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THE BIBLIOMETRIC ANALYSIS OF THE DIFFERENTIAL ITEM FUNCTIONING USING VOSviewer

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ABSTRACT

In this study, the purpose was to analyze the articles published in journals indexed in the SSCI, SCI-Expanded, and A&HCI indexes in the Web of Science (WoS) database on differential item functioning (DIF) using a bibliometric analysis approach. To this end, a total of 2167 articles were analyzed. The data of the study were accessed through the WoS database. In the analysis of the data, VOSviewer software was used. Within this context, the trends of publications related to the research topic over the years, the most productive and influential researchers, institutions, and countries were evaluated within a general framework. In this study, the highest number of publications was found to be in the Health Care Sciences Services category. The number of publications reached the highest number in 2019 and 2021. Northwestern University came to the fore as the most influential institution on the research topic. In terms of citation count, the most influential countries were found to be “USA”, “UK” and “Australia” respectively. As a result of keyword analysis, the terms “differential item functioning”, “Rasch analysis” and “item response theory” were found to be the most recurring words.

Keywords: Differential item functioning (DIF), bibliometric analysis, VOSviewer.

INTRODUCTION

Measurement has an important place both in our daily lives and in scientific studies. The level of significance of any measurement depends on the attainment of reliable and valid measurement results (Baykul, 2010). Measurement is performed for a specific purpose. The goal is to make an evaluation of individuals, events, or objects in terms of the characteristics under investigation and to make informed decisions based on the evaluation results. According to Turgut (1983), measurement is the observation of any quality and expressing the observation results with numbers or other symbols. Before starting the measurement process, the characteristics to be measured must be defined. Measuring tools are needed to facilitate the measurement of the specified characteristics and to make more accurate measurements. After the completion of the measurement process, some decisions are made about the measured characteristic based on the results obtained through the measurement tools. The measurement process aims to make measurements as accurate as possible to obtain accurate information about the measured characteristics and make correct decisions based on these measurement results.

Since more direct measurements can be made in physical sciences, it is easier to determine the direction and amount of constant and systematic errors that interfere with measurement results. However, since measurements made in social sciences are mostly indirect measurements, it is not easy to determine the direction and amount of constant and systematic errors. Therefore, in scientific research conducted in social sciences, conducting and interpreting measurements with high reliability and validity is crucial but significantly more challenging due to the nature of the variables under examination. Measuring tools must have certain structural features to give accurate results (Baykul, 2010). The most important of these features are validity and reliability. Reliability refers to the degree to which measurement results are free from random errors. Another important feature, validity, refers to the ability of a test to measure the intended quality without confounding it with other variables. The prerequisite for reliability is validity, and without validity, measurement results are meaningless (Zumbo, 1999). Therefore, it is not possible to discuss the reliability of any measurement instrument that lacks validity.

The presence of biased items in a test during measurement reduces the validity of the test. The state of an item being biased arises when individuals from different subgroups, such as gender, school type, language, ethnicity, belief, etc., but with the same ability level, have varying probabilities of answering an item correctly (Adams & Rowe, 1988; Camilli & Shepard, 1994; Devine & Raju, 1982; Holland & Wainer, 1993; Osterlind, 1983; Zumbo, 1999).

Research on bias requires the collection of experimental evidence regarding the performance of the focus and reference groups on test items. There must be empirical evidence to conclude that bias exists. The first step in determining whether an item is biased is to apply statistical analyses for detecting Differential Item Functioning (DIF). It can be said that an item exhibits DIF when individuals from different groups with the same ability level

have different probabilities of answering the item correctly. However, the presence of DIF in an item does not necessarily imply that it is biased. Expert opinions are sought for items exhibiting DIF to determine whether they are biased or not (Camilli & Shepard, 1994; Hambleton et al., 1991).

When the literature is reviewed, it is seen that there are many studies on differential item functioning. These studies have not only been conducted in the field of education sciences but also in health, social, and natural sciences. There are many studies conducted using variables and data sets in different conditions. These studies in the literature serve as an important guide for future research. Therefore, evaluating past studies, and examining their findings and their relationships with each other is important in determining the direction and subjects of future research.

This research was based on the need to determine trends in the DIF and to provide scientific data on leading authors, countries, institutions, and references. Before conducting research, it was checked whether the scope of DIF research, including content analysis, descriptive analysis, systematic review, extensive literature review, meta-analysis, and meta-synthesis techniques, had been evaluated. Table 1 shows the years of analysis of these studies, their title, the authors of the studies, the purposes of the studies, the databases used, and the number of publications used in the analysis.

Table 1. Reviewing Studies on DIF

Analyzed years	Title	Writer(s)	Purpose of the research & analysis dimensions	Databases	Number of analyzed publications
1975 - 2000	A bibliometric study of differential item functioning	Juana Gómez Benito, María Dolores Hidalgo Montesinos, Georgina Guilera Ferre, Macarena Moreno Torrente	The aim is to provide an overview of the research activities in this area, to describe its most important aspects and its evolution over the last quarter of the 20th century, and to provide data on the foundations for the development of this activity in the early 21st century.	Web of Science	271
1975 - 2000	Citation analysis in research on differential item functioning	Georgina Guilera, Juana Gómez-Benito, M. Dolores Hidalgo	This study aimed to conduct a bibliometric study of the reference to the end of the article in the DIF literature. This was done by analyzing the references mentioned in the published studies and distinguishing between self-citations and other authors' works. The relationship between other variables is explored, such as the number of authors per article, the journal in which the article was published, and the total number of references cited per article.	Web of Science	271
1990-2018	Developments and trends in research on methods of detecting	Ángela I. Berrío, Juana Gómez-Benito, Erika Margarita Arias-Patiño	The main objective is to provide information about the overall structure, main developments, and current trends in the field.	Web of Science, PsycInfo, ERIC	291

	differential item functioning				
1975-2005	Differential item functioning: A bibliometric analysis of journals published in Spanish	Georgina Guilera, Juana Gómez y M. Dolores Hidalgo	This study aims to give an overview of scientific production relation articles published in Spanish on DIF	Web of Science	52

Several common findings analyzed in Table 1 have also been analyzed within the scope of the study. The findings and results obtained in this study are essential for establishing pioneering discoveries to identify leading countries, institutions, authors, etc. in DIF to determine the trends in DIF research. Although many bibliometric analysis studies have been conducted in the fields and subjects of the educational sciences, there are few bibliometric analyses of the functions of DIF, which constitute the content of this study. Bibliometric analyses aim to present a comprehensive perspective on studies related to the concept to the attention of researchers. In addition, it is thought that this bibliometric analysis study will also shed light on future research on the subject, allow the field to be viewed from a general perspective, and will be a guide for scientists who will work in this field from now on.

