175	50.10	129	14	176	910	3.9	93.9	16.5	1976	1976
Educational Researcher	513	17,098	33.33	67	717	39,978	55.76	100	8	93	403	5.4	98.5	7.8	1972	2008
Int J Sci Educ	1,230	16,859	13.71	46	3,241	92,957	28.68	115	3	145	1,963	2.3	77.7	4.7	1976	1987
ETR&D-Educ Tech Res	904	16,740	18.52	59	1,742	56,356	32.35	102	10	95	926	3.3	91.6	10.7	1953	1989
Sci Educ	1,019	16,131	15.83	55	2,485	85,377	34.36	123	8	172	1,307	3.1	90.3	6.6	1929	1984
J Res Sci Teach	558	14,899	26.70	58	2,523	117,767	46.68	145	13	284	1,532	1.9	93.7	3.7	1963	1963
J Comput Assist Lear	747	14,682	19.65	54	1,466	45,664	31.15	98	1	94	840	5.1	98.3	9.7	1985	1995
Am Educ Res J	450	13,846	30.77	60	2,086	127,688	61.21	166	27	278	1,272	3.5	93.1	9	1964	1964
Educ Psychologist	192	13,680	71.25	66	764	96,337	126.10	155	32	208	394	14.3	99.9	17.1	1963	1985
Educ Psychology	670	11,712	17.48	49	997	22,688	22.76	66	0	29	613	3.6	93.7	6.4	1981	2007
Brit J Educ Psychol	549	10,005	18.22	49	2,780	78,072	28.08	119	9	140	1,318	3.1	76.4	7.7	1931	1931
J Learn Sci	189	5,475	28.97	41	442	36,724	83.09	100	12	88	267	3.8	89.1	12	1991	1994
J Exp Educ	369	5,454	14.78	35	3,074	37,289	12.13	81	3	59	767	2.2	87.9	4.9	1932	1932
J Educ Res	440	5,298	12.04	33	6,079	66,520	10.94	93	2	79	1,420	2.6	74.5	6.2	1920	1920
Cognition Instruct	163	3,122	19.15	30	509	35,847	70.43	98	7	88	321	3.3	58.8	7.6	1976	1988

P10, C10, C/P10 and H10, Publications, citations, cites per paper and h-index between 2014 and 2023; TP, TC, C/P and H, Total publications, citations, cites per paper and h-index available in Scopus; ≥500, ≥100 and ≥10, Number of articles with equal or more than 500, 100 and 10 citations (non-cumulative); IF, Impact Factor (Web of Science); JIF, Journal Impact Factor Percentile; CS, CiteScore (Scopus); Y, Year of origin; YW, Year available in WoS. The numbers provided in the table only consider “Articles,” and “Reviews” up to 31 December 2023.

nology and instructional methodologies. The diversity in the research areas of the citing journals, which includes fields such as Psychology, Computer Science, Social Sciences, and even Environmental Sciences, underscores the interdisciplinary appeal of the research published in Instructional Science. For instance, journals like *Computers in Human Behavior* and *Frontiers in Psychology* highlight the journal's influence beyond traditional educational research, particularly in understanding the psychological aspects of technology use in education.

Moreover, the presence of high-citation journals in specialized fields, such as the *International Journal of Science Education* and *Learning and Instruction* suggests that *Instructional Science* is a key resource for educators and researchers focusing on specific instructional strategies and learning theories. The consistent citations by journals in diverse disciplines, such as Health Care Sciences, Business Economics, and Environmental Sciences, indicate that the journal's research outputs are highly valued across various academic and practical domains.

### Influential papers in *Instructional Science*

Table 6 shows the ranking of the top 50 most cited articles in *Instructional Science*. According to the data provided, it reveals a notable concentration of influential authors and high-impact publications. Among the listed works, several authors stand out for their substantial contributions to the field. Specifically, the list includes authors who have published extensively, with some contributing articles with over 200 citations, indicating a prolific output and sustained engagement in research.

Notably, authors such as D. Royce Sadler and Ference Marton, are featured prominently, each with publications that have garnered significant attention. Sadler's work on formative assessment, for example, has received 1,686 citations, reflecting its foundational impact on instructional design. Similarly, Marton's contributions to phenomenography and educational psychology have been widely recognized, with his 1981 publication receiving 1,547 citations, underscoring his influence in the field.

The data underscores the prominence of these authors within the academic community, as their works are frequently cited, indicating widespread recognition and influence. The substantial citation counts reflect the enduring relevance of their research, as well as the high regard in which these authors are held by their peers. This analysis highlights the critical role that these influential researchers play in advancing the field of Instructional Science, contributing to its development and shaping its future directions.

The Table 7 presents the top 50 most cited documents in *Instructional Science* publications, spanning from 1972 to 2020. The data showcases a diverse range of influential works, including seminal papers and foundational books that have shaped the field over the decades.

Among the most cited documents, the work of Jacob Cohen titled "Statistical Power Analysis for the Behavioral Sciences", published in 1988, stands out as the most referenced, with 66 total citations. This seminal work has been instrumental in the development of statistical methodologies in educational and psychological research. Similarly, John Sweller's 1998 article on cognitive load theory, published in *Educational Psychology Review*, is highly influential, reflecting the enduring relevance of cognitive load theory in instructional design and educational psychology.

**Table 4** Citing articles of *Instructional Science*: authors, universities and countries

R	Author	TP	University	TP	Country	TP
1	Tsai CC	128	Utrecht U	335	USA	6921
2	Paas F	102	Open U Netherlands	297	Germany	1801
3	Renkl A	84	Maastricht U	286	Australia	1757
4	Van Gog T	83	U Hong Kong	278	Netherlands	1669
5	Van Merriënboer JIG	75	Nanyang Technological U	264	UK	1640
6	Kirschner PA	74	U Twente	249	PR China	1582
7	Hwang GJ	71	National Taiwan Normal U	245	Canada	1145
8	De Jong T	69	Purdue U	233	Spain	1054
9	Scheiter K	65	Erasmus U Rotterdam	219	Taiwan	966
10	Mayer RE	61	U Sydney	210	Sweden	911
11	Fischer F	59	Arizona State U	208	Turkey	766
12	Sweller J	59	National Inst Education Singapore	204	Finland	583
13	Chai CS	57	U New South Wales Sydney	200	Israel	441
14	Järvelä S	52	National Taiwan U Sci Tech	199	Belgium	428
15	Rey GD	50	U Helsinki	199	Norway	417
16	Van der Vleuten CPM	50	Indiana U Bloomington	198	South Korea	342
17	Kalyuga S	46	U Gothenburg	193	Singapore	336
18	Van Keer H	45	U Munich	192	New Zealand	331
19	Bräten I	44	U Pittsburgh	192	Switzerland	320
20	Valcke M	44	Eberhard Karls U Tübingen	190	South Africa	309
21	Winne PH	43	U North Carolina	182	Italy	308
22	Schmidt HG	42	Arizona State U Tempe	180	France	297
23	Liang JC	41	U Amsterdam	179	Malaysia	257
24	Mason L	41	U Freiburg	179	Iran	205
25	Schneider S	40	Pennsylvania State U	178	Greece	201
26	Schunn CD	39	Education U Hong Kong	170	Japan	183
27	Elen J	37	U Georgia	167	Chile	173
28	Dolmans DHJM	36	KU Leuven	157	Portugal	172
29	Berthold K	35	U Oslo	155	Indonesia	164
30	Gasevic D	35	U Gothe	151	Brazil	146

R, Rank; TP, Total publications.

The list also highlights the prominence of classic works, such as Lev S. Vygotsky's "Mind in Society: The Development of Higher Psychological Processes", and Allen Newell and Herbert A. Simon's "Human Problem Solving", which have been foundational in understanding cognitive processes and educational strategies. These books continue to be cited frequently, underlining their long-lasting impact on the field.

Notably, multiple entries from key authors such as Michelene T.H. Chi, Fred GWC Paas, and Slava Kalyuga demonstrate their significant contributions to cognitive science and educational research. Chi's research, including the 1981 and 1989 papers published in *Cognitive Science*, provides crucial insights into learning processes and instructional strategies, influencing both theoretical and practical applications in education.

Overall, the data underscores the broad impact of these top-cited documents, which include 12 books and numerous journal articles across various disciplines. This diverse collection of foundational works and articles highlights the interdisciplinary nature of *Instructional Science* and its influence across multiple fields, including psychology, cognitive

**Table 5** Citing articles of *Instructional Science*: journals and research areas

R	Journal	TP	Research area	TP
1	Instructional Science	645	Education educational research	15,100
2	Computers Education	636	Psychology	5552
3	ETR&D Educational Technology Res Develop	386	Computer science	1603
4	Computers in Human Behavior	376	Engineering	778
5	Frontiers in Psychology	335	Linguistics	680
6	Int J Science Education	333	Business economics	662
7	Learning and Instruction	312	Health care sciences services	442
8	J Computer Assisted Learning	256	Social sciences other topics	419
9	Educational Psychology Review	250	information science library science	386
10	J Educational Psychology	248	Science technology other topics	383
11	British J Educational Technology	232	Nursing	301
12	Frontiers in Education	219	Environmental sciences ecology	294
13	Teaching and Teacher Education	217	Rehabilitation	231
14	J Research in Science Teaching	207	Communication	209
15	Science Education	203	Chemistry	187
16	Assessment Evaluation in Higher Education	202	Public environ occupational health	186
17	Education and Information Technologies	165	General internal medicine	132
18	Interactive Learning Environments	165	Neurosciences neurology	115
19	Contemporary Educational Psychology	164	Physics	93
20	Education Sciences	163	Mathematics	76
21	Educational Technology Society	157	Sociology	69
22	J Educational Computing Research	157	Life Sci biomedicine other topics	68
23	Higher Education	143	Sport sciences	65
24	Research in Science Education	139	Dentistry oral surgery medicine	64
25	Studies in Higher Education	137	History philosophy of science	64
26	Chemistry Education Research and Practice	134	Telecommunications	64
27	Learning and Individual Differences	133	Psychiatry	61
28	Sustainability	133	Pharmacology pharmacy	60
29	J Science Education and Technology	132	Medical informatics	58
30	Int J Computer Supported Collaborative Learning	122	Music	56

R, Rank; TP, Total publications.

science, and educational research. The inclusion of multiple entries from prominent authors further emphasizes their ongoing influence and the critical role of their research in shaping the discourse in educational sciences.

### Leading authors, institutions and countries

Table 8 describes the top 40 leading authors in *Instructional Science*, ranking them based on total publications (TP) and resolving ties by total citations (TC). The analysis highlights significant contributions from key researchers in the field, emphasizing both productivity and citation impact.

Jeroen Van Merriënboer (Maastricht University) and Alexander Renkl (University of Freiburg) emerge as the most productive authors with 18 and 17 publications, respectively. This high citation count places him among the top influencers in the field, reflected in his *h*-index of 11, which indicates a broad and sustained impact of his work. Similarly, Henk G.

**Table 6** The 50 most cited documents of *Instructional Science*

R	TC	Title	Author/s	Year	C/Y
1	1686	Formative assessment and the design of instructional systems	Sadler, DR	1989	46.83
2	1547	Phenomenography—describing conceptions of the world around us	Marton, F	1981	35.16
3	612	Promoting general metacognitive awareness	Schraw, G	1998	22.67
4	519	Cognitive load theory, educational research, and instructional design: some food for thought	de Jong, Ton	2010	34.6
5	516	Cognitive load theory: Instructional implications of the interaction between information structures and cognitive architecture	Paas, F; Renkl, A; Sweller, J	2004	24.57
6	438	Content analysis of online discussion in an applied educational psychology course	Hara, N; Bonk, CJ; Angeli, C	2000	17.52
7	321	Lecturers' approaches to teaching and their relationship to conceptions of good teaching	Kember, D; Kwan, KP	2000	12.84
8	319	Concept maps and VEE diagrams—2 metacognitive tools to facilitate meaningful learning	Novak, JD	1990	9.11
9	300	Decreasing cognitive load for novice students: Effects of explanatory versus corrective feedback in discovery-based multimedia	Moreno, R	2004	14.29
10	292	Exploring teachers' perceived self-efficacy and technological pedagogical content knowledge with respect to educational use of the World Wide Web	Lee, Min-Hsien; Tsai, Chin-Chung	2010	19.47
11	281	Contextual differences in student motivation and self-regulated learning in mathematics, English, and social studies classrooms	Wolters, CA; Pintrich, PR	1998	10.41
12	275	The expert learner: Strategic, self-regulated, and reflective	Ertmer, PA; Newby, TJ	1996	9.48
13	268	The nature of feedback: how different types of peer feedback affect writing performance	Nelson, Melissa M.; Schunn, Christian D	2009	16.75
14	258	Epistemic and social scripts in computer-supported collaborative learning	Weinberger, A; Ertl, B; Fischer, F; Mandl, H	2005	12.9
15	255	Cognitive, metacognitive, and motivational aspects of problem solving	Mayer, RE	1998	9.44
16	230	The foundations and assumptions of technology-enhanced student-centered learning environments	Hannafin, MJ; Land, SM	1997	8.21
17	230	Immersive training systems: Virtual reality and education and training	Psozka, J	1995	7.67
18	226	Alternative frameworks, conceptual conflict and accommodation—Toward a principled teaching strategy	Nussbaum, J; Novick, S	1982	5.26
19	222	Instructional design consequences of an analogy between evolution by natural selection and human cognitive architecture	Sweller, J	2004	10.57
20	213	The role of conceptual conflict in conceptual change and the design of science instruction	Hewson, PW; Hewson, MGA	1984	5.2
21	212	Tutor learning: the role of explaining and responding to questions	Roscoe, Rod D.; Chi, Michelene T. H	2008	12.47
22	199	Overcoming misconceptions via analogical reasoning—Abstract transfer versus explanatory model construction	Brown, DE; Clement, J	1989	5.53
23	197	The shuffling of mathematics problems improves learning	Rohrer, Doug; Taylor, Kelli	2007	10.94

