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# A Bibliometric Analysis of Articles on Physics Education in Turkey Between 2010 and 2020*

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**ABSTRACT**

This study aims to make a bibliometric analysis in terms of the research trends, trendsetter institutions and staff in physics education departments in Turkey. The papers published by staff in physics education departments indexed in Web of Science (WoS) and Education Resources Information Center (ERIC) databases between 2010 and 2020 were examined. 286 articles by 91 academic staff were included in the study. The information obtained from the databases was analyzed descriptively. Paper statistics, statistics on preferred journals, statistics on institutions have been analyzed. In addition, research trends are determined. As a result, it is concluded that the quantity of the researchers' papers is affected by the important social events in the country, and the quality by the academic promotion criteria. The proficiency of English and the publishing policies of the journals are influential in the preferences of the journal. Institutions that set research trends tend to focus more on misconception, learning difficulties and conceptual learning. These trends are in line with trends in the world in physics education.

**Keywords:** Bibliometrics, physics education, research trends

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## 1. INTRODUCTION

Physics education studies have an important part in science education studies. Physics education researchers look for ways to teach physics more effectively, to make it popular with society, and to train more qualified physics teachers. Just like physics, the research areas of physics education are extensive.

Each physics education researcher may have different research tendencies in line with their interests. However, research trends emerge when researchers are influenced by each other. For example, during their postgraduate studies at the beginning of their career, they may be influenced by their mentors and other researchers in their institution. This influence can continue in the later stages of their careers. In every field of research, there can be trend-setting researchers who influence their circle especially with their publications and opinions.

In many fields of education, there are bibliometric analyzes that examine trends and researchers' preferences. Abdullah (2022) revealed the global trends in the field of biology education. Conducted different bibliometric analyzes on STEM (e.g., Assefa & Roriss, 2013; Jamali, Ebrahim, Jamali, 2022). Similar analyzes were also made for mathematics education (Jiménez-Fanjul, Maz-Machado, & Bracho-López, 2013; Özkaya, 2018). In the field of science education, as in general bibliometric analyzes (Chang, Chang, & Tseng, 2010; Orhan & Aydın, 2022; Yurdakul & Bozdoğan, 2022); specific bibliometric analyzes were also conducted on topics such as scientific literacy (Effendi, et al., 2021), misconceptions (Kurtuluş & Tatar, 2021).

If it is considered that the first Ph.D. dissertation was published in physics education in 2001 (Yiğit, 2001), the history of the physics education studies in Turkey is not very old. However, physics education departments (PED) in universities are quite old. Universities have had PEDs since the early 20th century. But researchers in these departments have only studied in pure physics for many years. Physics education studies begin to appear in the last decade of the 20th century (Akarsu, 2010; Sözbilir & Canpolat, 2006). After 2001, with the rapid increase in the number of physics education researchers with Ph.D. degrees, physics education studies have also increased.

* No human subjects were used in this study. It includes bibliometric analysis of data obtained from the literature. For these reasons, ethics committee approval is not required.

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With the launch of Sputnik in 1957, the revision of science curricula came to the fore. The first products of these revisions are known as ChemStudy, Physical Sciences Study Committee, Biological Science Curriculum Study in the USA, and Nuffield in the UK (Sözbilir & Canpolat, 2006). Thus, physics education studies emerged as an independent discipline. While the history of physics education research as an independent research area in the world dates back to the 1960s, physics education studies in Turkey began to come into an independent area in 1990s (Akarsu, 2010; Sözbilir & Canpolat, 2006). Akarsu (2010) explains the reason for this delay as follows:

"Early physics professors chose to isolate themselves from physics education in instructional and curriculum because similar to experienced teachers they do not want to improve themselves and put any effort to exercise more advanced teaching strategies and tools in their classes. That's a very typical characteristic of old and experienced educators and teachers." (Akarsu, 2010, p.15).

In the past years, both the number of physics education researchers has increased, and the number of physics education papers has increased in Turkey. It gained momentum especially after the restructuring of education faculties in 1997 (Kaltakçı Gürel & Didiş Körhasan, 2018). An increase of quantity in articles is seen in the last decade in Turkey on physics education. The purpose of this study is to make an overview in terms of the research trends, trendsetter institutions and staff in PEDs in Turkey. Various trend studies have been conducted so far regarding the studies of physics education.