The purpose of this study is to review and visualize the Differential Item Functioning (DIF) journal articles obtained from the Clarivate Analytics Web of Science (WoS) database. To identify trends in the field, the following research questions are addressed:

1. What is the distribution of DIF studies by research category?
2. What is the distribution of DIF studies by publication year?
3. Who are the top 10 authors with the highest number of citations in relation to DIF?
4. Which authors have made the most significant contributions to the field on DIF, and what are the numbers of their publications?
5. Which countries have been most active in terms of publications on DIF?
6. Which institutions have been most active in terms of publications on DIF?

METHOD

Research Model

In the current study, research on Differential Item Functioning (DIF) was examined using bibliometric techniques. The study employs a descriptive survey model as it aims to analyze the effectiveness of articles on Differential Item Functioning (DIF) in Web of Science (WoS) in terms of bibliometric indicators. Descriptive survey research describes an event, situation, or object under investigation in its current conditions and as it currently exists

(Karasar, 2016). This research method is used to describe the structure of objects, societies, institutions, and the functioning of events (Cohen et al., 2007).

Data Collection Process

For the analysis used in this study, documents were obtained from the Clarivate Analytics Web of Science (WoS) database. In order to access publications on Differential Item Functioning, a search was conducted in Clarivate Analytics Web of Science (WoS) using the keyword “differential item functioning” with the “all fields” option selected. In this search, a total of 3821 studies were reached. Then, some filters were applied. The “Publication years” were restricted to the period from 2012 to 2022, resulting in a list of 2593 publications. Then, "Document types" were narrowed down to "article," resulting in a list of 2456 publications. Another filtering step involved selecting the “Web of Science Index”, where Science Citation Index-Expanded (SCI-Expanded), Social Sciences Citation Index (SSCI), and Arts & Humanities Citation Index (A&HCI) were checked, resulting in a total of 2167 studies obtained. The search record is as follows;

"differential item functioning" (All Fields) and 2022 or 2021 or 2012 or 2013 or 2014 or 2015 or 2016 or 2017 or 2019 or 2020 or 2018 (Publication Years) and Article (Document Types) and Social Sciences Citation Index (SSCI) or Science Citation Index Expanded (SCI-EXPANDED) or Arts & Humanities Citation Index (A&HCI) (Web of Science Index)ik kurul onayı yöntem kısmında detaylandırılmalıdır.

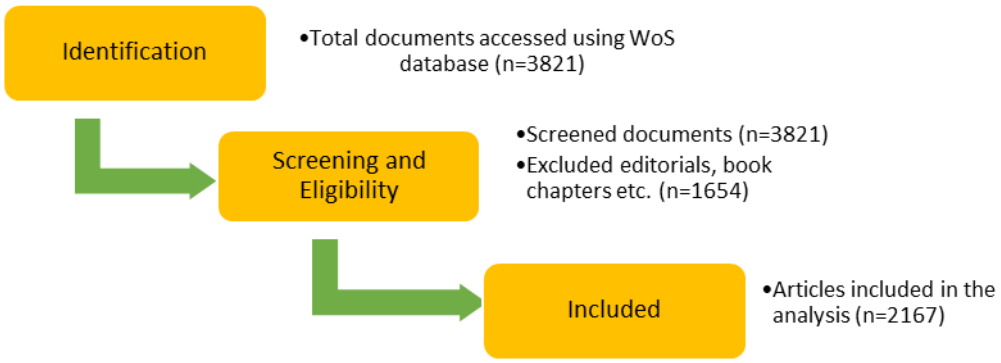

Figure 1. The Stages for the Determination and Selection of documents

Data Analysis

Bibliometric analysis is a statistical method that can quantitatively analyze research papers related to a particular topic in mathematical ways (Chen et al., 2014). It can also access research quality, analyze key research fields, and predict future directions. The Web of Science Online Database (WoS) contains almost all important research papers and provides integrated analytical tools to generate representative figures. Furthermore, the search results from WoS can be exported to software for further analysis, such as VOSviewer. Data such as authors, institutions, countries and keywords, etc. of the 2167 publications obtained were downloaded with txt text

extension and analyzed using the bibliometric analysis program VOSviewer 1.6.9 (Van Eck & Waltman, 2010). VOSviewer is a software to create and visualize bibliometric networks.

Limitations of the Study

This study is limited to 2167 research articles indexed in the Web of Science Core Collection database, specifically in the Science Citation Index-Expanded (SCI-Expanded), Social Sciences Citation Index (SSCI), and Arts & Humanities Citation Index (A&HCI), on the subject of differential item functioning between the years 2012 and 2022.

FINDINGS

The findings obtained from the bibliometric data analysis of the publications reached through a systematic literature review are presented in the relevant headings to answer the research questions.

Table 2. Number of Publications Across the Research Categories

Field Web of Science Categories	Record Count	% of 2.167
Health Care Sciences Services	293	13.52%
Health Policy Services	237	10.93%
Public Environmental Occupational Health	237	10.93%
Psychology Clinical	209	9.64%
Psychiatry	208	9.59%
Psychology Educational	192	8.86%
Psychology Mathematical	190	8.76%
Rehabilitation	184	8.49%
Psychology Multidisciplinary	179	8.26%
Education Educational Research	144	6.64%

As seen in Table 2, a significant portion of the studies published between 2012 and 2022, based on the criteria of SCI, SSCI, and AHCI, fall within the category of Health Care Sciences Services, followed by Health Policy Services, Public Environmental Occupational Health, Psychology clinical and the last category here is Education Educational Research. The distribution of “differential item functioning” publications across the Web of Science Categories is shown in Figure 2 below.