**Table 6** (continued)

R	TC	Title	Author/s	Year	C/Y
24	191	Interaction and cognitive engagement: An analysis of four asynchronous online discussions	Zhu, Erping	2006	10.05
25	182	Team learning: building shared mental models	Van den Bossche, Piet; Gijsselaers, Wim; Segers, Mien; Woltjer, Geert; Kirschner, Paul	2011	13
26	170	Students' perceptions about peer assessment for writing: their origin and impact on revision work	Kaufman, Julia H.; Schunn, Christian D	2011	12.14
27	161	Adaptive human scaffolding facilitates adolescents' self-regulated learning with hypermedia	Azevedo, R; Cromley, JG; Winters, FI; Moos, DC; Greene, JA	2005	8.05
28	156	Peer reviewers learn from giving comments	Cho, Young Hoan; Cho, Kwangsu	2011	11.14
29	148	Assisting self-explanation prompts are more effective than open prompts when learning with multiple representations	Berthold, Kirsten; Eysink, Tessa H. S.; Renkl, Alexander	2009	9.25
30	146	Multimedia learning environments: Issues of learner control and navigation	Lawless, KA; Brown, SW	1997	5.21
31	141	Support, belonging, motivation, and engagement in the college classroom: a mixed method study	Zumbrunn, Sharon; McKim, Courtney; Buhs, Eric; Hawley, Leslie R	2014	12.82
32	140	Productive failure in mathematical problem solving	Kapur, Manu	2010	9.33
33	139	The impact of scaffolding and student achievement levels in a problem-based learning environment	Simons, Krista D.; Klein, James D	2007	7.72
34	139	Beyond lesson study: Comparing two ways of facilitating the grasp of some economic concepts	Pang, MF; Marton, F	2003	6.32
35	133	Reflection: Issues related to improving professors' teaching and students' learning	McAlpine, L; Weston, C	2000	5.32
36	131	Supporting self-regulated hypermedia learning through prompts	Bannert, Maria; Reimann, Peter	2012	10.08
37	131	Designing instructional examples to reduce intrinsic cognitive load: Molar versus modular presentation of solution procedures	Gerjets, P; Scheiter, K; Catrambone, R	2004	6.24
38	130	Teacher vision: expert and novice teachers' perception of problematic classroom management scenes	Wolff, Charlotte E.; Jarodzka, Halszka; van den Bogert, Niek; Boshuizen, Henny P. A	2016	14.44
39	130	Using web-based pedagogical tools as scaffolds for self-regulated learning	Dabbagh, N; Kitsantas, A	2005	6.5
40	130	Metacognition, abilities, and developing expertise: What makes an expert student?	Sternberg, RJ	1998	4.81
41	129	Relations between teachers' emotions in teaching and their approaches to teaching in higher education	Trigwell, Keith	2012	9.92
42	129	Assessment of cognitive load in multimedia learning with dual-task methodology: auditory load and modality effects	Brünken, R; Plass, JL; Leutner, D	2004	6.14
43	128	Intelligence and experience—neo-piagetian approach	Pascualleone, J; Goodman, D	1979	2.78
44	126	Online peer assessment: effects of cognitive and affective feedback	Lu, Jingyan; Law, Nancy	2012	9.69

**Table 6** (continued)

R	TC	Title	Author/s	Year	C/Y
45	125	How fading worked solution steps works—A cognitive load perspective	Renkl, A; Atkinson, RK; Grosse, CS	2004	5.95
46	123	20 years of research on advance organizers—assimilation theory is still the best predictor of results	Mayer, RE	1979	2.67
47	122	Collaborative design as a form of professional development	Voogt, Joke; Laferriere, Therese; Breuleux, Alain; Itow, Rebecca C.; Hickey, Daniel T.; McKenney, Susan	2015	12.2
48	121	Productive failure in learning the concept of variance	Kapur, Manu	2012	9.31
49	120	Scaffolding peer-questioning strategies to facilitate metacognition during online small group discussion	Choi, I; Land, SM; Turgeon, AJ	2005	6
50	119	Process-oriented worked examples: Improving transfer performance through enhanced understanding	van Gog, T; Paas, F; van Merriënboer, JIG	2004	5.67

R, Rank; TC, Total citations; C/Y, Cites per year.

Schmidt and Fred GWC Paas, both affiliated with Erasmus University Rotterdam, also rank highly in productivity and citations, with 14 and 13 publications, each. Paas stands out with an impressive 79.62 citations per paper, underscoring the significant impact of his contributions to cognitive load theory and instructional design.

John Sweller from the University of New South Wales Sydney, although having published only 9 papers, achieves a remarkable 940 citations, resulting in a leading citations per paper ratio of 104.44 among the top 10 most productive authors. This metric highlights the depth of his influence, particularly in cognitive load research. Notably, this high citation per paper ratio place Sweller as a critical thought leader in the field despite having fewer publications compared to others.

Authors such as Tamara Van Gog from Utrecht University and Christian D. Schunn from the University of Pittsburgh also demonstrate significant impact, with C/P ratios of 35.42 and 54, respectively. Their work has contributed to advancing educational psychology and instructional methods, reflected in their high citation counts and *h*-index values. The analysis also reveals a diverse international representation among the leading authors, with contributions from researchers based in Germany (8), the Netherlands (8), and the USA (9). This global participation underscores the widespread interest and research activity in Instructional Science, highlighting the field's international relevance and collaborative nature.

Table 9 presents the results of the temporal evolution of the most productive authors. The temporal analysis reveals that in each period, different authors have emerged as leaders in their respective fields.

During the period from 1972 to 1983, Bhaskar led with 5 publications, followed by Dillard, Mayer, Omark, and Suppes, each with 4 publications. This period shows a diverse range of authors with contributions mainly ranging from 2 to 5 publications. In the next decade, from 1984 to 1993, Brna emerged as the most productive author with 7 publications. The period also saw significant contributions from Duboulay, Hativa, Samuel, and Yazdani, each with 4 publications. This shift highlights a change in leading figures, with some previous leaders not appearing in the top ranks.

**Table 7** Top 50 most cited documents in *Instructional Science* publications

Rank	Year	First author	Reference	Vol	Page	Type	TC
1	1988	Cohen J	Stat Power Anal Beha			B	66
2	1998	Sweller J	Educ Psychol Rev	v10	p251	A	66
3	2006	Kirschner PA	Educ Psychol	v41	p75	A	58
4	1978	Vygotsky LS	Mind Society Devel High Psych Proc			B	54
5	1972	Newell A	Human Problem Solving			B	47
6	1989	Brown JS	Educational Researcher	v18	p32	A	46
7	1992	Paas FGWC	J Educ Psychol	v84	p429	A	45
8	1994	Chi MTH	Cognitive Sci	v18	p439	A	39
9	1989	Chi MTH	Cognitive Sci	v13	p145	A	37
10	1981	Chi MTH	Cognitive Sci	v5	p121	A	36
11	2003	Kalyuga S	Educ Psychol	v38	p23	A	36
12	1988	Sweller J	Cognitive Sci	v12	p257	A	35
13	1976	Wood D	J Child Psychol Psych	v17	p89	A	34
14	1998	Schwartz DL	Cognition Instruct	v16	p475	A	33
15	2004	Schwartz DL	Cognition Instruct	v22	p129	A	30
16	1983	Gick ML	Cognitive Psychol	v15	p1	A	29
17	2003	Paas F	Educ Psychol	v38	p63	A	29
18	1989	Resnick LB	Knowing Learning Instruction			B	28
19	1983	Van Dijk T	Strateg Discourse Comprehension			B	28
20	2003	Paas F	Educ Psychol	v38	p1	A	27
21	2011	Schwartz DL	J Educ Psychol	v103	p759	A	27
22	1979	Flavell JH	Am Psychol	v34	p906	A	26
23	1997	Marton F	Learning And Awareness			B	26
24	1998	De Jong T	Rev Educ Res	v68	p179	A	25
25	2007	Kalyuga S	Educ Psychol Rev	v19	p509	A	25
26	2012	Kapur M	J Learn Sci	v21	p45	A	25
27	1987	Larkin JH	Cognitive Sci	v11	p65	A	25
28	1956	Miller GA	Psychol Rev	v63	p81	A	25
29	1983	Reigeluth CM	Instructional Design			B	24
30	1968	Ausubel DP	Educational Psych Cognitive View			B	24
31	1992	Brown AL	J Learn Sci	v2	p141	A	24
32	1985	Gagne RM	Conditions Learning Theory Instr			B	24
33	1976	Marton F	Brit J Educ Psychol	v46	p4	A	24
34	1994	Paas FGWC	J Educ Psychol	v86	p122	A	24
35	2020	Mayer RE	Multimedia Learning			B	23
36	1996	Anderson	Architecture Cogniti			B	23
37	2007	Hmelo-Silver CE	Educ Psychol	v42	p99	A	23
38	2008	Kapur M	Cognition Instruct	v26	p379	A	23
39	1998	Kintsch W	Comprehension Paradi			B	23
40	1986	Paivio A	Mental Representat Dual Cod Ap			B	23
41	2006	Ainsworth S	Learn Instr	v16	p183	A	22
42	1981	Marton F	Instr Sci	v10	p177	A	22
43	2003	Barron B	J Learn Sci	v12	p307	A	21
44	1994	Cohen EG	Rev Educ Res	v64	p1	A	21
45	2004	Hmelo-Silver CE	Educ Psychol Rev	v16	p235	A	21
46	1991	Lave J	Situated Learning Le			B	21
47	1987	Schon D	Ed Reflective Practi			B	21
48	1985	Sweller J	Cognition Instruct	v2	p59	A	21

**Table 7** (continued)

Rank	Year	First author	Reference	Vol	Page	Type	TC
49	1994	Sweller J	Learn Instr	v4	p295	A	21
50	2000	Atkinson RK	Rev Educ Res	v70	p181	A	20

A, Article; B, Book; TC, Total citations.

The period from 1994 to 2003 was marked by the dominance of Schmidt, who published 5 papers. Other notable contributors included De Jong, Dijkstra, Hannafin, and Mason, each with 3 publications. This period indicates a consolidation of leading authors, with fewer new names emerging at the top.

From 2004 to 2013, Renkl, Schmidt, and Van Merriënboer led with 8 publications each. This period also featured significant contributions from Paas, Tsai, Gerjets, and others, each publishing between 4 and 6 papers. The presence of multiple authors with high publication counts suggests an intensification of research activity. In the most recent period, 2014 to 2023, Van Gog stood out with 9 publications. Renkl continued to be a leading author, maintaining a high output with 8 publications. Other notable contributors include Rummel, Paas, Schunn, Van Merriënboer, and Wittwer, each with between 5 and 7 publications. This period reflects a dynamic and competitive field, with many authors contributing extensively.

Overall, the analysis indicates that while some authors, like Renkl, Schmidt, and Van Merriënboer, have been among the most productive during several periods, others have emerged or re-emerged over time. The changing ranks and presence of new authors in each period underscore the evolving nature of research contributions in this field.

Table 10 shows the 40 most productive and influential institutions in *Instructional Science*. Like the author analysis, the institutions are ranked according to the number of publications (TP), while in case of a tie, the total number of citations (TC) is considered.

The Open University of Netherlands and the University of Twente are the most productive institutions in *Instructional Science*, followed by Maastricht University and the University of Freiburg. It is worth noting that the first three universities are from the Netherlands, while the fourth is from Germany. In terms of ‘citations per paper’ (C/P), the University of Gothenburg (Sweden) shows the best performance with a remarkable 117.77 citations per paper. Several institutions stand out for their high citation impact on individual publications. For example, the Open University Netherlands and the University of Pittsburgh (USA) each have multiple publications with 100 or more citations. Maastricht University, the University of Pittsburgh, and the University of Gothenburg also have notable performances with a substantial number of high-impact publications.

The ranking reflects the global distribution of leading institutions in *Instructional Science*, with significant representation from the Netherlands, the USA, and Germany. Currently, there are 14 universities from the USA in the top 40, seven from the Netherlands, and three from Germany and Israel. This indicates a diverse and international engagement in the academic field.

To further investigate the evolution of the most productive institutions over time, we analyze the top institutions in four distinct periods: 1972–1983, 1984–1993, 1994–2003, 2004–2013, and 2014–2023. Table 11 shows the results. In the first period between 1972 and 1983, the Open University UK was the most productive institution with 12 publications, followed by the University of Illinois Urbana-Champaign and Stanford University, each

**Table 8** Top 50 leading authors in *Instructional Science*

R	Author name	University	Country	TP	TC	H	C/P	≥100	≥10	T50
1	Van Merriënboer JJG	Maastricht U	Netherlands	18	756	15	42	2	16	1
2	Renkl A	U Freiburg	Germany	17	1273	11	74.88	4	8	3
3	Schmidt HG	Erasmus U Rotterdam	Netherlands	14	472	13	31.47	0	13	0
4	Paas F	Erasmus U Rotterdam	Netherlands	13	1035	10	79.62	3	7	2
5	Van Gog T	Utrecht U	Netherlands	12	425	10	35.42	2	8	2
6	Sweller J	U New South Wales	Australia	9	940	8	104.44	2	6	2
7	Schunn CD	U Pittsburgh	USA	9	486	7	54	1	5	2
8	Mason L	U Padua	Italy	9	464	8	51.56	2	6	0
9	Kapur M	Swiss Fed Inst Tech	Switzerland	9	444	6	49.33	3	2	2
10	Scheiter K	U Potsdam	Germany	9	327	6	36.33	2	3	1
11	Kirschner PA	Open U Netherlands	Netherlands	9	250	7	27.78	0	7	1
12	Rummel N	Ruhr U Bochum	Germany	9	228	8	25.33	0	6	0
13	Brna P	U Leeds	UK	9	97	6	10.78	0	5	0
14	Boshuizen HPA	U Turku	Finland	8	388	7	48.5	1	6	1
15	Kiewra KA	U Nebraska Lincoln	USA	8	286	7	35.75	0	6	0
16	De Jong T	U Twente	Netherlands	7	692	5	98.86	1	3	1
17	Tsai CC	Nat Taiwan Normal U	Taiwan	7	579	7	82.71	2	5	1
18	Mayer RE	UC Santa Barbara	USA	7	540	7	77.14	2	4	2
19	Fischer F	U Munich	Germany	7	444	5	63.43	1	4	1
20	Hannafin MJ	U Georgia	USA	7	369	7	52.71	1	6	1
21	Berthold K	U Bielefeld	Germany	7	283	7	40.43	1	6	1
22	Wittwer J	U Freiburg	Germany	7	49	4	7	0	2	0
23	Pang MF	U Hong Kong	China	6	410	6	68.33	1	5	1
24	Jarodzka H	Open U Netherlands	Netherlands	6	342	6	57	2	3	1
25	Reigeluth CM	Indiana U Bloomington	USA	6	242	6	40.33	0	5	0
26	Nückles M	U Freiburg	Germany	6	176	5	29.33	0	4	0
27	Kalyuga S	Loughborough U	UK	6	142	4	23.67	0	4	0
28	Merrill MD	Wesleyan U	USA	6	130	6	21.67	0	4	0
29	Niaz M	U Oriente Cumana	Venezuela	6	130	5	21.7	0	5	0
30	Hativa N	Tel Aviv U	Israel	6	58	4	9.67	0	1	0
31	Suppes P	Stanford U	USA	6	29	4	4.83	0	1	0
32	Marton F	U Gothenburg	Sweden	5	1853	5	370.6	2	3	2
33	Trigwell K	U Sydney	Australia	5	331	5	66.2	1	4	1
34	Azevedo R	U Central Florida	USA	5	307	5	61.4	1	4	1
35	Gerjets P	Leibniz Inst Wissens	Germany	5	298	5	59.6	2	2	1
36	McKenney S	U Twente	Netherlands	5	289	4	57.8	1	2	1
37	Lindblom-Ylänne S	U Helsinki	Finland	5	203	5	40.6	0	5	0
38	Kali Y	U Haifa	Israel	5	193	4	38.6	0	3	0
39	Bråten I	U Oslo	Norway	5	154	3	30.8	0	2	0
40	Watkins D	Denver CEC	USA	5	148	5	29.6	0	4	0

R, Rank; TP, Total number of publications; TC, Total citations; H, h-index; C/P, Cites per paper; ≥100 and ≥10, Number of articles in the journal with more than 100 and 10 citations; T50, Number of documents in the Top 50 of Table 6.