On a local scale, there are studies that analyze physics education articles and graduate theses on physics education published in Turkey (Kaltakçı Gürel, et.al, 2017a; Kaltakçı Gürel, et. al, 2017b). There are some bibliometric analyzes of physics education on a global scale. Specific bibliometric analyzes were performed such as about learning e-books in physics education (Dawana, Dwikoranto, Setiani, & Marsini, 2022), about augmented reality in physics education (Dewi, et.al., 2021), about misconceptions in physics education (Önder-Çelikkanlı & Kızılcık, 2022), problem solving in physics education (Masitoh, et. al., 2021), physics education during the pandemic (Jatmiko, et. al., 2021; Prahani, et. al., 2022). All of these researches are focused on specific issues within the field of physics education on a global scale. Jamali et. al. (2015) found that Turkey is the second country with the highest number of publications in physics education research, after the USA. Therefore, Turkish physics education researchers are involved in bibliometric analyzes for these special topics. How much and what are the general contributions of Turkish researchers? The answer to this question is uncertain. Because, in Turkey there is limited study on national trends.

These researches sometimes cover only national congresses (Kanlı, et. al. 2014; Ünsal, Kızılcık, & Yarımkaya, 2018), sometimes only certain topics such as STEM (Çevik, 2017), and sometimes only published in one or a few journal articles (Önder, et. al., 2013; Sağlam-Arslan & Paliç, 2012). No general national trending research was found for leading indexes in academic promotions such as Web of Science and ERIC. However, the studies in these indexes constitute the main part of Turkey's contribution to the world physics education literature. Thus, it may be possible to forecast on the future of physics education studies in Turkey. With this study, it will be seen whether the physics education studies, which have a history of about 20 years in Turkey, can catch up with the trends in the world. In addition, it will be revealed how much these studies contribute to the physics education literature in the world. In addition, the factors affecting the number of studies and study subjects will be determined. It will be useful to see which subjects' physics education researchers tend to research and where and how they publish their studies, in terms of their contributions to the world literature. In this way, an idea can be formed to guide future research.

The questions that the study seeks to answer are:

- What is the distribution of articles by years and indexes?
- What is the distribution of the citations of the articles by years?
- Which journals were preferred the most and in which country are the publishers of these journals?
- What is the contribution of universities to physics education articles?
- What are the main research themes?

## 2. METHODOLOGY

This study is a bibliometric analysis study. Ellegaard and Wallin (2015, p.1810) states that "Bibliometric methods have been used for providing quantitative analysis of written publications ... These overviews were subdivided into lists of author productions, national or subject bibliographies.". It often focuses on a number of papers or patterns such as geographical (Lin 2012; Zhuang et al. 2013) or institutional aspects, including development over time periods (Huffman et al., 2013), or types of literature and authorships (White & McCain, 1998). Bibliometric analysis has the advantages of being globally comprehensive and reliable, and not requiring expert opinion (Tehci, 2022). Öztürk and Kurutkan (2020) state that bibliometric analysis can be performed for performance analysis and science mapping. Bibliometric analyzes for performance analysis are the evaluation of institutions and publications made in those institutions. Bibliometric analyzes for science mapping are carried out to reveal the dynamics of that science field. Bibliometric studies can be carried out in three ways depending on the nature of the research questions: (i) Narrow focus: Focuses on the research questions that guide the study. (ii) Dynamic focus: It focuses on comparing studies by dividing them into temporal groups. (iii) Structural focus: It focuses on the relationships between institutions,

authors and publications (Durieux & Gevenois, 2010). This study was conducted with a structural focus for the purpose of performance analysis.

Descriptive analysis was conducted as data analyses technique. Web of Science (WoS) and Education Resources Information Center (ERIC) databases were used to collect the data. The most effective index in academic promotion and rewarding in Turkey is WoS. In addition, the leading field index in the field of education is ERIC. They are leading indexes in academic promotions in Turkey. Also, the studies in these indexes constitute the main part of Turkey's contribution to the world physics education literature. Therefore, these indexes were chosen.

Paper bibliographies and the information of the academic staff were collected "YÖK Academic Search" database of Council of Higher Education (YÖK: Yükseköğretim Kurulu) which holds updated data of all academic staff at all Turkish universities. An academic staff can publish different types of papers such as articles, proceedings, theses, and books. However, academic articles are the type of paper that best reflects a researcher's publication tendencies. In this study, the word "paper" is used for "articles".

The research was limited to papers of academic staff currently assigned in PEDs in Turkey. Because there are researchers and academic staff who have papers on physics education even though they are not assigned in PEDs. In addition, in this study, only the papers published by academic staff on physics education were taken into consideration. Because notable number of academic staff who are working in PED also publish papers in pure physics.