Figure 2. Number of Publications Across the Research Categories

Table 3. Distribution of the Publications by Publication Years

Publication Years	Record Count	% of 2.167
2012	134	6.18%
2013	148	6.83%
2014	164	7.56%
2015	190	8.76%
2016	156	7.19%
2017	186	8.58%
2018	187	8.62%
2019	261	12.04%
2020	238	10.98%
2021	262	12.09%
2022	241	11.12%

As seen in Table 3, there is an increase in the number of publications starting from the year 2012. A decrease was observed in 2016. Then, the numbers of the studies published in 2017 and 2018 are very close to each other. The number of publications reached the highest number in 2019 and 2021. It is seen that the biggest increase in the number of publications was recorded as of 2019. The distribution of "differential item functioning" publications across the publication years is shown in Figure 3.

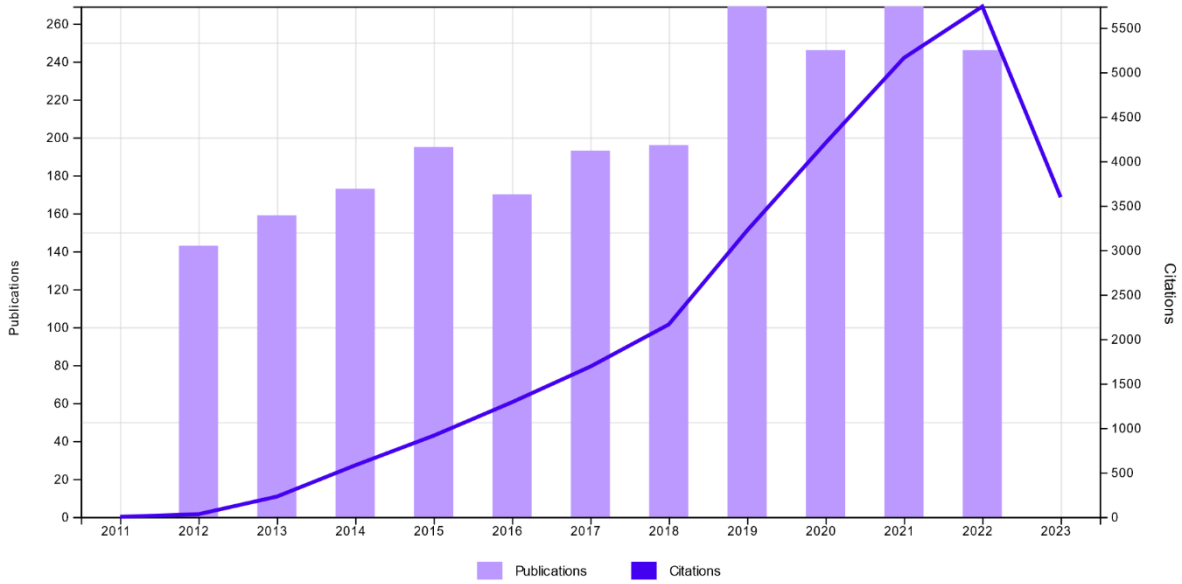

Figure 3. Distribution of the Differential Item Functioning Publications by Publication Year

Table 4. The Top Ten Co-Cited Authors Obtained from VOSviewer

Rank	Author	Documents	Citations	Total link strength
1	Morin, Alexandre J. S.	12	1075	39
2	Lin, Chung-Ying	26	740	69
3	Cella, David	16	706	86
4	Pakpour, Amir H.	20	576	58
5	Dewalt, Darren A.	5	554	38
6	Hahn, Elizabeth A.	12	457	85
7	Lai, Jin-Shei	10	429	53
8	Thissen, David	9	427	50
9	Amtmann, Dagmar	9	406	41
10	Brostrom, Anders	11	401	41

As Table 4 shows, the top ten co-cited authors include Morin, A. J. S.; Lin, C.; Cella, D.; Pakpour, A. H.; Dewalt, D. A.; Hahn, E. A.; Lai, J.; Thissen, D.; Amtmann, D.; Brostrom, A.

Co-authorship Analysis

A network map was created by setting criteria of at least two publications and at least two citations to identify authors who are the most linked and collaborative based on co-authorship analysis. The relevant figure is given in figure 4 below.