**Table 9** Temporal evolution of the most productive authors

R	Author	TP	R	Author	TP
<i>1972–1983</i>			<i>2004–2013</i>		
1	Bhaskar R	5	1	Renkl A	8
2	Dillard JF	4	2	Schmidt HG	8
3	Mayer RE	4	3	Van Merriënboer JGG	8
4	Omark DR	4	4	Paas F	6
5	Suppes P	4	5	Tsai CC	6
6	Merrill MD	3	6	Gerjets P	5
7	Reigeluth CM	3	7	Mason L	5
8	Stephens RG	3	8	Pang MF	5
9	White RT	3	9	Scheiter K	5
10	25 authors	2	10	Boshuizen HPA	4
<i>1984–1993</i>			<i>2014–2023</i>		
1	Brna P	7	11	Dochy F	4
2	Duboulay B	4	12	Kapur M	4
3	Hativa N	4	13	Kirschner PA	4
4	Samuel AE	4	14	Lindblom-Ylänne S	4
5	Yazdani M	4	15	3 authors	4
6	Boreham NC	3	1	Van Gog T	9
7	Brayshaw M	3	2	Renkl A	8
8	Bundy A	3	3	Rummel N	7
9	Eisenstadt M	3	4	Paas F	6
10	3 authors	3	5	Schunn CD	6
<i>1994–2003</i>			<i>2014–2023</i>		
1	Schmidt HG	5	6	Van Merriënboer JGG	6
2	De Jong T	3	7	Wittwer J	6
3	Dijkstra S	3	8	Ben-Zvi D	5
4	Hannafin MJ	3	9	Berthold K	5
5	Mason L	3	10	Fischer F	5
6	Mcalpine L	3	11	Jarodzka H	5
7	Niaz M	3	12	Kali Y	5
8	Treagust DF	3	13	Kapur M	5
9	Weston C	3	14	McKenney S	5
10	Young MF	3	15	Eitel A	4
			16	6 authors	4

R, Rank; TP, Total number of publications.

with 9 publications. This period marked the early contributions of these institutions to the field of *Instructional Science*.

From 1984 to 1993, the Open University UK continued to lead with 13 publications. Tel Aviv University and the University of Edinburgh both emerged as significant contributors, each with 7 publications. This decade saw a more diverse set of institutions entering the top ranks. In the decade from 1994 to 2003, Maastricht University took the lead with 10 publications, followed by the University of Twente with 9 publications. This period highlights the rise of these institutions in the field, with the University of Connecticut and Hasselt University also making notable contributions.

The period from 2004 to 2013 saw the Open University Netherlands becoming the most productive institution with 19 publications. The University of Hong Kong and Nanyang

**Table 10** The most productive and influential institutions in *Instructional Science*

R	Institution	Country	TP	TC	H	C/P	≥100	≥10	T50	QS	ARWU
1	Open U Netherlands	Netherlands	37	2195	21	59.32	6	24	4	-	-
2	U Twente	Netherlands	37	1614	18	43.62	3	19	2	210	401–500
3	Maastricht U	Netherlands	33	1266	20	38.36	2	24	0	256	201–300
4	U Freiburg	Germany	33	1191	17	36.09	3	19	2	212	101–150
5	Utrecht U	Netherlands	30	684	15	22.8	0	24	0	112	52
6	U Pittsburgh	USA	29	1725	16	59.48	5	12	4	181	83
7	U Hong Kong	China	27	1064	17	39.40	2	19	3	21	88
8	Open U UK	UK	27	182	8	6.74	0	6	0	-	-
9	Erasmus U Rotterdam	Netherlands	23	641	14	27.86	2	14	0	208	88
10	Indiana U Bloomington	USA	22	758	10	34.45	1	9	2	355	151–200
11	U Amsterdam	Netherlands	22	668	12	30.36	2	13	1	58	101–150
12	McGill U	Canada	20	665	12	33.25	3	1	2	31	70
13	U Haifa	Israel	19	436	11	22.94	0	11	0	701–705	601–700
14	U Gothenburg	Sweden	18	2120	14	117.77	2	12	2	185	101–150
15	Nanyang Technological U	Singapore	18	1097	15	60.94	5	11	2	19	93
16	U New South Wales	Australia	17	1080	11	63.52	2	9	0	45	72
17	Eberhard Karls U Tubingen	Germany	16	751	10	46.93	3	8	1	169	222
18	Leibniz Inst Wissensmedien	Germany	16	706	10	44.12	3	7	0	-	-
19	National Inst Educ	Singapore	15	1055	14	70.33	5	10	0	-	-
20	U Georgia	USA	15	724	10	48.26	2	10	3	601–650	301–400
21	U Helsinki	Finland	15	486	12	32.4	0	12	0	106	101–150
22	U California Berkeley	USA	15	218	8	14.53	0	17	1	27	5
23	U Illinois Urbana Champaign	USA	15	137	6	9.13	0	4	0	85	52
24	U Sydney	Australia	14	681	12	48.64	2	10	0	41	73
25	U California Santa Barbara	USA	13	552	7	42.46	2	4	0	149	63
26	National Taiwan Normal U	Taiwan	13	463	7	35.61	1	5	1	332	201–300
27	U Turku	Finland	13	343	9	26.38	1	8	1	291	301–400
28	Pennsylvania State U	USA	13	333	9	25.92	1	8	0	93	101–150
29	Tel Aviv U	Israel	13	163	6	12.53	0	4	0	260	201–300
30	Florida State U	USA	12	331	8	27.58	0	6	0	511–522	201–300
31	Carnegie Mellon U	USA	12	294	8	24.5	0	8	0	52	101–150
32	U Edinburgh	UK	12	204	7	17	0	6	0	15	38
33	Technion Israel Inst Tech	Israel	12	180	7	15	0	7	0	408	79
34	Stanford U	USA	12	85	6	7.08	0	4	0	3	2

**Table 10** (continued)

R	Institution	Country	TP	TC	H	C/P	≥100	≥10	T50	QS	ARWU
35	Arizona State U	USA	11	504	8	45.81	2	5	2	219	101–150
36	Utah State U	USA	11	471	8	42.81	1	7	0	1001–1200	401–500
37	Pennsylvania State U—U Park	USA	11	310	8	28.18	1	7	0	93	101–150
38	Radboud U Nijmegen	Netherlands	11	229	8	29.9	0	7	0	232	101–150
39	KU Leuven	Belgium	11	216	7	19.63	0	7	0	63	78
40	U Wisconsin Madison*	USA	11	211	7	19.18	0	7	0	83	35

ARWU, Academic Ranking of World Universities; QS, Quacquarelli & Symonds University Ranking.

Technological University followed closely with 15 and 14 publications, respectively. This period also saw increased contributions from institutions in Asia and Europe, reflecting the global spread of research in *Instructional Science*.

In the most recent period from 2014 to 2023, the University of Freiburg emerged as the most productive institution with 20 publications. The Open University Netherlands continued its strong performance with 16 publications, while the University of Haifa and Utrecht University also made significant contributions with 15 and 14 publications, respectively. This period demonstrates a continued diversification of leading institutions, with a strong presence from European universities. Overall, the analysis reveals a dynamic and evolving landscape of productive institutions in *Instructional Science*, with shifts in leadership and the emergence of new key players over the decades. The data highlights the ongoing contributions of established institutions and the rise of new leaders in the field.

Table 12 presents the most productive and influential countries in *Instructional Science*. The USA leads with 467 publications and is followed by the Netherlands with 166 publications and the UK with 130 publications. Germany and Australia also perform remarkably well, obtaining the fourth and fifth positions, respectively. The USA not only tops the list in terms of total publications but also has the highest number of citations 13,756 and the highest *h*-index 58. The Netherlands, despite its smaller population, shows an impressive performance with a high citation rate per paper 35.09 and significant impact per capita metrics, demonstrating its influence in the field.

Sweden, Finland, and Belgium, also stand out, especially considering their population sizes. Sweden ranks ninth overall but has the highest citations per paper 71.52, indicating the high impact of its research. Finland and Belgium follow with strong publications and citations per capita ratios, showcasing their substantial contributions relative to their populations. Israel and Singapore show notable performance with high citation rates per paper and significant contributions to high-impact publications. Israel's influence is highlighted by its cites per capita of 143.98, and Singapore demonstrates a robust research output with a cites per paper of 50.72.

China and Taiwan represent Asia in the top ranks, reflecting their growing contributions to *Instructional Science*. China, with 50 publications and 1,609 citations, and Taiwan, with 25 publications and 834 citations, are becoming more prominent in the field. Other countries like Canada, Switzerland, and New Zealand show strong citation metrics and impact-

**Table 11** Temporal evolution of the most productive institutions

R	Institution	TP	R	Institution	TP
<i>1972–1983</i>			<i>2004–2013</i>		
1	Open U UK	12	1	Open U Netherlands	19
2	U Illinois Urbana Champaign	10	2	U Hong Kong	15
3	Stanford U	9	3	Nanyang Technological U	14
4	U California Santa Barbara	9	4	Maastricht U	13
5	Indiana U Bloomington	5	5	Erasmus U Rotterdam	12
6	Queens U Canada	5	6	National Inst Educ Singapore	12
7	U Pittsburgh	5	7	U Freiburg	12
8	Brigham Young U	4	8	U Gothenburg	10
9	Carnegie Mellon U	4	9	U Sydney	10
10	3 Institutions	4	10	U Twente	9
<i>1984–1993</i>			<i>2014–2023</i>		
1	Open U UK	13	11	Pennsylvania St U–U Park	8
2	Tel Aviv U	7	12	U Helsinki	8
3	U Edinburgh	7	13	Utrecht U	8
4	Lancaster U	6	14	Eberhard Karls U Tubingen	7
5	McGill U	5	15	5 Institutions	7
6	US Department of Defense	5	1	U Freiburg	20
7	U Amsterdam	5	2	Open U Netherlands	16
8	U Sussex	5	3	U Haifa	15
9	U Twente	5	4	Utrecht U	14
10	4 Institutions	4	5	Erasmus U Rotterdam	11
<i>1994–2003</i>			<i>2014–2023</i>		
1	Maastricht U	10	6	U Pittsburgh	11
2	U Twente	9	7	U Twente	11
3	U Connecticut	7	8	Indiana U Bloomington	10
4	Hasselt U	6	9	Maastricht U	10
5	U Amsterdam	6	10	Leibniz Inst Wissensmedien	9
6	McGill U	5	11	National Taiwan Normal U	9
7	U Edinburgh	5	12	Eberhard Karls U Tubingen	8
8	Utrecht U	5	13	Ruhr U Bochum	8
9	Curtin U	4	14	Technical U Munich	8
10	7 Institutions	4	15	2 Institutions	8

Abbreviations are available in the previous tables.

ful research contributions. Canada's 70 publications with 2,128 citations and Switzerland's high cites per paper of 44.47 underline their influential research outputs.

Although countries like Spain, France, and Italy have fewer publications, their impact is still notable, with significant citations per paper. Developing countries such as Turkey and South Africa are in the lower half of the list but are making strides in contributing to the field. The results in Table 12 highlight the diverse global participation in *Instructional Science* research, with a significant presence from European countries. The high impact per capita metrics from smaller countries emphasize their influential contributions, while the leading positions of the USA and the Netherlands underscore their dominant roles in the field.

**Table 12** The most productive and influential countries in *Instructional Science*

R	Country	TP	TC	H	C/P	≥100	≥10	T50	Population	P/Po	C/Po
1	USA	467	13,756	58	29.45	30	208	28	335.8	1.39	40.96
2	Netherlands	166	5825	43	35.09	12	94	6	17.9	9.27	325.42
3	UK	130	1704	23	13.10	1	39	0	66.9	1.94	25.47
4	Germany	124	3988	35	32.16	10	72	6	84.6	1.46	47.13
5	Australia	81	4318	28	53.3	5	45	5	26.1	3.10	165.44
6	Canada	70	2128	27	30.4	6	34	3	40.3	1.74	52.80
7	Israel	67	1411	21	21.05	1	37	1	9.8	6.84	143.98
8	PR China	50	1609	22	32.18	3	24	3	1425	0.04	1.12
9	Sweden	42	3004	23	71.52	4	30	3	10.4	4.04	288.85
10	Finland	34	920	17	27.05	1	24	1	5.5	6.18	167.27
11	Belgium	31	910	15	29.35	2	19	1	11.7	2.65	77.78
12	Singapore	25	1268	20	50.72	5	17	1	5.6	4.46	226.43
13	Taiwan	25	834	14	33.36	2	14	1	23.5	1.06	35.49
14	Switzerland	19	845	10	44.47	1	10	1	9	2.11	93.89
15	Spain	15	173	7	11.53	0	5	0	48.5	0.31	3.57
16	France	15	95	5	6.33	0	3	0	68.5	0.22	1.39
17	Italy	11	470	8	42.72	2	6	0	61	0.18	7.70
18	Norway	11	242	6	22	0	5	0	5.5	2.00	44.00
19	New Zealand	10	285	8	28.5	0	8	0	5.1	1.96	55.88
20	South Korea	9	479	8	53.22	2	6	1	51.7	0.17	9.26
21	Turkey	8	179	5	22.37	0	3	0	85.5	0.09	2.09
22	Japan	8	135	6	16.87	0	4	0	124.3	0.06	1.09
23	Venezuela	6	130	5	21.66	0	5	0	28.8	0.21	4.51
24	Denmark	6	129	3	21.5	1	1	0	5.9	1.02	21.86
25	South Africa	5	273	3	54.6	1	2	1	60.6	0.08	4.50
26	Greece	5	155	4	31	0	3	0	10.4	0.48	14.90
27	Chile	4	84	4	21	0	2	0	19.9	0.20	4.22
-	3 countries	3	-	-	-	-	-	-	-	-	-
-	3 countries	2	-	-	-	-	-	-	-	-	-
-	16 countries	1	-	-	-	-	-	-	-	-	-

Abbreviations are available in the previous tables except for: P/Po and C/Po, Number of papers and citations per million inhabitants.