When the list of academic staff of 14 universities with PEDs in Turkey was accessed from their websites as of June 2021, it was seen that there are 91 physics education researchers were assigned as academic staff in these departments. The study group was limited to these participants. Also, there are researchers from other departments (primary education, science education, engineering, physics, and other departments) studying in physics education. However, it is very difficult to distinguish them. They are excluded from the study. These could be the subject of another study.

There are only 14 PEDs in Turkish universities. All universities with PEDs are state universities. These departments have 91 academic staff with various academic degrees and titles (see Table 1). The average number of academic staff in PEDs is 91/14 = 6.5.

Table 1.
*Demographics of Academic Staff by Universities, Genders and Titles (F: Female; M: Male; U: University).*

| **Institutions** | **Prof.** | | **Assoc. Prof.** | | **Assist. Prof.** | | **Lecturer** | | **Res. Assist.** | | **Total** | | **Total** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **F** | **M** | **F** | **M** | **F** | **M** | **F** | **M** | **F** | **M** | **F** | **M** | |
| Akdeniz U. (AU) | - | 2 | 1 | - | - | - | 1 | - | - | - | 2 | 2 | 4 |
| Balıkesir U. (BU) | - | 3 | 1 | - | 1 | - | - | - | - | 1 | 2 | 4 | 6 |
| Boğaziçi U. (BOU) | - | - | 1 | 1 | 1 | - | - | - | - | 1 | 2 | 2 | 4 |
| Dokuz Eylül U. (DEU) | 3 | 2 | 1 | 1 | - | - | 1 | - | - | 1 | 5 | 4 | 9 |
| Dicle U. (DU) | - | 4 | 2 | - | - | 1 | - | - | - | - | 2 | 5 | 7 |
| Gazi U. (GU) | 3 | 5 | - | 4 | - | - | - | - | 2 | 1 | 5 | 10 | 15 |
| Hacettepe U. (HU) | 2 | 4 | 2 | - | - | - | 1 | - | 2 | 1 | 7 | 5 | 12 |
| Marmara U. (MU) | 2 | - | - | - | - | 1 | - | - | - | - | 2 | 1 | 3 |
| Middle East Tech. U. (METU) | - | 1 | - | 2 | - | - | - | 1 | 5 | - | 5 | 4 | 9 |
| Necmettin Erbakan U. (NEU) | 1 | 4 | - | 2 | - | - | - | - | 1 | 1 | 2 | 7 | 9 |
| Ondokuz Mayıs U. (OMU) | - | 1 | 2 | 2 | - | - | - | - | - | - | 2 | 3 | 5 |
| Trabzon U. (TU) | 1 | 2 | - | - | - | - | - | - | - | - | 1 | 2 | 3 |
| Van Yüzüncü Yıl U. (VYYU) | - | 2 | - | - | - | - | - | - | - | - | - | 2 | 2 |
| Zonguldak Bülent Ecevit U. (ZBEU) | - | 1 | 1 | - | - | - | - | - | 1 | - | 2 | 1 | 3 |
| **Total** | 12 | 31 | 11 | 12 | 2 | 2 | 3 | 1 | 11 | 6 | 39 | 52 | 91 |

It is accessed 286 papers of 91 academic staff indexed in WoS and ERIC. In the studies included in both databases, the study was taken as WoS. In the ERIC category, papers not indexed in WoS but indexed in ERIC were taken into consideration. The papers indexed in Science Citation Index Expanded (SCI-Exp.), Social Science Citation Index (SSCI) and Arts and Humanities Citation Index (AHCI) in WoS were evaluated according to quartiles (Q1, Q2, Q3 and Q4). Quartiles are the grouping of journals with the same subjects according to the impact factor (IF) by Clarivate Analytics. Journals in the top 25% slice with the highest IF are grouped in Q1, while those in the last 25% slice are grouped in Q4 (Clarivate Analytics, 2021). The Emerging Sources Citation Index (ESCI) was also taken into consideration in separately. The number of citations of the papers in WoS was determined according to the year the paper was published. In addition, the number of citations per paper published that year was also calculated.