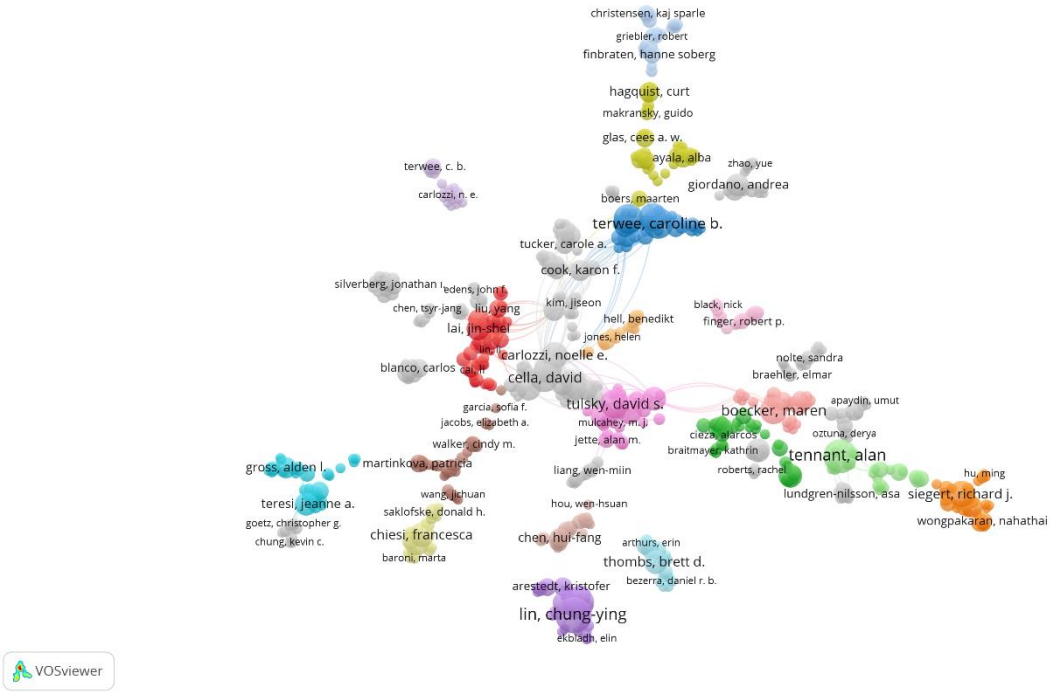

Figure 4. Network Map of Co-authorship of Authors

When Figure 4 is examined together with Table 3, it can be seen that the most cited authors are Morin, Alexandre J. S. with 1075 citations, Lin, Chung-Ying with 740 citations, and Cella, David with 706 citations. However, it is also seen that these authors are not the most linked authors. The most prolific authors do not appear to be among the most linked authors (Lin, Chung-Ying with 26 publications and Pakpour, Amir H. with 20 publications, respectively).

A network map was created by setting criteria of at least five publications and at least five citations to identify authors who are the most linked and collaborative based on co-authorship analysis. The relevant figure is given in figure 5 below.

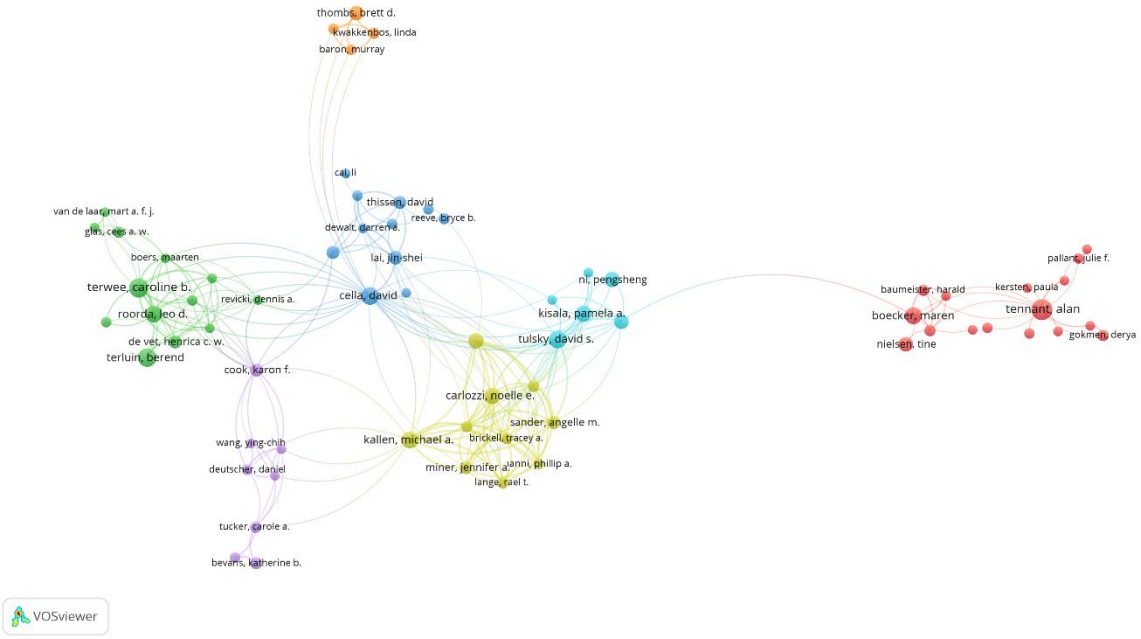

Figure 5. A Network Map Created Selecting at Least Five Publications with Five Citations Each**.**

Citation of Countries

An analysis was conducted based on the criterion of at least two publications and two citations from a single country in order to create a network map depicting citations received by the countries of origin of the publications.

Table 5. The Twenty Co-Cited Countries for Documents Obtained from VOSviewer

Rank	Country	Documents	Citations	Total link strength
1	USA	928	12073	590
2	England	224	4269	365
3	Australia	187	3539	269
4	Canada	187	2462	228
5	Netherlands	164	1987	260
6	Peoples R China	148	1585	158
7	Germany	147	2035	226
8	Spain	137	1468	192
9	Sweden	120	2196	229
10	Italy	93	1573	151
11	Denmark	84	1349	130
12	Switzerland	79	859	170
13	France	67	781	130
14	Norway	59	1194	119
15	Taiwan	59	728	85
16	**Turkey**	**53**	**320**	**77**
17	Brazil	51	704	95
18	Iran	48	781	101
19	Belgium	44	536	55
20	South Korea	42	477	41

Table 5 shows the top twenty countries for documents. The top five countries for documents include respectively USA, England, Australia, Canada, and the Netherlands. Türkiye ranks 16th in terms of the number of publications. It can be seen that the USA, England, and Australia, which receive the most citations, are also the most linked countries, respectively. The USA, which is the country with the highest number of publications, also appears to be among the most linked countries. The relevant figure is given in figure 6 below.