To see the evolution of countries’ publications over time, Table 13 presents the number of papers published annually in *Instructional Science* by the top 20 countries. The table mainly focuses on the last years for annual analysis, while earlier years are grouped by decades.

The USA has consistently led in the field, with a substantial productivity over the years. From 2004 to 2013, the USA published 93 papers, and this number rose to 127 in the most recent decade 2014–2023. Notably, the USA maintained high annual outputs, peaking at 18 papers in 2018 and 17 papers in 2014 and 2017. This trend indicates the USA’s continued dominance and increasing influence in *Instructional Science*.

The Netherlands has also shown remarkable growth, with 57 publications in the latest decade, up from 49 in the previous decade (2004–2013). The country’s annual output peaked at 12 papers in 2015, demonstrating a strong and consistent research presence. The UK’s contributions were significant in the first decades (1972–2003). However, its annual output has declined in recent years, with only a few papers published since 2014. Germany’s

**Table 13** Annual number of papers classified by countries

R	Country	Total	D1	D2	D3	D4	D5	23	22	21	20	19	18	17	16	15	14
1	USA	467	127	93	60	64	123	13	10	11	10	10	18	17	8	13	17
2	Netherlands	166	57	49	35	16	9	3	3	9	3	4	4	4	7	12	8
3	UK	130	4	12	30	48	36	0	0	0	0	1	1	0	0	0	2
4	Germany	124	74	36	7	3	4	7	9	7	9	7	5	5	7	5	13
5	Australia	81	26	24	13	11	7	3	2	4	1	2	1	3	3	2	5
6	Canada	70	15	15	14	14	12	1	0	0	1	2	3	0	1	4	3
7	Israel	67	29	11	7	13	7	8	2	0	2	1	6	3	0	6	1
8	PR China	50	23	19	5	3	0	5	3	2	4	3	0	1	2	2	1
9	Sweden	42	11	18	7	3	3	0	0	0	0	1	2	3	5	0	0
10	Finland	34	12	17	5	0	0	4	2	1	0	2	1	0	2	0	0
11	Belgium	31	11	14	3	1	2	1	0	2	1	0	1	0	1	3	2
12	Singapore	25	5	17	1	2	0	0	0	0	0	0	0	1	1	0	3
13	Taiwan	25	11	14	0	0	0	0	5	1	1	1	1	0	0	1	1
14	Switzerland	19	11	5	0	2	1	1	1	2	0	1	3	2	0	0	1
15	France	15	2	1	12	0	0	0	0	1	0	1	0	0	0	0	0
16	Spain	15	7	5	2	1	0	0	1	1	1	1	1	0	0	2	0
17	Italy	11	1	5	4	1	0	0	1	0	0	0	0	0	0	0	0
18	Norway	11	5	4	2	0	0	1	1	1	0	1	1	0	0	0	0
19	New Zealand	10	2	6	0	2	0	0	0	0	0	0	0	0	0	0	2
20	South Korea	9	3	6	0	0	0	0	0	0	0	0	0	0	0	2	1

R, Rank; D1, 2014–2023; D2, 2004–2013; D3, 1994–2003; D4, 1984–1993; D5, 1972–1983; 23–14, Annual number of articles between 2014 and 2023.

productivity has surged in recent years, with 74 publications in the latest decade, up from 36 in the previous decade. The country shows steady annual contributions, peaking at 13 papers in 2014 and maintaining consistent output in subsequent years. Australia's research output has steadily increased, with 26 publications in the latest decade, up from 24 in the previous decade.

Canada has shown consistent contributions across decades, with 15 publications in the latest decade. The country's annual productivity peaked at 4 papers in 2015, indicating steady research activity. Israel has shown a strong increase in productivity, with 29 publications in the latest decade. The country's annual output peaked at 8 papers in 2023, highlighting its growing influence in the field. China has also demonstrated significant growth, with 23 publications in the latest decade. The country's annual productivity peaked at 5 papers in 2023, reflecting an increasing research presence.

Overall, the table highlights the USA's dominant and sustained productivity in *Instructional Science*, with notable contributions from European countries and growing outputs from Asian countries. The data reflects evolving research trends and the global distribution of contributions in the field, indicating a positive trajectory of increased annual publications across most countries. To provide an overview of the publication structure of the journal from a supranational perspective, Table 14 offers a detailed breakdown. North America and Europe are the leading regions in terms of total publications and total citations, with 529 and 549 publications, and 15,569 and 15,878 citations, respectively. Both regions have a comparable *h*-index of 65, demonstrating a strong influence in the field.

Asia also shows noteworthy contributions, but still needs to grow more considering the population size. Oceania, although smaller in population, demonstrates high research productivity and impact with 92 publications, a cites per paper of 49.85, and 99.5 citations per million inhabitants, reflecting a strong research presence relative to its size. Latin and South America, and Africa have lower publication outputs, with 16 and 9 publications, respectively. However, Africa exhibits a relatively high cites per paper ratio of 37.44, indicating the potential impact of its limited research contributions. Overall, the journal demonstrates a global reach with diverse representation from multiple regions, although there are noticeable disparities in publication and citation metrics across these regions.

## Mapping *Instructional Science* with VOS viewer software

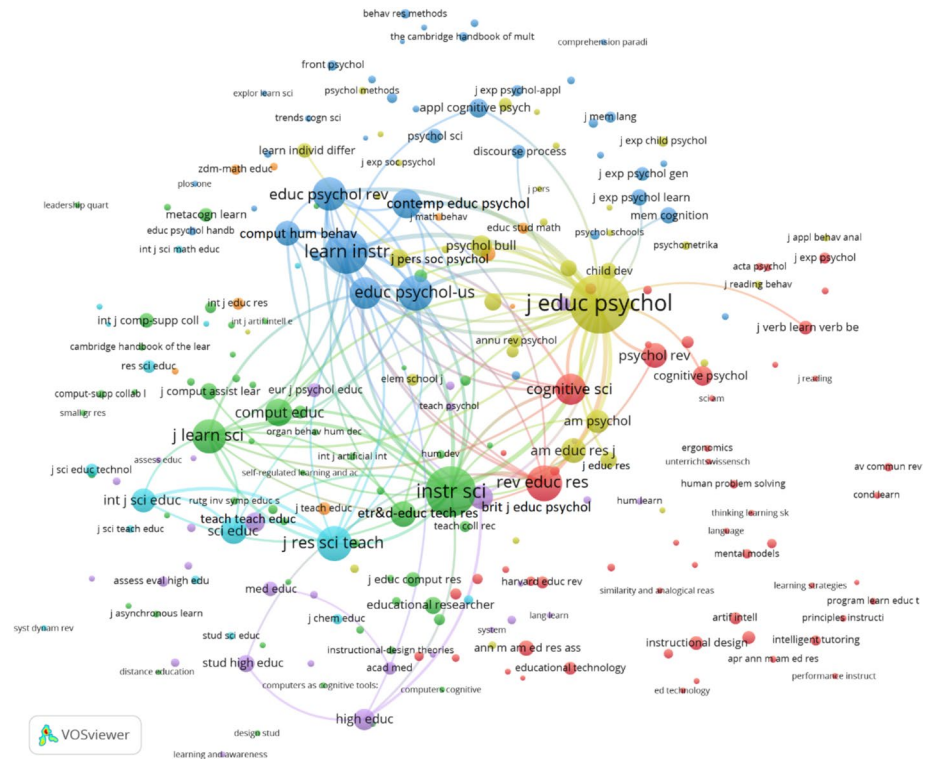
### General overview

The previous section gives an overall summary of the most productive and influential factors within the journal. To provide a more detailed analysis of the publication structure, this section focuses on visualizing the bibliographic connections between the top sources. For this purpose, the study utilizes VOS viewer software (Van Eck & Waltman, 2010), which gathers bibliographic data and creates graphical maps based on bibliographic coupling (Kessler, 1993), citation and co-citation analysis (Small, 1973), co-authorship, and the co-occurrence of author keywords (Gaviria-Marín et al., 2018; Rialp et al., 2019). We begin by examining the co-citation of journals referenced in *Instructional Science*. It is important to remember that co-citation occurs when two documents from different journals are both cited by a third document from another journal (Small, 1973). Figure 4 presents the co-citation

**Table 14** Publication structure classified by supranational regions

R	Region	TP	TC	H	C/P	≥100	≥10	T50	Population	P/Pop	C/Pop
1	Europe	549	15,878	65	28.92	23	287	18	746.4	0.73	21.27
2	North America	529	15,569	65	29.43	35	235	31	381.2	1.38	40.84
3	Asia	168	5164	39	30.73	11	95	6	4561.8	0.03	1.13
4	Oceania	92	4587	30	49.85	5	53	5	46.1	1.99	99.5
5	Latin and South America	16	300	9	18.75	0	9	0	656	0.02	0.45
6	Africa	9	337	6	37.44	1	3	1	1497	0.006	0.22

Abbreviations are available in the previous tables.



**Fig. 4** Co-citation of journals in *Instructional Science*: minimum citation threshold of 20 and 100 links

network of journals in *Instructional Science*, based on a minimum citation threshold of 20 and shows the 100 strongest links. The visualization illustrates the interconnectedness and influence among various journals in the field.

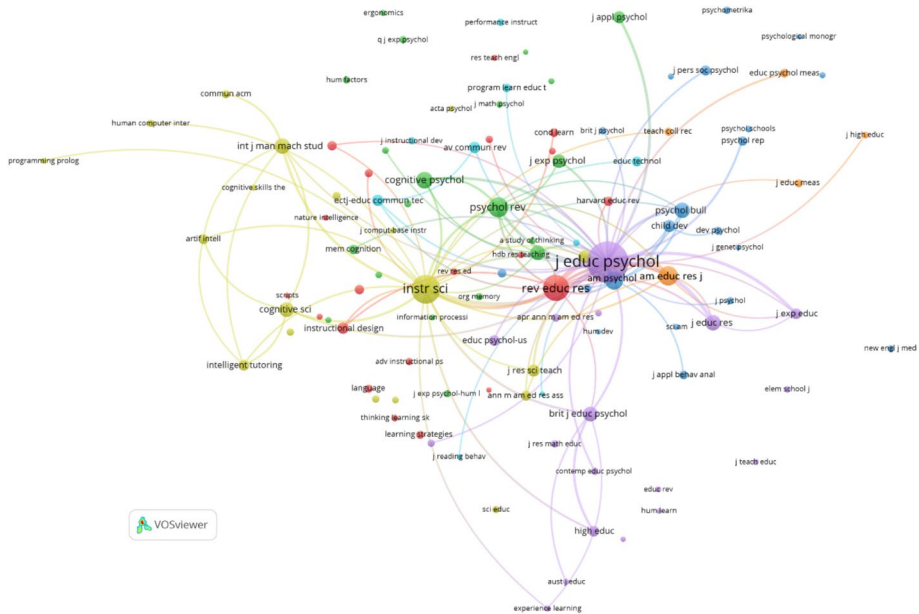
Figure 4 presents the co-citation network of journals in *Instructional Science*, based on a minimum citation threshold of 20 and showing the 100 strongest links. The visualization illustrates the interconnectedness and influence among various journals in the field.

The *Journal of Educational Psychology* is by far the most cited journal, followed by the self-citations of *Instructional Science*, and *Learning and Instruction*. The figure groups the journals into seven clusters. The yellow cluster is central in the figure, and it is formed

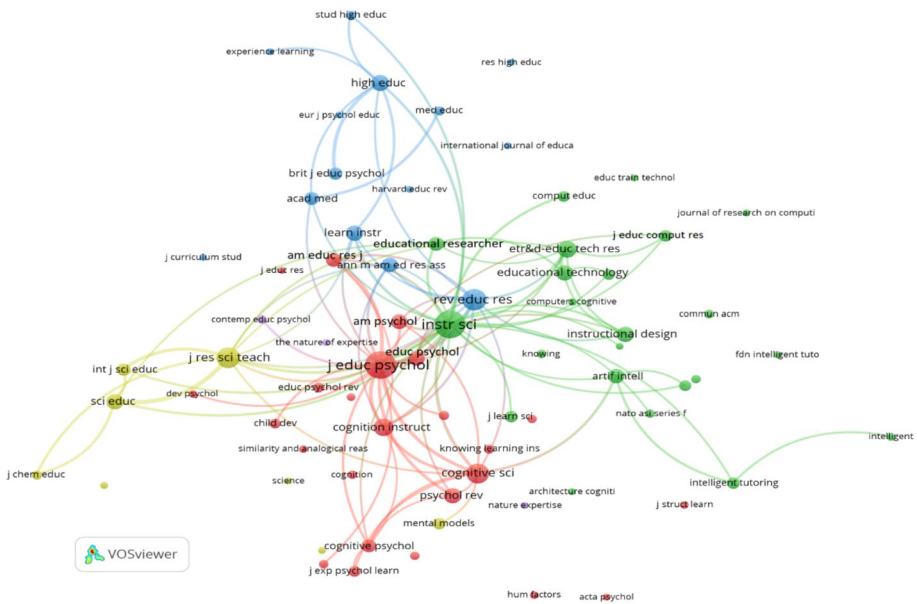
around the *Journal of Educational Psychology*. This cluster includes general journals in psychology like the *American Psychologist* and the *Psychological Bulletin*, and the *American Educational Research Journal*. The red cluster is also very significant and includes journals in the field of educational research, cognition and psychology like the *Review of Educational Research*, *Cognitive Science*, and the *Psychological Review*. The blue cluster is another representative cluster and includes journals like *Learning and Instruction*, *Educational Psychologist*, *Educational Psychology Review*, *Contemporary Educational Psychology*, and *Computers in Human Behavior*.