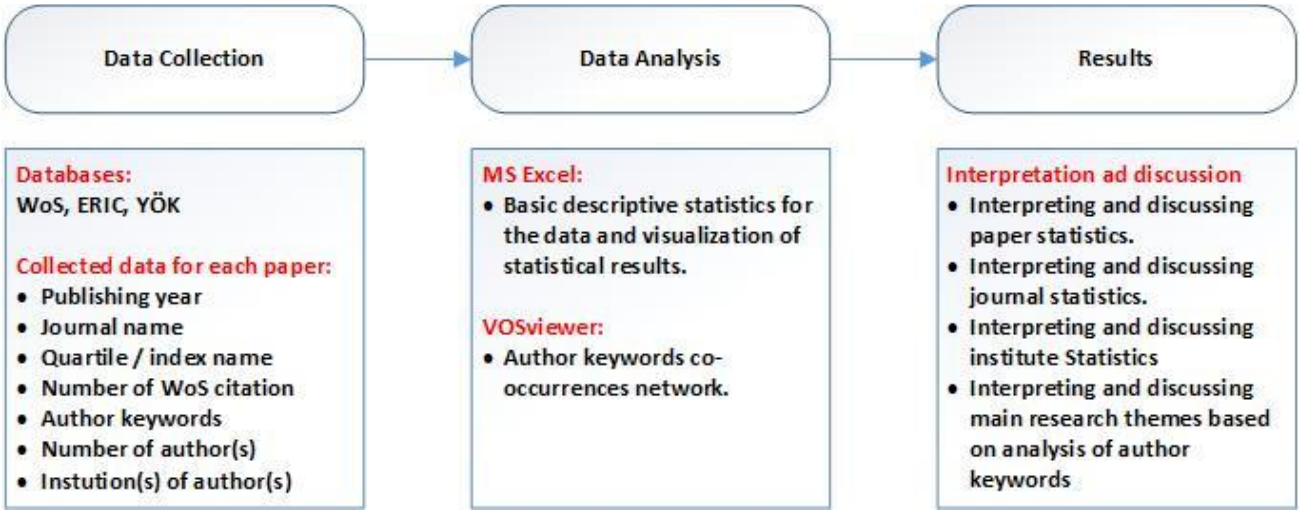

Figure 1. Overview of the research methodology

Most preferred journals were found in the statistics. The journal statistics also give information on the countries of publisher which preferred academic staff in physics education in Turkey. The number of papers and co-authorship of each academic staff were examined. For each paper, the rate of contribution was calculated by dividing it by the number of authors. For example, in a paper with three authors, each author's rate of contribution is considered as 1/3. It should be noted that some of the authors are not academic staff or may be academic staff other than PEDs. Therefore, the total rate of contribution of a paper may not always be 1. In addition, by summing up the academic staff's rate of contributions in a same institution, the rate of contribution made by an institution on papers was calculated. Rate of contribution to paper by gender and title of academic staff was calculated. Main research themes based on analysis of author keywords were also examined.

All data are obtained from open sources. Information about academic staff was obtained from the website of YÖK, data about WoS was obtained from the website of Clarivate Analysis, and information about other journals was obtained from the websites of these journals. Keywords were written by the authors to the article and taken directly from there. These databases provide objective data. In addition, the accuracy of the data was mutually confirmed from different databases (YÖK and ERIC/WoS). All data are taken directly without interpretation. Therefore, whether the data is valid and reliable can be confirmed from open sources. It was double-checked whether the information on all eligible academic staff was obtained. Thus, it was ensured that no study and academic staff were excluded. To ensure validity and reliability, bibliometric research should be replicable and transparent (Block & Fisch, 2020). To this end, how the dataset was obtained, and its sources are clearly stated. No additional validity and reliability studies were required.

## 3. RESULTS AND DISCUSSION

In this section, statistics about papers, statistics about the journals in which the papers are published and statistics about the academic staff and their intuitions are presented.

### 3.1. Paper Quantities

First of all, the distribution of 286 papers in total according to the indexes and their citations in WoS were examined. The papers in WoS are grouped by quartiles. In addition, ESCI, which is not evaluated as a quartile, has been handled separately. The papers that are not indexed in WoS but only indexed in ERIC are also grouped. WoS has been taken into consideration in both WoS and ERIC. The number of papers in indexes by years is presented in Table 2.