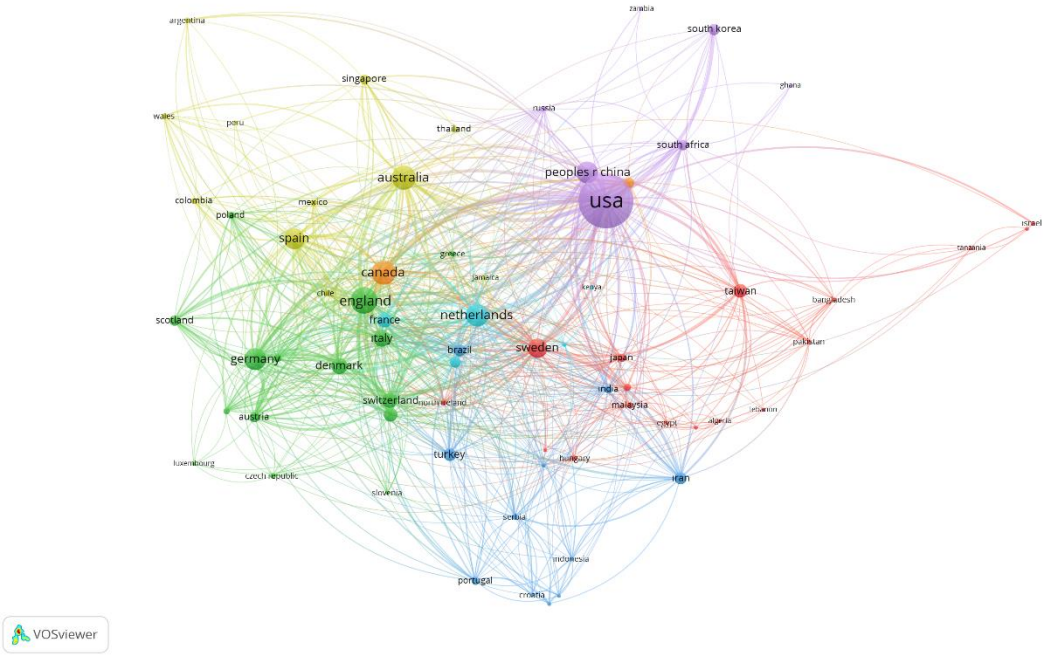

Figure 6. Network Map of Citation Analysis of Countries

Citation of Authors

A network map for author citation analysis was created based on the criterion of at least two publications and at least two citations to identify citation networks. The authors with the highest number of citations are Morin, Alexandre J. S. with 1075 citations, Lin, Chung-Ying with 740 citations, and Cella, David with 706 citations. Except for Cella, David, the other two authors are not among the top three in terms of total link strength. The relevant figure is given in figure 7 below.

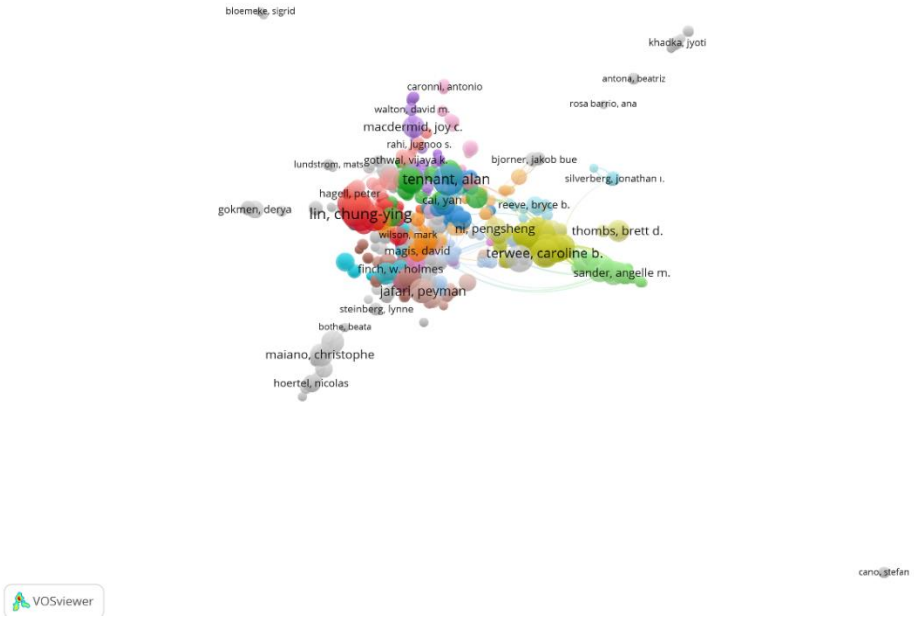

Figure 7. Network Map of Author Citation Analysis

Co-occurrence of All Keywords

When the most frequently used keywords in publications on differential item functioning are examined, it is seen that the top three terms are “differential item functioning” with 585 occurrences, “Rasch analysis” with 230 occurrences, and “item response theory” with 229 occurrences. These three keywords are also the most powerful in terms of total link strength. The relevant figure is given in figure 8 below.