The green cluster is led by *Instructional Science* together with the *Journal of Learning Sciences* and *Computers & Education*. The light blue and the purple clusters are smaller than the previous four but include some journals significantly cited in the journal. The light blue cluster is mainly formed by science education journals like the *Journal of Research in Science Teaching*, *Science Education*, and the *International Journal of Science Education*. The purple cluster includes the *British Journal of Educational Psychology*, *Higher Education*, *Teacher and Teaching Education*, and *Studies in Higher Education*. The orange cluster is a very small one and includes journals like the *Journal of Teacher Education* and the *International Journal of Educational Research*.

Next, let us investigate the evolution through time with Figs. 5, 6, 7, and 8. Figure 5 presents the co-citation of journals between 1972 and 1993, using a minimum citation threshold of 10 and the 100 most frequent co-citation links. During the initial years, core journals such as *Journal of Educational Psychology*, the *Review of Educational Research*, and *Instructional Science*, were highly co-cited, reflecting their foundational role in the field. Note that the yellow cluster of *Instructional Science* connects with computer science journals like the *International Journal of Man–Machine Studies* and *Artificial Intelligence*. Psychology



**Fig. 5** Co-citation of journals in *Instructional Science*: 1972–1993 (minimum citation threshold of 10 and 100 links)



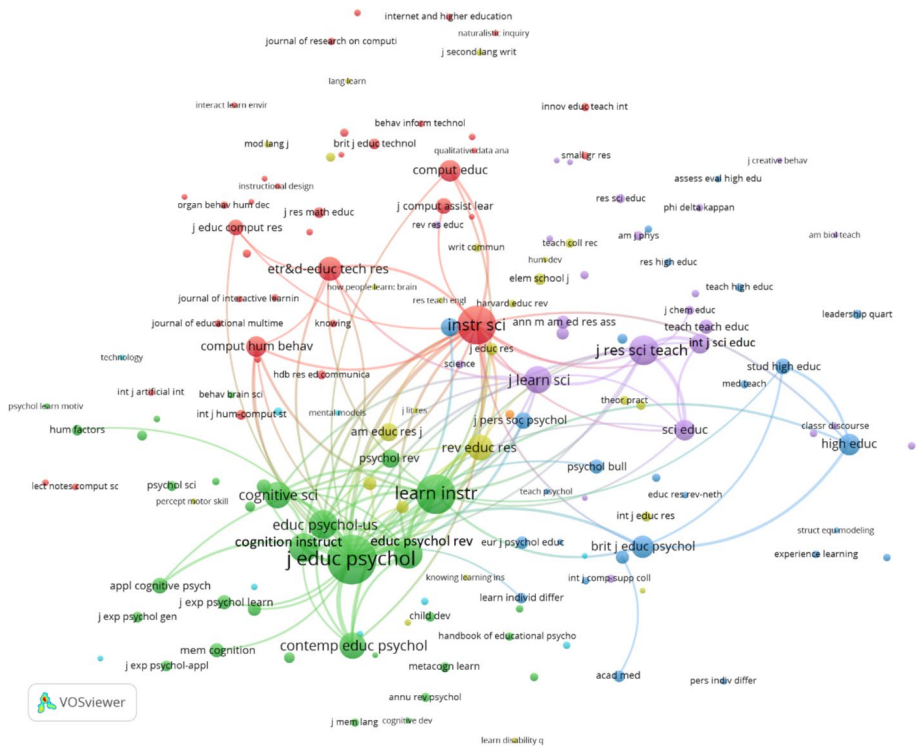
**Fig. 6** Co-citation of journals in *Instructional Science*: 1994–2003 (minimum citation threshold of 5 and 100 links)

journals have a significant influence in this period and appear mostly in the green, purple, and blue clusters.

Figure 6 analyzes the period of 1994 and 2003, where we see mainly four clusters. The red cluster encompasses journals in psychology and cognition. *Instructional Science* is in the green cluster together with other educational research journals and *Artificial Intelligence*. The blue cluster is also around educational journals like the *Review of Educational Research*, *Learning and Instruction*, and *Higher Education*. But it connects with some psychological and medical journals like *Academic Medicine* and *Medical Education*. The yellow cluster is smaller and includes journals in science education like the *Journal of Research in Science Teaching* and *Science Education*.

As the field evolved, other influential journals like *Computers in Human Behavior* and *Computers & Education* gained prominence, demonstrating the expanding scope and interdisciplinary nature of *Instructional Science*. Since the 2000s, there has been a significant increase in the co-citation of journals related to educational technology and learning sciences, such as the *Journal of Learning Sciences* and *ETR&D – Educational Technology Research & Development*. This trend highlights the growing importance of integrating technology into educational research and practice.

In recent years, the network shows strong co-citation links among journals from educational psychology, cognitive science, and instructional methods. Journals like *Cognitive Science* and *American Psychologist* have become increasingly central, indicating a deeper integration of cognitive science principles into educational research. The co-citation network underscores the interdisciplinary nature of *Instructional Science* and the evolving trends in research focus. The strong connections between journals from different fields reflect the collaborative efforts to integrate diverse perspectives and methodologies in advancing edu-

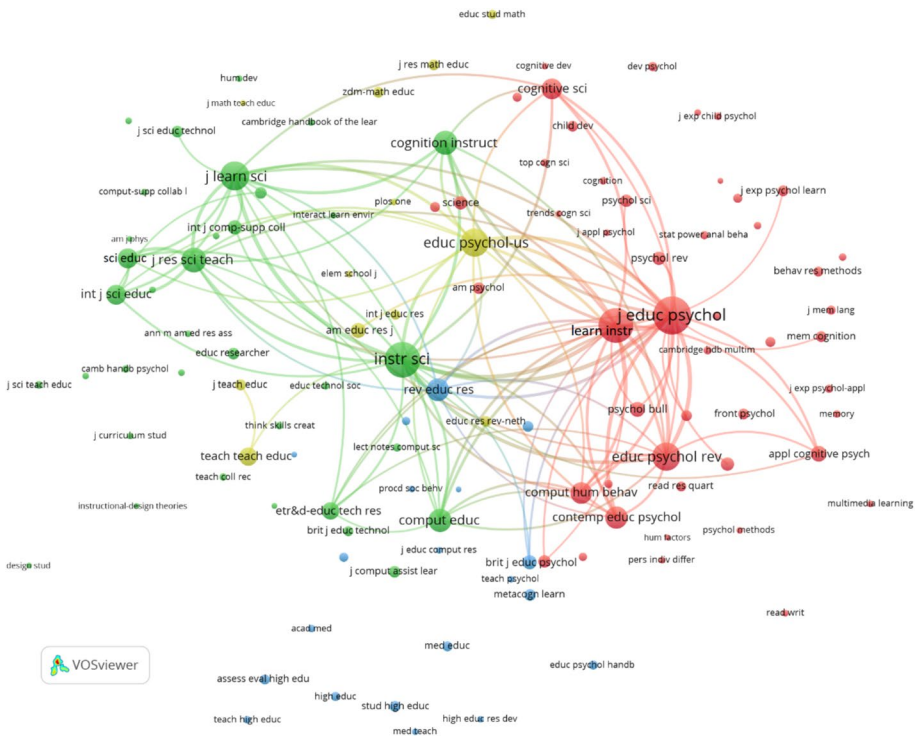


**Fig. 7** Co-citation of journals in *Instructional Science*: 2004–2013 (minimum citation threshold of 10 and 100 links)

cational research. The visualization indicates a robust and dynamic research landscape, with emerging journals and areas of study continuously contributing to the field's growth.

Figure 7 presents the co-citation of journals between 2004 and 2013 with a minimum citation threshold of 10 and the 100 strongest co-citation links. The *Journal of Educational Psychology* continues to be the most cited journal followed by *Learning and Instruction*, and *Instructional Science*. There are five representative clusters. The green one is the most cited cluster and includes the two most cited journals together with *Cognitive Science*, *Cognition and Instruction*, *Educational Psychologist*, and *Educational Psychology Review*. The red cluster includes *Instructional Science* together mostly with technology and computer science journals. The purple cluster has a strong focus on science education although it includes the *Journal of Learning Sciences*. The blue cluster connects journals of higher education with educational psychology journals. The yellow cluster is smaller and includes some journals in educational research like the *Review of Educational Research*.

Figure 8 shows the results for the period between 2014 and 2023. Note that this figure uses a threshold of 20 citations and visualizes 100 co-citation links. The red and green clusters dominate this figure. The red one focuses on educational psychology and cognition, while the green cluster includes *Instructional Science* together with science education and technology journals. It also includes the *Journal of Learning Sciences* and *Cognition and*



**Fig. 8** Co-citation of journals in *Instructional Science*: 2014–2023 (minimum citation threshold of 20 and 100 links)

*Instruction*. The blue and yellow clusters are smaller and include journals on various topics about educational research.

To summarize the results of the co-citation analysis of journals and supplement detailed co-citation data, Table 15 presents the 30 most co-cited journals in *Instructional Science*, considering the overall results and three different regions: North America, Europe, and the Rest of the World. The results regarding global and regional analysis confirm the strong influence of *Journal of Educational Psychology* and *Instructional Science* over the entire field of *Instructional Science*. These journals are consistently the most co-cited across all regions, reflecting their central role in the dissemination and development of research in the field.

Globally, *Journal of Educational Psychology* is the most co-cited journal with 2,075 citations, followed by *Instructional Science* with 1,472 citations. *Learning and Instruction* and *Review of Educational Research* also rank highly, indicating their significant impact on the field. In North America, *Journal of Educational Psychology* leads with 972 citations, followed by *Instructional Science* and *Journal of Learning Sciences*, highlighting the prominence of educational psychology and learning sciences research in this region. In Europe, *Journal of Educational Psychology* again tops the list with 842 citations. Notably, *Learning and Instruction* ranks second with 768 citations, emphasizing the strong focus on instructional research within European scholarship. *Educational Psychology Review* and

**Table 15** Co-citation of journals in *Instructional Science*: global and temporal analysis

R	Global		North America		Europe		Rest of the world	
	journal	Cit	journal	Cit	journal	Cit	journal	Cit
1	J Educ Psychol	2075	J Educ Psychol	972	J Educ Psychol	842	J Educ Psychol	463
2	Instr Sci	1472	Instr Sci	508	Learn Instr	768	Instr Sci	398
3	Learn Instr	1112	J Learn Sci	381	Instr Sci	732	J Res Sci Teach	310
4	Rev Educ Res	746	Rev Educ Res	352	Educ Psychol Rev	401	Learn Instr	278
5	Educ Psychol	714	J Res Sci Teach	321	Educ Psychol	342	Sci Educ	196
6	J Res Sci Teach	704	Educ Psychol	293	Cognitive Sci	285	Rev Educ Res	191
7	J Learn Sci	690	Cognition Instruct	236	Rev Educ Res	276	J Learn Sci	178
8	Educ Psychol Rev	660	Cognitive Sci	223	Cognition Instruct	251	Int J Sci Educ	173
9	Cognition Instruct	594	Am Educ Res J	222	Contemp Educ Psychol	251	Comput Educ	168
10	Cognitive Sci	565	Learn Instr	218	Comput Hum Behav	234	Cognition Instruct	164
11	Contemp Educ Psychol	492	ETR&D-Educ Tech Res	204	J Learn Sci	217	Educ Psychol	160
12	Comput Educ	433	Educ Psychol Rev	193	Comput Educ	209	Educ Psychol Rev	149
13	Sci Educ	406	Contemp Educ Psychol	184	Brit J Educ Psychol	173	Brit J Educ Psychol	131
14	ETR&D-Educ Tech Res	383	Educational Researcher	174	High Educ	167	Cognitive Sci	113
15	Comput Hum Behav	373	Psychol Rev	163	J Res Sci Teach	165	Contemp Educ Psychol	113
16	Am Educ Res J	362	Am Psychol	157	Psychol Rev	154	High Educ	108
17	Psychol Rev	361	Sci Educ	157	Teach Teach Educ	140	ETR&D-Educ Tech Res	101
18	Int J Sci Educ	348	Comput Educ	135	Appl Cognitive Psych	139	Comput Hum Behav	91
19	Brit J Educ Psychol	336	Psychol Bull	125	ETR&D-Educ Tech Res	131	Educational Researcher	85
20	Educational Researcher	324	Int J Sci Educ	119	Educational Researcher	116	Teach Teach Educ	78
21	Am Psychol	307	Cognitive Psychol	110	Am Educ Res J	112	Psychol Rev	74
22	High Educ	273	Comput Hum Behav	102	Psychol Bull	101	Am Psychol	69
23	Psychol Bull	260	J Educ Res	93	Am Psychol	100	Stud High Educ	66
24	Teach Teach Educ	233	Science	92	Int J Sci Educ	99	Am Educ Res J	62
25	Cognitive Psychol	223	Ann M Am Ed Res Ass	88	J Comput Assist Lear	98	Psychol Bull	56
26	Appl Cognitive Psych	210	J Exp Educ	82	Cognitive Psychol	97	J Pers Soc Psychol	55
27	J Pers Soc Psychol	202	Educational Technology	79	J Pers Soc Psychol	94	J Comput Assist Lear	47
28	Science	170	J Pers Soc Psychol	79	Stud High Educ	92	J Exp Educ	46

**Table 15** (continued)

R	Global		North America		Europe		Rest of the world	
	journal	Cit	journal	Cit	journal	Cit	journal	Cit
29	Stud High Educ	167	Child Dev	76	Sci Educ	91	Res Sci Educ	45
30	Mem Cognition	166	Teach Teach Educ	74	Mem Cognition	85	Brit J Educ Technol	44

R, Rank; Cit, Citations.

*Cognitive Science* also have substantial co-citation links, indicating their importance in European educational research.