Table 2.
*Number of Papers Indexed in WoS and ERIC by Year*

| Years | Mean Number of Authors | Web of Science (WoS) | | | | | | WoS Total | ERIC | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | | SCI-Exp. / SSCI / AHCI | | | | | ESCI | | | |
| | | Q1 | Q2 | Q3 | Q4 | Total | | | | |
| 2010 | 1.67 | 1 | 7 | 2 | 6 | 16 | | 16 | 7 | 23 |
| 2011 | 2.06 | - | 1 | 1 | 9 | 11 | | 11 | 5 | 16 |
| 2012 | 2.32 | 2 | - | 3 | 12 | 17 | | 17 | 5 | 22 |
| 2013 | 1.82 | 1 | 2 | 3 | 9 | 15 | | 15 | 13 | 28 |
| 2014 | 1.91 | 2 | - | 3 | 7 | 12 | | 12 | 9 | 21 |
| 2015 | 1.76 | - | 2 | 3 | 8 | 13 | | 13 | 16 | 29 |
| 2016 | 2.26 | - | 3 | 3 | 8 | 14 | 6 | 20 | 15 | 35 |
| 2017 | 2.29 | - | 1 | 3 | 4 | 8 | 5 | 13 | 11 | 24 |
| 2018 | 2.22 | - | - | 6 | 5 | 11 | 5 | 16 | 21 | 37 |
| 2019 | 2.15 | 1 | 4 | 3 | 6 | 14 | 3 | 17 | 9 | 26 |
| 2020 | 2.52 | 1 | 2 | 3 | 3 | 9 | 8 | 17 | 8 | 25 |
| **Total** | | 8 | 22 | 33 | 77 | 140 | 27 | 167 | 119 | 286 |
| **Mean (per year)** | | 0.73 | 2.00 | 3.00 | 7.00 | 12.73 | 5.40 | 15.18 | 10.82 | 26.00 |

On average, 26 papers are published per year. Of these, 15.18 are indexed in WoS and 10.82 in ERIC. 2018 and then 2016 were the years with the most articles published. Every year but 2018, the number of papers in Q4 is higher than other quartiles. In 2018, Q3 is a surplus. In general, the lower the level of quartile (Q4 to Q1) is the higher the number of papers. In fact, in 5 out of 11 years no papers were published in Q1, and in 2 of them no papers were published in Q2. The ESCI was launched in late 2015 by Thomson Reuters. Therefore, the mean of the last five years has been considered for ESCI. Still, the mean of papers published in ESCI is lower than Q4 but higher than Q3. The number of papers published in SCI-Exp., SSCI or AHCI reached the highest level in 2012, and the number of published in all WoS in 2016. Worldwide, Turkey is the second country with the highest number of publications in science education and physics education research, after the USA (Jamali et. al., 2015; Orhan & Aydın, 2022).

The mean of papers indexed in ERIC is close to the mean of the total of papers indexed in almost all WoS. They make up 41.61% of all papers. The year 2018 is the year when papers indexed in ERIC reached the highest level. The distribution is presented in Figure 1. As can be seen from the distribution, Turkish physics educators mostly prefer journals indexed in Q4 in WoS or journals indexed in ERIC. In general, there is a gradual decrease in the papers published in the journals indexed in WoS, while there is an increase in the ones published in ERIC.

The number of authors of the papers ranges from 1 to 8. The mean number of authors is 2.07 for all. Most papers have one, two or three authors. 150 of the papers (52.45%) have two authors. 67 of them (23.43%) are single authors. The number of papers with three authors is 53 (18.53%). Kaltakçı Gürel et al. (2017b) drew attention to the lack of collaboration with foreign authors in articles on physics education written between 1995 and 2015. This situation is still valid today. International cooperation is still very low.

In recent 11 years, 91 academic staff have published 286 articles indexed in WoS and ERIC databases. 52.45% of the articles have two authors. Therefore, a total of 3.14 articles per person were published. This means that an average of 0.29 articles are published per person per year. This is a fairly low number. This number indicates that the research productivity of academic staff is insufficient. Moreover, 48.95% of the articles are indexed to SCI-Exp. / SSCI / AHCI. 55% of these were published in journals in Q4. In other words, more publications are made in journals of relatively low quality in journals indexed in SCI-Exp. / SSCI / AHCI.

With the launching ESCI in 2015, the number of articles in WoS has increased. The launch of ESCI in 2015 also seems to increase the total number of articles published in the following year. Because publication processes take about a year. Therefore, studies published in any year were performed in the previous year. Gülmez, Özteke and Gümüş (2021) found a similar decline in 2017 in their bibliometric analysis of educational papers in Turkey. This decrease is seen not only in the number of physics education papers, but also in all education papers in general. In 2017, unlike other years, there was a decrease in the total number of academic staff in universities across the country (YÖK, 2022). This decrease may influence the number of publications.