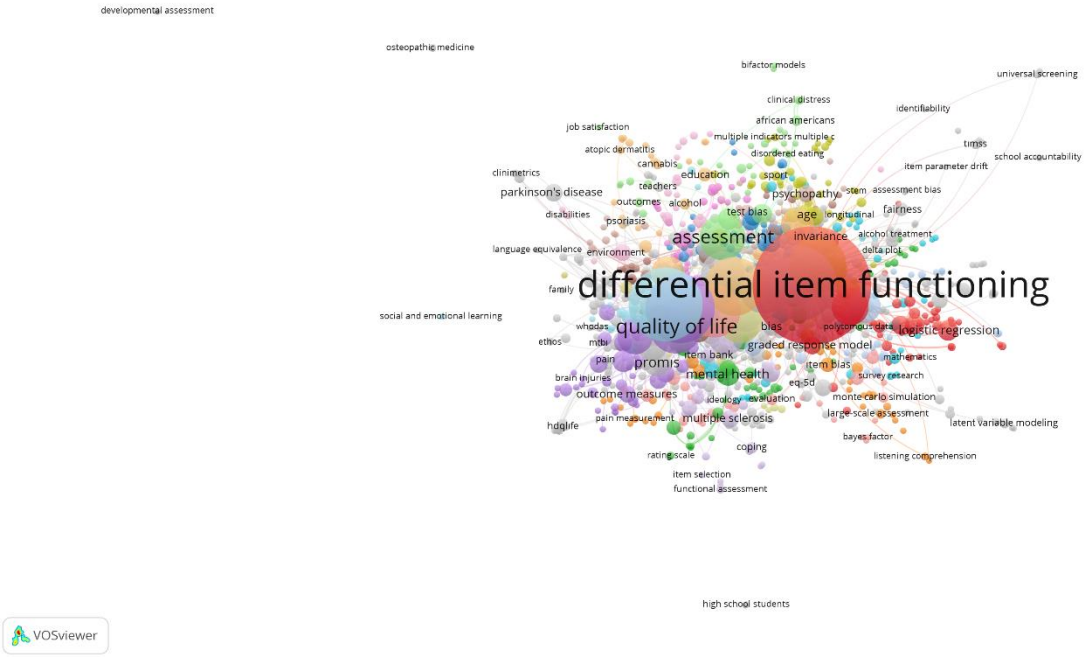

Figure 8. Network Map of Co-occurrence Analysis of All Keywords

Bibliographic Coupling of Documents

Bibliographic coupling refers to the situation where two independent sources cite a common work or reference. The analysis was conducted based on the criterion of having been cited at least once. The publications with the highest bibliographic coupling are Marsh (2014) with 957 citations, Carleton (2013) with 282 citations, and Gershon (2012) with 236 citations. The publications with the highest total link strength are Teresi (2021), Dimitrov (2017) and Teresi (2017), respectively. The relevant figure is given in figure 9 below.

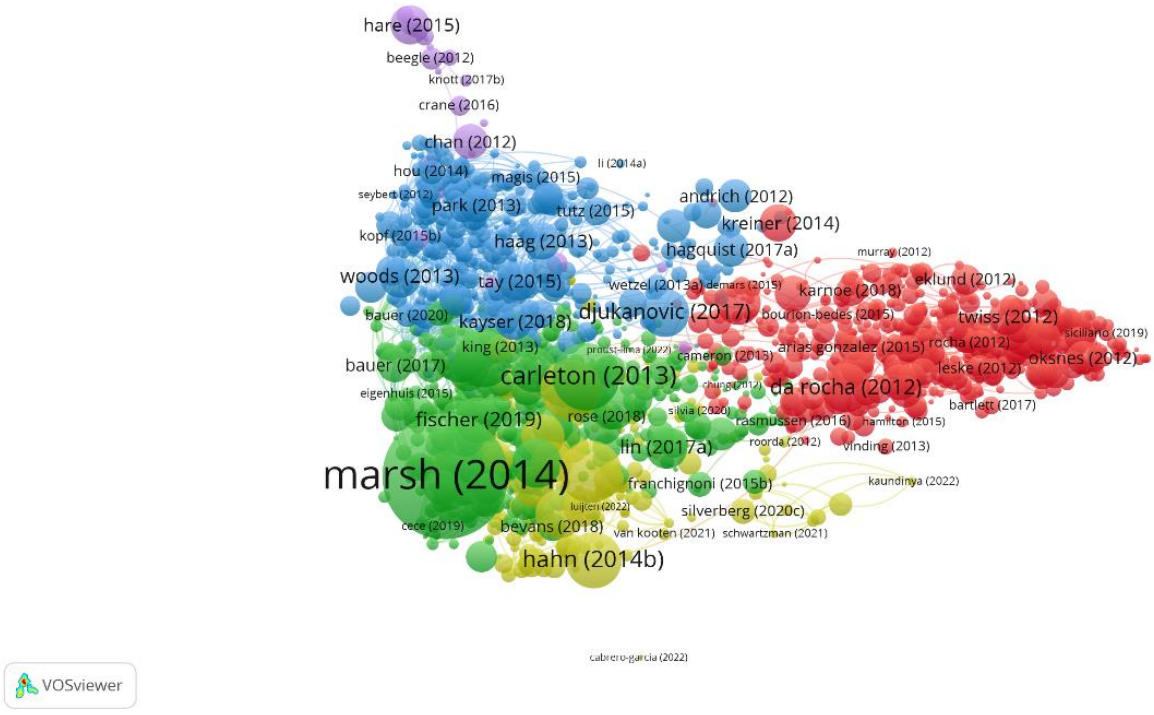

Figure 9. Network Map of the Bibliographic Coupling of Documents

Bibliographic Coupling of Authors

The analysis was conducted based on the criterion of having published at least 2 works and received at least 2 citations. The authors with the highest bibliographic coupling are Morin, Alexandre J. S. with 1075 citations (26638 total link strength), Lin, Chung-Ying with 740 citations (26550 total link strength), and Cella, David with 706 citations (54723 total link strength). The relevant figures are given in figure 10 and figure 11 below.