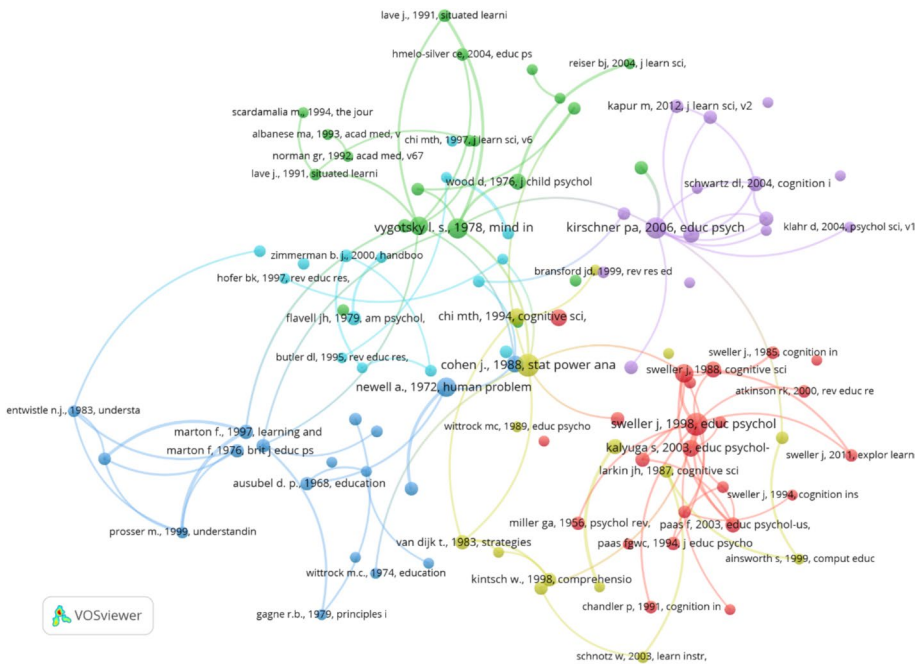
For the Rest of the World, *Journal of Educational Psychology* remains the most co-cited journal with 463 citations, followed closely by *Instructional Science* with 398 citations. *Journal of Research in Science Teaching* and *Learning and Instruction* also feature prominently, suggesting a broad interest in science education and instructional methodologies globally. In general, the analysis highlights the enduring influence of core journals like *Journal of Educational Psychology* and *Instructional Science*, which are pivotal across all regions. Additionally, it reveals regional variations in research focus, with North America showing a strong inclination towards learning sciences, Europe emphasizing instructional research, and the Rest of the World displaying a balanced interest in science education and instructional methodologies.

These findings underscore the diverse and evolving landscape of *Instructional Science*, where foundational journals maintain their influence while new areas of interest and regional priorities emerge. The increasing co-citation links across different journals suggest a growing interconnectedness and interdisciplinary collaboration within the field, contributing to its dynamic and expanding nature.

Next, let us analyze the co-citation of documents. Figure 9 presents the results considering a minimum citation threshold of 15 and the 100 strongest co-citation links. The results shown in Fig. 9 are consistent with those presented in Table 7. The main advantage of this figure is the visualization of the most co-cited documents, allowing us to see their relevance and interconnectedness within the field of *Instructional Science*.

It is worth noting that the seminal work by Sweller on cognitive load theory, specifically his 1998 paper published in *Educational Psychology Review*, has a strong co-citation connection with other fundamental works on cognitive processes in education, such as those by Kirschner and Chandler. These documents are among the most influential in *Instructional Science* publications, highlighting their foundational impact on instructional design and learning research. The influential document by Cohen on statistical power analysis, published in 1988, also shows significant co-citation links with various methodological and educational psychology studies. This indicates its importance in shaping research methodologies and analytical approaches within the field.

Another notable document is Bransford's "How People Learn: Brain, Mind, Experience, and School," which has strong co-citation links with a variety of educational research works, reflecting its comprehensive impact on understanding learning processes and instructional strategies. Furthermore, the work by Vygotsky on "Mind in Society," published in 1978, remains highly cited and has strong connections with documents related to social and cognitive development, underscoring its long-standing influence on educational theory and practice.

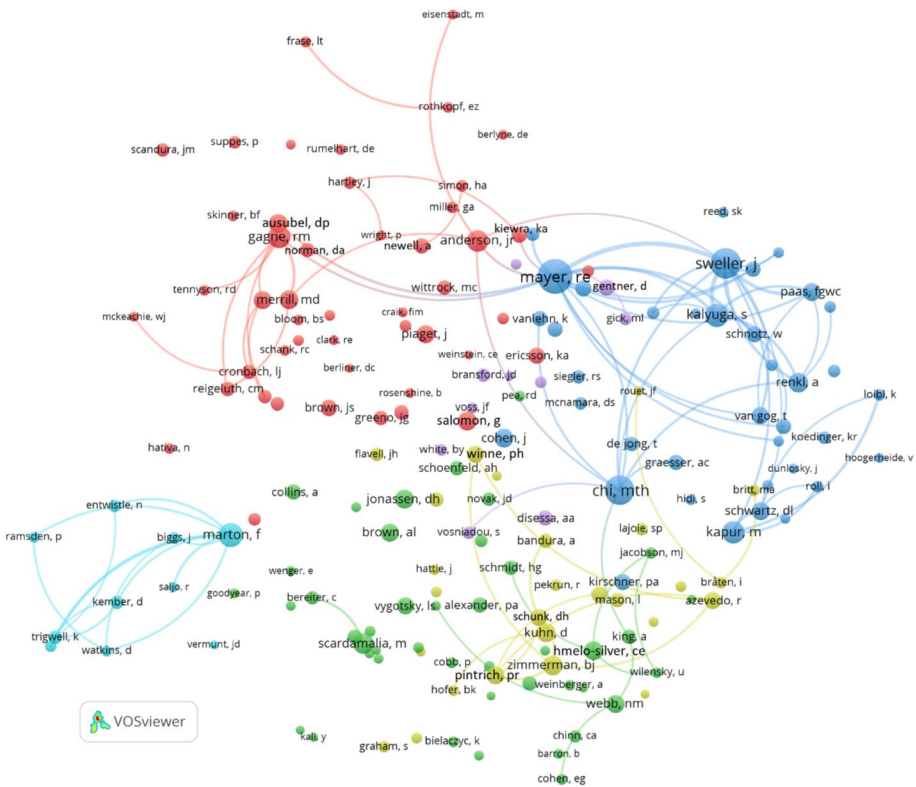


**Fig. 9** Co-citation of documents in *Instructional Science*: minimum citation threshold of 15 and 100 links

The graphical visualization in Fig. 9 also highlights the interdisciplinary nature of *Instructional Science*, with documents from cognitive psychology, educational technology, and instructional methods all interconnected. This reflects the field's integration of diverse perspectives to enhance educational research and practice. This figure provides a detailed and visually intuitive representation of the co-citation landscape in *Instructional Science*, showcasing the central and influential documents, their thematic clusters, and the interconnectedness of research areas. This co-citation analysis offers valuable insights into the intellectual structure and evolving trends in the field, emphasizing the foundational contributions of key works and the interdisciplinary collaboration that drives ongoing research.

Figure 10 presents the co-citation network of authors in *Instructional Science*, with a minimum threshold of 30 citations and the 100 most representative co-citation connections among authors. The results of this figure are consistent with those presented in Table 8. The main advantage of this figure is the visualization of the most influential authors, highlighting their relevance and interconnectedness in the field. Notably, *Richard Mayer* and *John Sweller* are among the most co-cited authors, reflecting their significant contributions to cognitive load theory and multimedia learning. Their strong co-citation connections with other influential authors like *Paas* and *Chandler* emphasize their foundational role in the field.

Figure 11 presents the bibliographic coupling of documents published in *Instructional Science*, with a minimum threshold of 50 citations and the 100 strongest bibliographic coupling connections. The results are consistent with Table 6, where seminal papers like *Sadler (1989)* and *Marton (1981)* have received high citations among *Instructional Science* publications. From an overall perspective, most highly cited publications span a broad range of

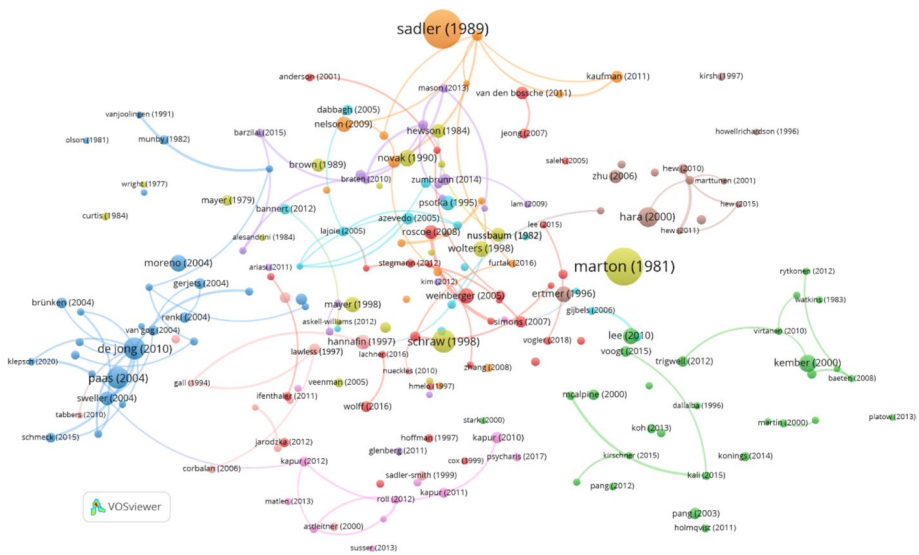


**Fig. 10** Co-citation of authors in *Instructional Science*: minimum citation threshold of 30 and 100 links

years, with notable clusters around the late twentieth century and early twenty-first century. This trend is logical, as older studies have had more time to accumulate citations.

This figure is beneficial for visualizing documents with similar bibliographic profiles, meaning those that cite the same references. For example, there is a strong connection between the works of *Sadler (1989)* and subsequent research focusing on assessment and educational standards. Similarly, *Marton (1981)*'s work on phenomenography shows strong links to later studies on student learning and conceptions of learning. Other interesting observation is the clustering of recent influential works, such as those by *Mayer (2008)* and *Sweller (2006)*, which are central in the blue cluster. These documents highlight the ongoing relevance of cognitive load theory and multimedia learning in contemporary research. The visualization also reveals strong bibliographic coupling connections between works by *Lee (2010)* and *Kember (2000)* in the green cluster, indicating their shared references and thematic focus on student engagement and learning outcomes.

Figure 11 provides a comprehensive visualization of the bibliographic coupling landscape in *Instructional Science*, highlighting central documents, their temporal distribution, and the interconnectedness of research themes. This analysis offers valuable insights into the intellectual structure and evolving trends in the field, emphasizing foundational contributions and the development of key research areas.



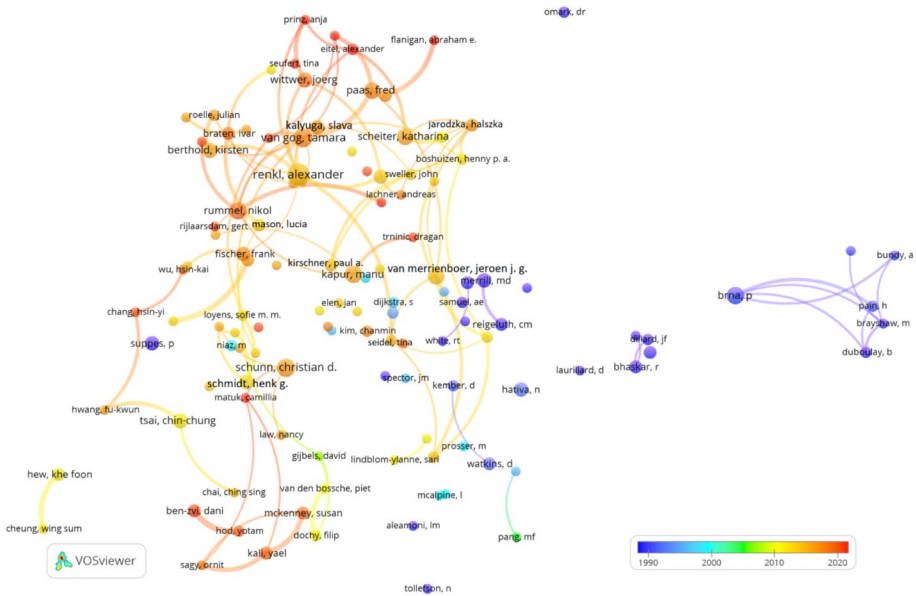
**Fig. 11** Bibliographic coupling of documents published in *Instructional Science*: minimum threshold of 50 citations and 100 links

Figure 12 provides a comprehensive visualization of the bibliographic coupling landscape of key authors in *Instructional Science*, showcasing central figures, distinct research themes, and the temporal evolution of the field. The visualization emphasizes the foundational contributions of leading authors and highlights emerging influencers, offering valuable insights into the intellectual structure and evolving trends in *Instructional Science* research. Note that the figure visualizes the most productive authors in *Instructional Science* with a minimum publication threshold of three documents and the 100 strongest bibliographic coupling connections between authors. The color of an author represents the average publication year of the author's documents, providing a temporal perspective on influential researchers.

Authors such as *Paul Kirschner*, *Jeroen J.G. van Merriënboer*, *Alexander Renkl*, and *Henk G. Schmidt*, are central in the network, indicating their significant contributions to the field. Their works are foundational, and their strong bibliographic coupling connections with other influential authors underscore their broad impact.

The network shows strong bibliographic coupling connections among authors from different clusters, reflecting the interdisciplinary nature of *Instructional Science*. For instance, connections between authors focusing on cognitive load theory and those working on motivational aspects highlight the integration of cognitive and affective factors in learning research. Recent influential authors such as *Christian D. Schunn* and *Gregory K.W.K. Chung* are notable in the network, indicating their growing impact on contemporary research. Their works are connected to both foundational and recent studies, showing their role in bridging different research areas.