In 2018, the total number of publications started to increase again, more than 2016. However, there is a decrease after 2019. The fact that education faculties started to provide education with a common curriculum in 2018 may have an impact. Some faculties may not have been able to adapt to this change. Similarly, the number of papers increased rapidly after 1997, similar reductions in paper numbers occurred in 2006 and 2007, due to the restructuring process in education faculties (Sözbilir & Kutu, 2008).

To sum up, the quantity of academic research in Turkey is likely affected by important changes in the education system. When changes with major academic impact such as restructuring occur, the number of academic publications decreases in that year or the following year. This may be affecting researchers' motivation and concentration.

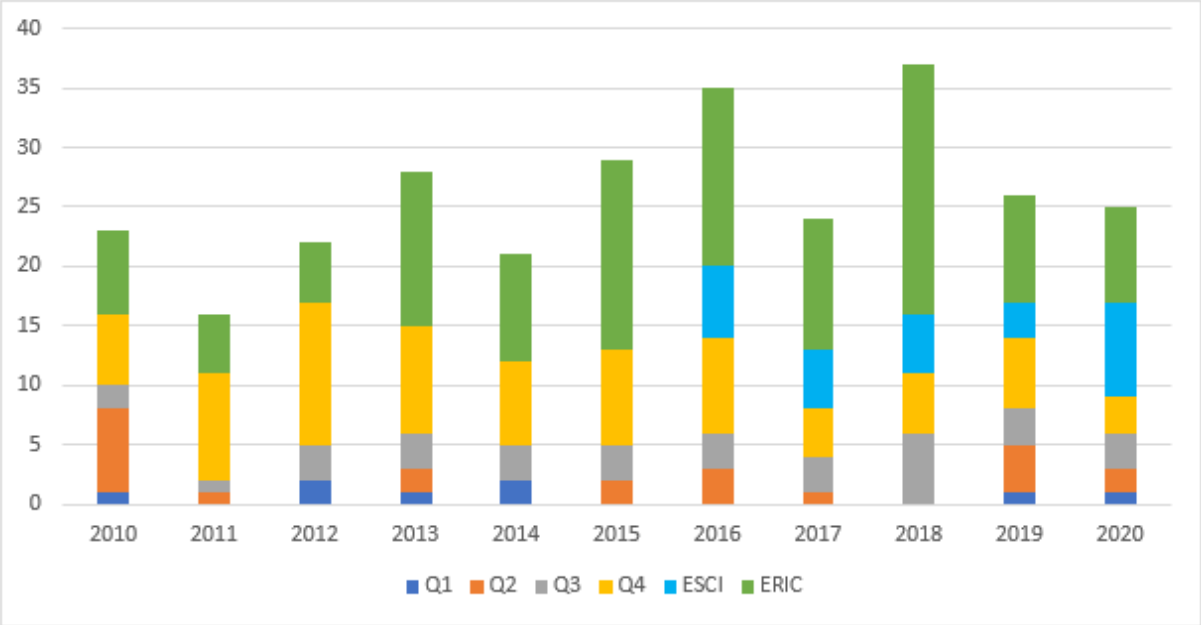


Figure 2. Distribution of papers by indexes

### 3.1. Paper Citations

The quantities of the papers can be understood from their distribution and numbers according to the indexes. However, it is very difficult to determine their qualities with these data. One of the ways to determine the quality of a paper is to look at how much it is cited on other papers. Citations to journals indexed in ERIC are difficult to access. These statistics are not kept in databases. However, it is possible to determine the papers indexed in WoS when they are cited from WoS. Table 3 shows the number of times the papers were cited in WoS according to the years they were published.

Table 3.
*Web of Science Citation Statistics of Papers*

| Publishing Years | Number of Papers | Number of Total Citations | Citations per paper (Number of Citations / Number of Papers) | Citations per paper per year [(Number of Citations / Number of Papers) / Year] |
|---|---|---|---|---|
| 2010 | 16 | 229 | 14.31 | 1.30 |
| 2011 | 11 | 171 | 15.55 | 1.55 |
| 2012 | 17 | 64 | 3.76 | .42 |
| 2013 | 15 | 69 | 4.60 | .58 |
| 2014 | 12 | 114 | 9.50 | 1.36 |
| 2015 | 13 | 90 | 6.92 | 1.15 |
| 2016 | 20 | 64 | 3.20 | .64 |
| 2017 | 13 | 35 | 2.69 | .67 |
| 2018 | 16 | 11 | .69 | .23 |
| 2019 | 17 | 10 | .59 | .29 |
| 2020 | 17 | 5 | .29 | .29 |
| **General** | 167 | 862 | 5.65 | .77 |