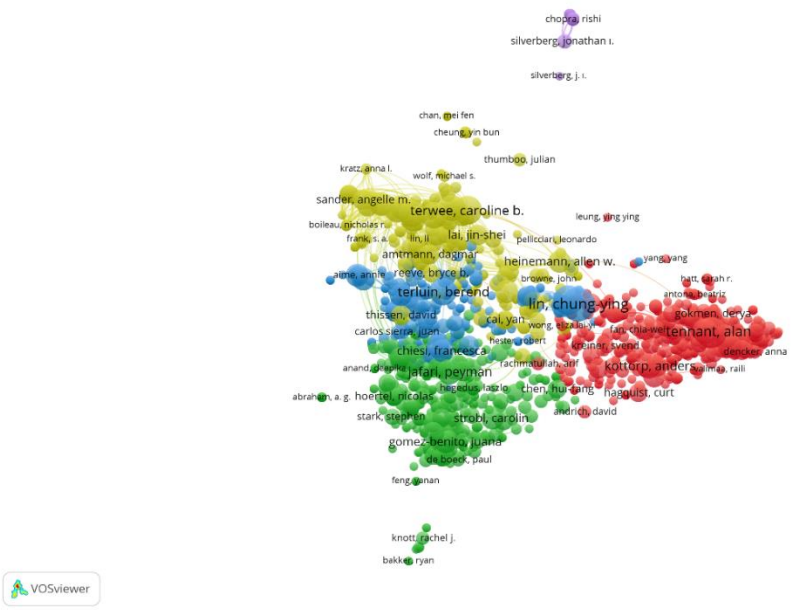

Figure 10. Network Map for Bibliographic Coupling of Authors

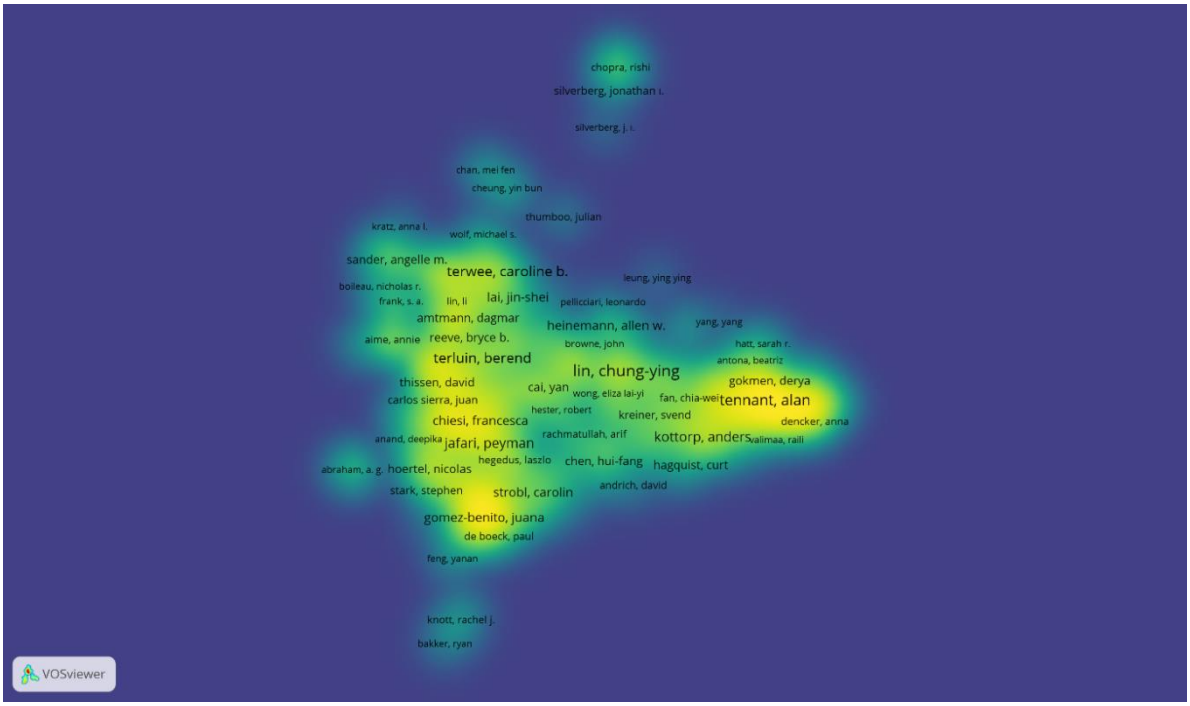

Figure 11. Density Map for Bibliographic Coupling of Authors

Co-authorship of Institutions

The analysis was conducted based on the criterion of having published at least two works and received at least two citations. The institution with the highest number of publications (93), citations received (2141) and total link strength (369) is Northwestern University. It was followed by Copenhagen University with 57 publications,

1082 citations and total link strength of 143 and then the University of North Carolina with 57 publications, 1391 citations and total link strength of 92. The relevant figures are given in figure 12 and figure 13 below.