Figure 13 presents the data with a minimum publication threshold of three documents and the 100 most representative bibliographic coupling links. Additionally, the color of an



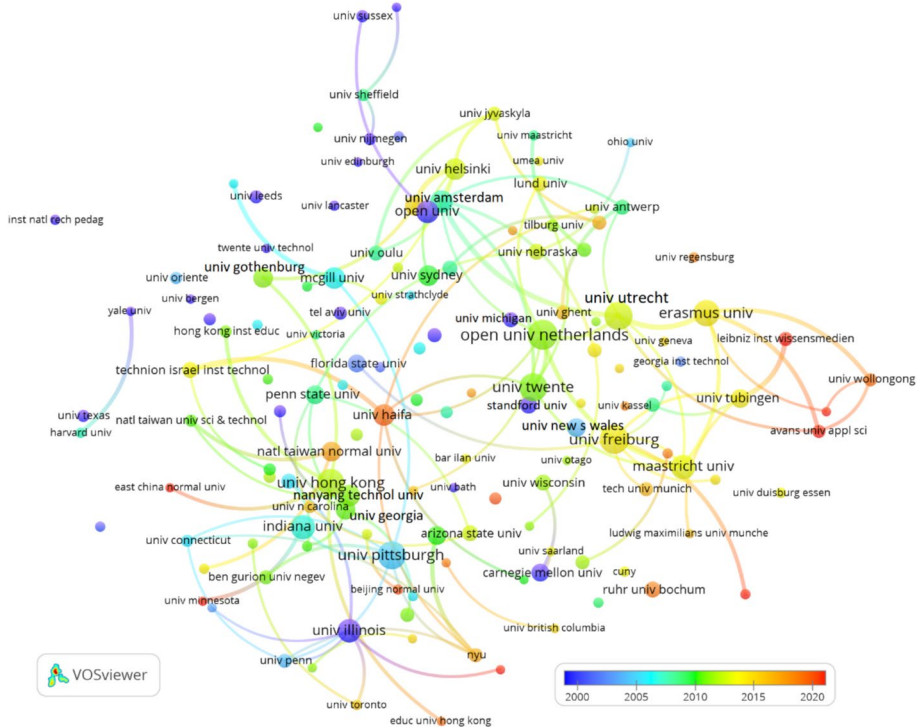
**Fig. 12** Bibliographic coupling of authors publishing in *Instructional Science*: minimum threshold of 3 documents and 100 links

institution indicates the average publication year of all the publications affiliated with this institution.

The leading institutions shown in this figure are consistent with those presented in Tables 10 and 11, where institutions like the *Open University Netherlands*, *University of Twente*, and *University of Freiburg* are among the most productive in *Instructional Science*. These institutions have published extensively in recent years, particularly around 2010–2015.

Based on Fig. 13, we can better understand how each leading institution is connected to the others. Institutions from the same countries or regions tend to be strongly connected, indicating that they cite similar bibliographic material and have similar research profiles. For example, institutions from the Netherlands, such as *Open University Netherlands*, *University of Twente*, and *Maastricht University*, are closely linked, reflecting their collaborative and thematic research focus. Another interesting observation is the strong connections between institutions from diverse geographic regions, such as *University of Hong Kong*, *Nanyang Technological University*, and *Pennsylvania State University*, indicating a global research network and the interdisciplinary nature of *Instructional Science*. The visualization also highlights the temporal evolution of research productivity. Institutions from the USA and the UK like the *University of Illinois*, *Carnegie Mellon University*, *Stanford University*, and the *Open University UK*, are the institutions with an average year of publication around 2000, indicating that they have published throughout the five decades of the journal.

Figure 14 presents the bibliographic coupling of countries publishing in *Instructional Science*, with a minimum publication threshold of one document and the 50 most representative bibliographic coupling connections. The color of a country indicates the average publication year of all the publications affiliated with that country.

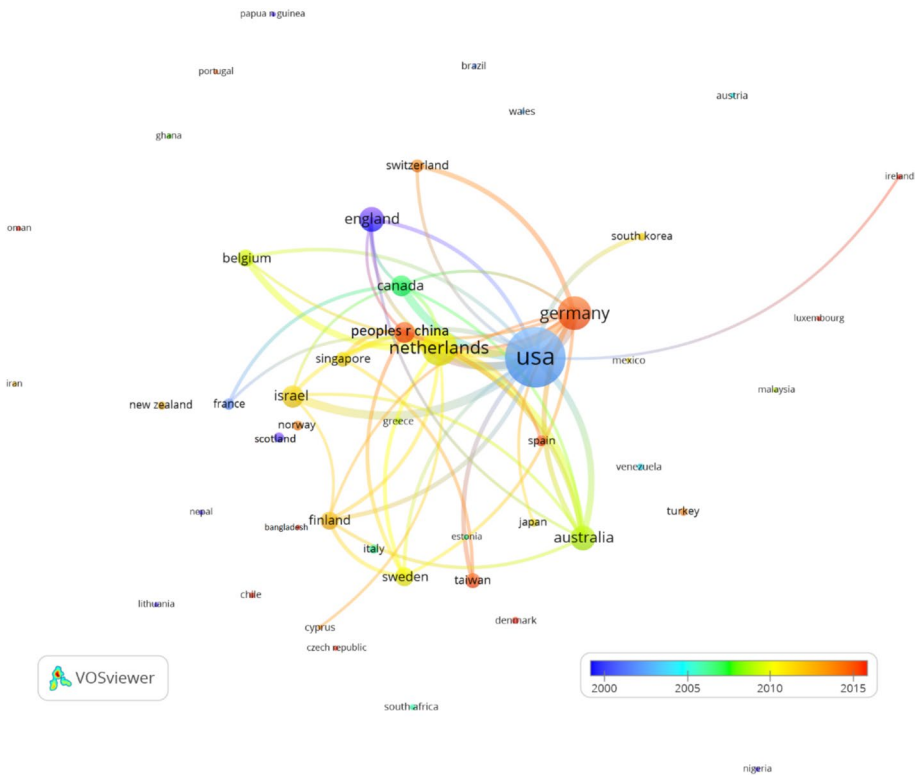


**Fig. 13** Bibliographic coupling of institutions publishing in *Instructional Science*: minimum publication threshold of 3 documents and 100 links

The USA and the Netherlands are the most productive countries, occupying significant positions in the field, followed closely by Germany, Australia, and the UK. These countries have strong bibliographic coupling links, indicating that they frequently cite similar research materials and have closely aligned research profiles.

Most of the leading countries are from Europe, reflecting a strong presence and collaboration within the region. For example, countries like the Netherlands, Germany, Belgium, and the UK show strong interconnections, suggesting robust collaborative research networks and shared thematic interests. The results are consistent with those of Tables 12 and 13, highlighting the prominence of European and North American countries in *Instructional Science* research. Notably, the USA, the Netherlands, and Germany have significant links, underscoring their central roles in driving research and innovation in the field.

The visualization also indicates temporal trends in research productivity. Countries like Australia and Singapore, which are represented in brighter colors, have more recent average publication years, reflecting their emerging influence and growing contributions to the field. Another interesting observation is the strong connections between geographically diverse countries, such as the USA, China, and Israel, indicating a global research network and the interdisciplinary nature of *Instructional Science*.



**Fig. 14** Bibliographic coupling of countries publishing in *Instructional Science*: minimum publication threshold of 1 document and 50 links

### Keyword and topical analysis

Figure 15 presents the results considering a minimum occurrence threshold of three and the 100 most significant co-occurrence connections. Note that the colour of the node indicates the average year of publication of the keyword. "Collaborative learning" and "problem-based learning" are the most frequent author keywords used in the journal publications and have the largest network connecting with many other author keywords on the map. From a general perspective, the keywords related to "learning" and "education" are the most common ones in the field of *Instructional Science*. As illustrated in Fig. 15, the journal employs a wide variety of keywords, indicating a multidisciplinary orientation that encompasses areas such as mathematics education, cognitive load, multimedia learning, and instructional design. This diverse range of keywords reflects the journal's broad focus on various educational strategies and methodologies.

Figures 16, 17 and 18, present the co-occurrence of keywords of the last 30 years classified by decades. Figures 16 and 17 consider the results between 1994–2003 and 2004–2013, respectively, with a minimum threshold of two occurrences and the 100 strongest co-occurrence links. Note that Fig. 18 uses a minimum threshold of three occurrences. Additionally, the colour of these figures indicates thematic clusters to see which keywords appear frequently in the same articles from a general point of view. The results follow the general



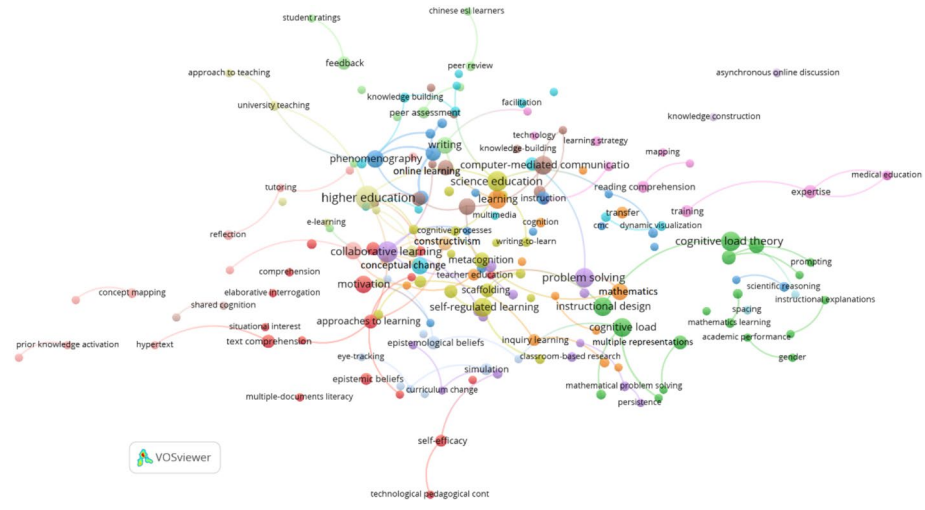


Fig. 17 Co-occurrence of author keywords in *Instructional Science* (2004–2013): minimum occurrence threshold of 2 and 100 links

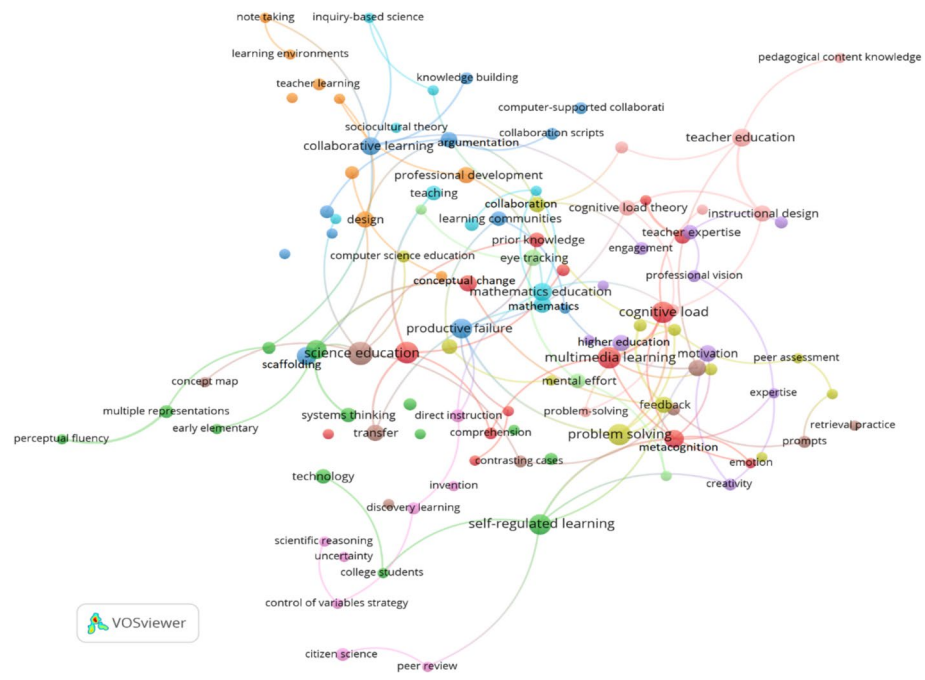


Fig. 18 Co-occurrence of author keywords in *Instructional Science* (2014–2023): minimum occurrence threshold of 3 and 100 links

Table 16 presents the co-occurrence of author keywords in *Instructional Science*, considering a global perspective as well as regional analyses for North America, Europe, and the Rest of the World. The results align with the general representation of leading keywords illustrated in Fig. 15. From a general point of view, "problem solving", "collaborative learning", and "learning" are the top three most frequent author keywords, each with occurrences of 31, 29, and 29, respectively. These keywords indicate a strong focus on various educational strategies and methodologies in the field.

In North America, the most frequent keywords are "science education" (17 occurrences), "collaborative learning" (12 occurrences), and "problem solving" (11 occurrences). This suggests a regional emphasis on science education and collaborative approaches. In Europe, "instructional design" (18 occurrences) and "higher education" (17 occurrences) are the leading keywords, reflecting a focus on structured educational frameworks and higher education methodologies. In the Rest of the World, "cognitive load theory" (11 occurrences) and "conceptual change" (9 occurrences) are prominent, indicating a focus on understanding cognitive processes and conceptual development in learning. The table highlights a diverse range of frequently occurring keywords across different regions, reflecting the multidisciplinary nature of research in *Instructional Science*. Notably, keywords such as "self-regulated learning", "cognitive load", and "phenomenography", are recurrent across multiple regions, emphasizing their global relevance in educational research.

Table 17 provides an analysis of the leading topics in *Instructional Science* between 2013 and 2022 based on Scopus data and provided by the SciVal platform (SciVal, 2024). The table includes metrics such as total papers (TP), field-weighted citation impact (FWCI), and worldwide prominent percentile (PP) (Klavans & Boyack, 2017; Purkayastha et al., 2019).

Notably, the top-ranked topic "Cognitive Load; E-learning; Multimedia" has 37 total papers, a FWCI of 1.53, and a PP of 97.78, indicating its high relevance and impact within the field. Other prominent topics include "Collaborative Learning; Case Study; Computer-Aided Instruction" with a FWCI of 2.43 and a PP of 88.356, and "Regulated Learning; E-learning; Self-Regulation" with a FWCI of 1.71 and a PP of 98.756, demonstrating significant attention and influence in these areas.

Moreover, several topics have been highly cited relative to the world average for similar publications. For instance, "Service Teacher; Teaching Practice; Professional Development" has a FWCI of 2.86, highlighting its substantial impact. Similarly, "Online Learning; Distance Education; Computer-Aided Instruction" and "Peer Review; Collaborative Learning; Computer-Aided Instruction" show high prominence with PPs of 98.621 and 93.703, respectively. Among the top 25 leading topics, six are within the top 5% of worldwide topics by prominence, and 10 are within the top 10%. This indicates that *Instructional Science* covers a wide array of influential and cutting-edge research areas, reflecting its multidisciplinary approach and significant contributions to educational research.