In Table 3, number of papers shows the number of articles published in WoS that year. Number of Total Citations shows the total number of citations that articles published on WoS that year have received so far (February 2021). The number of total citations for a paper is related to when the paper was published. Because, after a paper is published, the number of citations accumulatively increases over time. Therefore, the mean number of times a year can be found by dividing each paper by the number of years since the year it was published. Although the number of citations per paper published in 2011 is maximum, the number of citations is also higher when considering the time variable that has passed over the papers published in 2011. It is seen that citations per year have reduced for recent years. There was a dramatic decline in 2012 and 2013. After the rise in 2014, the decline has become steady. Figure 3 shows the citation change over the years.

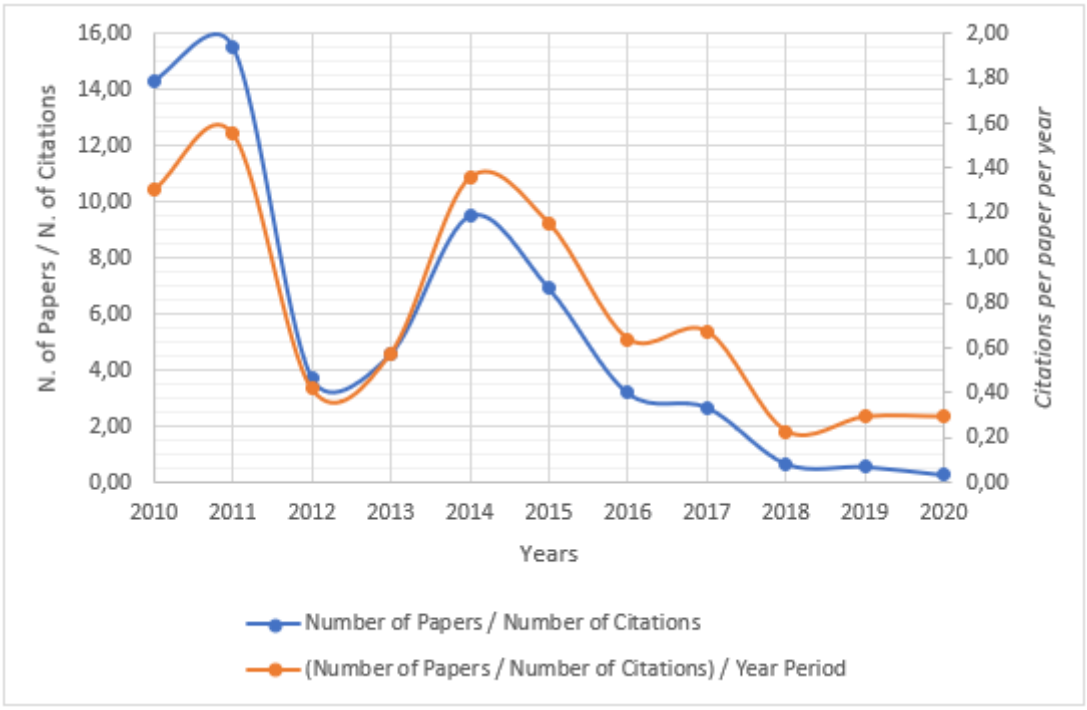


Figure 3. Citations by years

The number of citations per article dropped sharply in 2012 and 2013. Although there was an increase in 2014, there was a steady decline in the following years. There is also a steady decline in the average number of citations per article per year. This means that the citations of the articles published on WoS is gradually decreasing. Although there is an increase in the number of articles compared to the beginning of the decade, the citations of the article is rapidly decreasing.

Turkey ranks fourth among the most cited science education studies (Orhan & Aydın, 2022). But, criteria of promoting to associate professorship has changed in 2016 in Turkey. After 2016, more articles had to be written in order to be promoted to associate professorship. In addition, the obligation to publish articles in national indexes has been imposed. These changes may have caused the number of articles to increase but to decrease their quality. In short, the main reason for this problem may be academic promotion criteria based on quantity rather than quality.

### 3.3. Journals

The 286 papers were published in 69 different journals in total. This means that an average of 4.09 papers are published in a journal. However, while only one paper for each 32 journals was published, 32 papers were published in just one journal. The distribution of journals by country and the number of papers published in these journals are given in Table 4. The distribution of the number of papers published in the most preferred 20 journals by years can be seen in the Table 5.