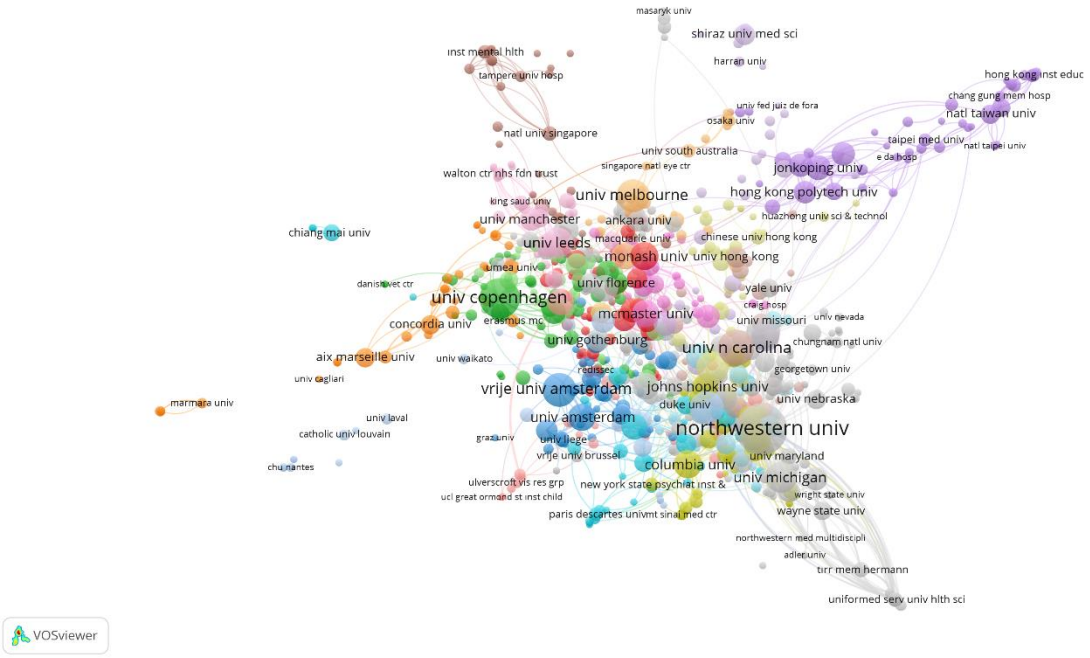

Figure 12. Network Map for Co-Authorship of Institutions

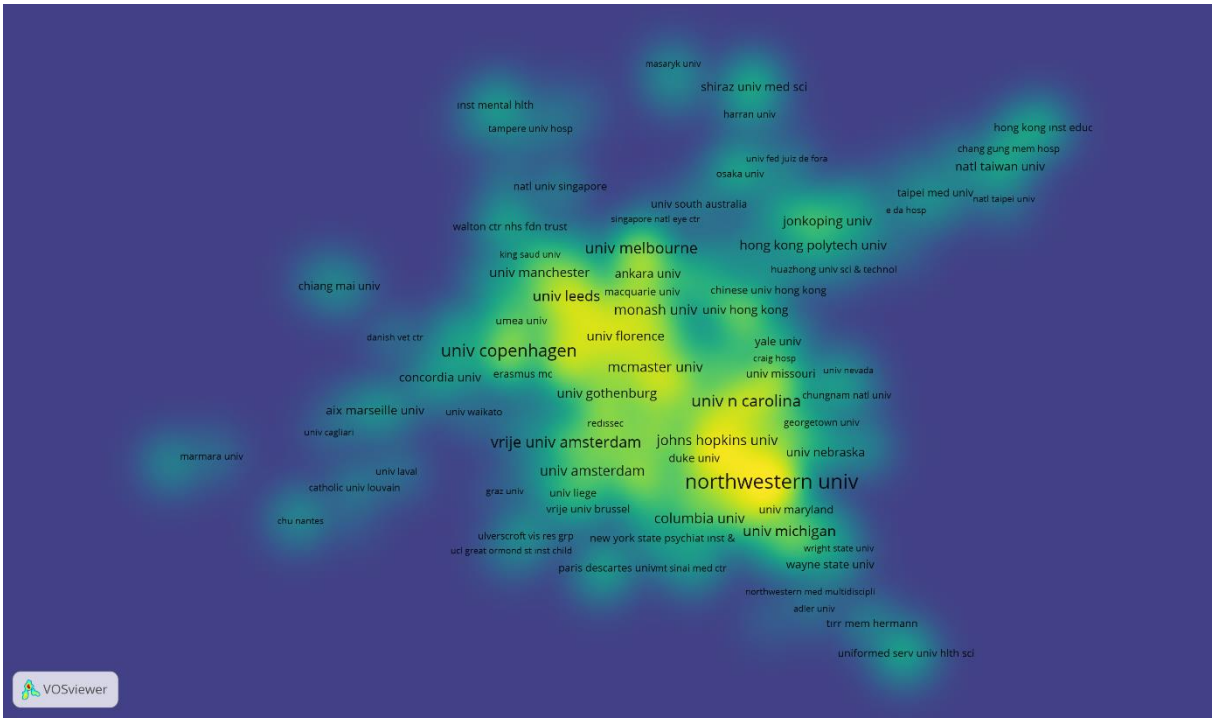

Figure 13. Density Map of Co-Authorship of Institutions

CONCLUSION and DISCUSSION

In this study, various aspects of differential item functioning research worldwide were examined, and a comprehensive analysis of the field was presented. When 2167 articles published between 2012 and 2022 were examined in journals available in the WoS database with certain search filters, it became apparent that the highest number of publications fell within the Health Care Sciences Services, Health Policy Services, Public Environmental Occupational Health, Psychology clinical category. The reason why these fields came to the fore may be because of the rapid advancement of the healthcare sector worldwide and the significant impact of changes in social fields such as psychology on people. Education Educational Research ranked the tenth. There are also a considerable number of studies in the field of Education Educational Research. With the development of science and technology in education, studies in this field have increased and it is expected that these will be reflected in education.

While the lowest number of publications was in 2012, the highest number of publications was in 2019. The results of the study are similar to the content analysis of the highest number of articles in 2019 and 2021 (Eminoğlu-Özmercan, 2023).

The publication count increased from 2012 onwards, but a decrease was observed in 2016. Alexandre J.S has 12 publications with the highest citation count, while Lin, Chung-Ying has the highest number of publications with 26, and 740 citations. It is also possible to say that these authors are not the most linked authors.

According to the analysis, it was revealed that the most effective country that makes the most contribution to the field internationally is the USA, followed by England and Australia. The fact that Turkey ranks the 16th with 53 articles, 320 citations and total link strength of 77 can indicate that more emphasis should be given to studies in this field. It is seen that the USA, in particular, is far ahead of other countries in terms of the number of articles. When the literature is examined, it is seen that there are studies reporting similar results (Aksu & Güzeller, 2019; Aksoy et al., 2021; Bozdoğan, 2019; Bozdoğan, 2020a; Bozdoğan, 2020b; Bozdoğan, 2020c; Bozdoğan et al., 2022; Bozdoğan & Sönmez, 2023; Büyükkıdık, 2022; Çelik, 2022; Delgado Vázquez et al., 2021; Er Türküresin, 2022; Gómez Benito et al., 2005; Huang et al., 2020; Karaca & Akbaba, 2021; Palaz, 2021; Sönmez, 2020; Süzük, 2023; Yeşiltaş & Yılmazer, 2021).

The keywords “differential item functioning”, “Rasch analysis” and “item response theory” were found to be the most recurring words. The publications with the highest bibliographic coupling are Marsh (2014), Carleton (2013) and Gershon (2012). The authors with the highest bibliographic coupling are Morin, Alexandre J. S., Lin, Chung-Ying, and Cella, David. Northwestern University is the institution that has published the most documents and received the most citations.

SUGGESTIONS

- Research can be conducted using various databases such as ERIC, ProQuest, Scopus, on the subject of "differential item functioning".
- A bibliometric analysis can be conducted again by including different types of publications, as this study only examined articles.
- A bibliometric analysis can be conducted again by including different indexes from the Web of Science database along with Science Citation Index-Expanded (SCI-Expanded), Social Sciences Citation Index (SSCI), and Arts & Humanities Citation Index (A&HCI).
- A bibliometric analysis can be conducted to specifically cover the field of educational sciences.

ETHICAL TEXT

In this article, the journal writing rules, publication principles, research and publication ethics, and journal ethical rules were followed. The responsibility belongs to the author for any violations that may arise regarding the article. This study that does not require an ethics committee approval.

Author(s) Contribution Rate: The contribution of the author is 100% in this study.

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