Furthermore, topics such as "Argumentation; Case Study; Science Education" and "Learning Systems; Systems Theory; Thinking Skill" also show high FWCI values, indicating their robust academic influence receiving more citations than the average of citations that this topic receives in other journals indexed in Scopus. The inclusion of diverse topics such as "Divergent Thinking; Creative Process; Electroencephalography" and "Science Museums; Case Study; Informal Learning" highlights the journal's broad scope, encompassing both traditional educational methods and innovative learning environments.

**Table 16** Co-occurrence of author keywords in *Instructional Science*: global and temporal analysis

R	Global		North America		Europe		Rest of the world	
	keyword	Occ	keyword	Occ	keyword	Occ	keyword	Occ
1	Problem solving	31	Science education	17	Instructional design	18	Cognitive load theory	11
2	Collaborative learning	29	Collaborative learning	12	Collaborative learning	17	Conceptual change	9
3	Learning	29	Problem solving	11	Higher education	17	Phenomenography	9
4	Instructional design	27	Learning	10	Learning	17	Self-regulated learning	9
5	Science education	27	Metacognition	10	Cognitive load	15	Higher education	7
6	Higher education	26	Online learning	9	Problem solving	15	Learning study	7
7	Self-regulated learning	24	Scaffolding	9	Multimedia learning	12	Problem solving	7
8	Cognitive load	23	Mathematics	8	Self-regulated learning	12	Collaborative learning	6
9	Problem-based learning	22	Problem-based learning	8	Teacher education	12	Problem-based learning	6
10	Conceptual change	20	Self-regulated learning	8	Text comprehension	11	Science education	6
11	Metacognition	20	Transfer	8	Argumentation	10	Cognitive load	5
12	Cognitive load theory	18	Design-based research	7	Cognitive load theory	10	Complex systems	5
13	Mathematics	18	Instructional design	7	Computer-suppl collab learn	10	Creativity	5
14	Motivation	18	Motivation	7	Constructivism	10	Online discussion	5
15	Scaffolding	17	Technology	7	Motivation	10	Expertise reversal effect	4
16	Multimedia learning	16	Worked examples	7	Phenomenography	10	Instructional design	4
17	Constructivism	15	Writing	7	Problem-based learning	10	Knowledge construction	4
18	Transfer	15	Cognition	6	Computer-mediated comm	9	Learning	4
19	Computer-mediated comm	14	Collaboration	6	Example-based learning	9	Learning strategies	4
20	Phenomenography	14	Computer-mediated comm	6	Eye tracking	9	Lesson study	4
21	Productive failure	14	Conceptual change	6	Mathematics	9	Multimedia learning	4
22	Teacher education	14	Feedback	6	Metacognition	9	Multiple representations	4
23	Text comprehension	14	Intelligent tutoring systems	6	Productive failure	9	Peer review	4
24	Collaboration	13	Mathematics education	6	Networked learning	8	Professional development	4
25	Computer-suppl collab learn	13	Complex systems	5	Didactics	7	Student learning	4
26	Feedback	13	Comp-suppl collab learn	5	Prior knowledge	7	Text comprehension	4
27	Mathematics education	12	Learning communities	5	Scaffolding	7	Variation theory	4

**Table 16** (continued)

R	Global		North America		Europe		Rest of the world	
	keyword	Occ	keyword	Occ	keyword	Occ	keyword	Occ
28	Argumentation	11	Learning strategies	5	Secondary education	7	Approaches to learning	3
29	Multiple representations	11	Middle school	5	Transfer	7	Approaches to teaching	3
30	Prior knowledge	11	Peer review	5	Conceptual change	6	Citizen science	3

Occ, Occurrences.

**Table 17** Leading topics in *Instructional Science* between 2013 and 2022 (Scopus)

R	Topic	TP	FWCI	PP
1	Cognitive load; e-learning; multimedia	37	1.53	97.78
2	Collaborative learning; case study; computer-aided instruction	22	2.43	88.356
3	Cognitive load; computer science; computer-aided instruction	18	1.12	76.267
4	Conceptual knowledge; collaborative learning; invention process	15	1.57	81.956
5	Learning systems; systems theory; thinking skill	12	1.91	73.299
6	Digital literacies; online information; text comprehension	11	1.66	88.831
7	Retrieval practice; testing effect; metacognition	10	1.23	95.855
8	Collaborative learning; e-learning; computer-aided instruction	10	1.39	92.037
9	Regulated learning; e-learning; self-regulation	8	1.71	98.756
10	Argumentation; case study; science education	8	1.2	96.263
11	Service teacher; teaching practice; professional development	8	2.86	94.291
12	Collaborative learning; legislation; metacognition	7	1.88	85.556
13	Learning approach; educational environment; academic performance	6	2.2	88.099
14	Testing; engineering education; conceptual change	6	0.86	79.711
15	Peer teaching; academic teaching personnel; computer-aided instruction	6	1.64	79.645
16	Online learning; distance education; computer-aided instruction	5	2.69	98.621
17	Peer review; collaborative learning; computer-aided instruction	5	2.14	93.703
18	Problem-based learning; medical student; undergraduate medical education	5	1.2	91.665
19	Case study; collaborative learning; english language	5	1.2	88.466
20	Case study; scientific practice; science education	5	0.85	76.714
21	Testing; reasoning skill; science education	5	1.35	72.204
22	Divergent thinking; creative process; electroencephalography	4	0.71	99.005
23	Science museums; case study; informal learning	4	0.76	87.539
24	Case Study; problem-based learning; computer-aided instruction	4	1.49	73.98
25	Learning performance; e-learning; self-efficacy	4	2.13	69.567
-	7 Topics	3	-	-
-	23 Topics	2	-	-
-	77 Topics	1	-	-

R, Rank; TP, Total papers; FWCI, Field-weighted citation impact (data from Scopus); PP, Worldwide prominent percentile (according to Scopus and FWCI).

Looking at the leading topic clusters in *Instructional Science*, "Multimedia; Computer-Aided Instruction; Student Learning" is at the first position of Table 18, and it is connected to 83 publications of the journal. The topic clusters in terms of "Science Education; High School Student; Student Learning" and "Self-Regulation; Computer-Aided Instruction;

**Table 18** Leading topic clusters in *Instructional Science* between 2013 and 2022 (Scopus)

R	Topic cluster	TP	FWCI	PP
1	Multimedia; computer-aided instruction; student learning	83	1.43	26.357
2	Science education; high school student; student learning	56	1.33	68.084
3	Self-regulation; computer-aided instruction; self-efficacy	53	2	44.277
4	Mathematics; mathematics education; pre-service teacher	27	1.52	64.683
5	Formative assessment; student learning; recall (cognitive psychology)	19	1.73	48.528
6	reflective practice; professional development; student learning	16	1.53	41.269
7	Information and communication technologies; educational technology; pre-service teacher	12	1.8	62.001
8	Activity theory; toddlers; english language	10	1.26	13.211
9	English language; language integrated learning; intercultural competence	7	0.91	81.23
10	Self-efficacy; academic performance; high school student	7	1.76	58.797
11	Social media; data mining; COVID-19	6	2.24	97.122
12	Language development; dyslexia; reading comprehension	6	1.64	67.495
13	Creative thinking; giftedness; gifted education	5	0.68	63.375
14	Problem-based learning; anatomy; medical education	5	1.2	59.124
15	Robot; artificial intelligence; software engineering	5	2.24	57.75
16	Gamification; serious game; computer-aided instruction	4	1.37	85.088
17	Self-Efficacy; gender difference; education research	4	2.17	56.508
18	Archeology; heritage conservation; climate change	4	0.76	27.404
19	Professional development; educational policy; pre-service teacher	3	1.11	78.156
20	Academic performance; student success; self-efficacy	3	3.15	36.952
-	11 Topic clusters	2	-	-
-	17 Topic clusters	1	-	-

Self-Efficacy" hold the 2nd and 3rd positions, respectively, with 56 and 53 publications. It is worth noting that the "Social Media; Data Mining; COVID-19" topic cluster obtains the highest PP (i.e., 97.122), which is considered one of the most prominent among the worldwide topic clusters in this field.

17 of the top 20 topic clusters in the journal have been cited more than the world average for similar publications. The top-ranked cluster, "Multimedia; Computer-Aided Instruction; Student Learning," has a FWCI of 1.43 and a PP of 26.357, indicating its significant impact above the average. "Science Education; High School Student; Student Learning" and "Self-

Regulation; Computer-Aided Instruction; Self-Efficacy" also demonstrate strong academic influence with FWICs of 1.33 and 2, respectively.

Noteworthy clusters such as "Reflective Practice; Professional Development; Student Learning" and "Information and Communication Technologies; Educational Technology; Pre-Service Teacher" highlight the journal's emphasis on professional development and educational technology. Furthermore, "Social Media; Data Mining; COVID-19" and "Robot; Artificial Intelligence; Software Engineering" reflect the journal's engagement with contemporary and emerging educational technologies. In summary, *Instructional Science* encompasses a diverse array of influential topic clusters, reflecting its multidisciplinary focus and substantial contributions to educational research. The prominence and impact of these clusters underscore the journal's role in advancing knowledge and practice in Instructional Science.

## Conclusions, implications and limitations

*Instructional Science* has reached its 50th anniversary, marking half a century of significant contributions to the field of learning sciences. This paper offers a bibliometric analysis of the journal's evolution from 1972 to 2023, highlighting key trends in its publications. The analysis primarily utilizes the WoS Core Collection databases to assess the journal's impact, productivity, and influential contributors in terms of authors, institutions, and countries.

The results demonstrate substantial growth in the journal's publication and citation impact over the years, reinforcing its status as a leading platform in the learning sciences. A notable finding is the dominance of specific regions, authors, and institutions that have consistently contributed high-impact research to the journal. For example, regions like Western Europe and North America, particularly the USA and the Netherlands, have emerged as key contributors.

Thanks to its population size, the USA is by far the most productive country in *Instructional Science*. This country has 14 institutions in the top 40 and nine authors are among the 40 most productive ones. The USA has regularly published in the journal since its origins and has maintained its leading position for five decades, although in the last decade, there is evidence that other countries are achieving a more significant position, especially, when measuring per capita.

Europe is the other main region publishing a lot in *Instructional Science*. During the first two decades, the UK was the leading country from this region. In the next two decades, the Netherlands became the most productive country. And in the last decade (2014–2023), Germany has become the most productive. The results of the Netherlands are the most remarkable. In total numbers, it is the most productive country of Europe. Four of the top five authors and institutions are from the Netherlands, including the most productive author, Jeroen Van Merriënboer (Maastricht University), and the two most productive institutions, the Open University of Netherlands and the University of Twente.

Germany is increasing a lot its productivity in the journal. Currently, it has eight authors in the top 40, including the second most productive author, Alexander Renkl (University of Freiburg). Three institutions appear in the top 40, including the University of Freiburg that it is ranked fourth. The UK is the third most productive country in *Instructional Science*, but it has decreased its productivity a lot during the last 20 years. Two authors are among

the 40 most productive, and two universities, including the Open University of the UK that rank eighth.

Other countries that publish significantly in the journal are Australia, Canada, Israel and China. John Sweller (University of New South Wales) is among the 10 most productive authors, and the University of New South Wales is in the top 20 of most productive universities. Canada has no author in the top 40, but McGill University is currently ranked 12th. Israel has two authors in the top 40 and three institutions, including the University of Haifa in the 13th position. China has been growing its influence a lot during the last few years. Currently, the University of Hong Kong is the leading institution from this country and achieves the 7th position in the list of most productive universities. Note that developing countries have not published many articles in *Instructional Science*, although the expectation is that they will improve in the future.

The use of VOS viewer software to create graphical visualizations further enriches the analysis by mapping bibliographic connections through methods such as co-citation and bibliographic coupling. These visualizations help to identify clusters of research activity and reveal the collaborative networks that underpin the journal's success. The journal's influence is further underscored by the high citation rates of its most significant publications, including several papers that have shaped the field's discourse on learning and instruction.

This bibliometric study fills a gap by providing a retrospective evaluation of the journal's impact and the evolution of its research focus, which has become increasingly diversified and global over time. *Instructional Science* has established itself as a cornerstone for the dissemination of high-quality and empirically based research in the learning sciences. The journal's growth trajectory suggests that it will continue to expand its international influence and contribute to shape future research agendas in education and learning.

Although this bibliometric analysis is a good approach for measuring the current trends occurring in the journal, it is worth mentioning some limitations. First, the result of this work is based on the bibliographic data available in WoS Core Collection. Therefore, the limitation of this database also apply to this article. For example, WoS uses full counting and does not consider fractional counting. That is, it gives one unit to each co-author of the document independently of the number of co-authors. Therefore, articles with many co-authors tend to have higher visibility than single-authored articles. This study partially solves this limitation by using fractional counting in the graphical mapping with a VOS viewer. However, further research is needed in this context, especially, when WoS also gives the possibility of analyzing the bibliographic information with fractional counting measures.

Second, the results of this work represent the current picture of the journal up to 2024. However, these results and rankings may change in the future depending on the evolution of the journal. For example, new emerging topics may appear or some of the current topics receive more attention, increasing their number of citations above the average. The previous issue also applies to authors, institutions and countries. Additionally, a future expectation is that, sooner or later, developing countries will become more relevant in the journal. A representative case is China, which has significantly improved its ranking in the journal during the last two decades. But still should improve more according to its population size. The performance of the rest of developing countries is still very low and no one has currently published more than 10 articles.

Another important limitation is that bibliometrics is a good approach for identifying leading trends, but it cannot provide results that are 100% accurate. The main reason is

that each subfield has different publication and citation characteristics, so it is difficult to compare the performance of authors working in different subfields. Even on the same topic, sometimes it is not easy to clearly identify the performance of different researchers and journals. A very simple example from the general literature of bibliometrics and according to the data of WoS, is that currently, the average number of citations and references per document is significantly different between fields. Additionally, in some fields, it is common to have more than 10 co-authors in the document while in some other fields, the number of co-authors of an article is usually below 10. Therefore, when comparing the publication and citation records of researchers and institutions from different fields, it is important to be aware of these limitations in the analysis of the bibliographic information.

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## Declarations

**Competing Interest** The authors declare no competing interests.

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