Table 4.
*Distribution of Journals by Countries and Papers*

| Index | Country of Publishers | Journals (Number of papers) |
|---|---|---|
| ERIC | Canada | Journal of Curriculum and Teaching (1) – Total: 1 |
| | China (HK) | Asia-Pacific Forum on Science Learning and Teaching (23) – Total: 23 |
| | Cyprus | European Journal of Science and Mathematics Education (1) – Total: 1 |
| | Indonesia | Elementary School Forum (Mimbar Sekolah Dasar) (1) – Total: 1 |
| | Kenya | Educational Research and Reviews (10) – Total: 10 |
| | Netherlands | European Journal of Educational Research (2) – Total: 2 |
| | Switzerland | Journal of Outdoor and Environmental Education (1) – Total: 1 |
| | Turkey | International Journal of Environmental Science Education (4); International Journal of Progressive Education (2); International Journal of Research in Education and Science (1); International Journal on New Trends in Education and Their Implications (1); Journal of Education in Science, Environment and Health (1); Journal of Turkish Science Education (1); Science Education International (9); Turkish Online Journal of Distance Education-TOJDE (2); The Turkish Online Journal of Educational Technology (1) – Total: 22 |
| | UK | Physics Education (32); Teacher Development (1) – Total: 33 |
| | US | European Journal of Physics Education (9); Universal Journal of Educational Research (4); Journal of Education and Training Studies (9) – Total: 22 |
| ESCI | Canada | Physics Essays (1) – Total: 1 |
| | India | MIER Journal of Educational Studies, Trends Practices (1) – Total: 1 |
| | Indonesia | Jurnal Pendidikan Fisika Indonesia (1) – Total: 1 |
| | Italy | Dialogues in Philosophy, Mental and Neurosciences (1) – Total: 1 |
| | Romania | BRAIN-Broad Research in Artificial Intelligence and Neuroscience (1) – Total: 1 |
| | Russia | European Journal of Contemporary Education (1) – Total: 1 |
| | Spain | Digital Education (1) – Total: 1 |
| | Turkey | Cukurova University Faculty of Education Journal (2); Eurasian Journal of Educational Research (3); Hacettepe Journal of Education (7); International Journal of Education in Mathematics, Science and Technology (2); International Journal of Instruction (1); Journal of Education and Future (2); Journal of Qualitative Research in Education (1); Pamukkale University Journal of Education (1); Turkish Online Journal of Distance Education-TOJDE (1) – Total: 20 |
| | UK | Curriculum Journal (1) – Total: 1 |
| | US | Education and Information Technologies (1); The Qualitative Report (1) – Total: 2 |
| SCI-Exp./SSCI/AHCI | Canada | Canadian Journal of Physics (7) – Total: 7 |
| | Greece | Chemistry Education Research and Practice (2) – Total: 2 |
| | Ireland | International Journal of Engineering Education (1) – Total: 1 |
| | Lithuania | Journal of Baltic Science Education (12) – Total: 12 |
| | Netherlands | Instructional Science (1); International Journal of Science and Mathematics Education (2); Journal of Science Education and Technology (5); Research in Science Education (6) – Total: 14 |
| | Nigeria | International Journal of Physical Sciences (2); Scientific Research and Essays (1) – Total: 3 |
| | Philippines | Asia-Pacific Education Researcher (1) – Total: 1 |
| | Romania | Romanian Reports in Physics (1) – Total: 1 |
| | Turkey | Educational Sciences-Theory & Practice (3); Education and Science (11); Energy Education Science and Technology (2); Energy Education Science and Technology Part B-Social and Educational Studies (9); Eurasia Journal of Mathematics Science and Technology Education (11); Eurasian Journal of Educational Research (4); Hacettepe Journal of Education (16) – Total: 56 |
| | UK | Computers & Education (1); European Journal of Physics (12); European Journal of Teacher Education (1); International Journal of Science Education (4); Learning and Individual Differences (1); Research in Science & Technological Education (5); Research in Science Technological Education (2); Science & Education (2) – Total: 28 |
| | US | Journal of Chemical Education (1); Journal of Materials Education (2); Physical Review Physics Education Research (6); The Journal of Educational Research (2); The Physics Teacher (4) – Total: 15 |

The articles were published in 21 different journals indexed only in ERIC, 19 different journals indexed in ESCI, and 32 different journals indexed in SCI-Exp. / SSCI / AHCI. The indexes of three journals (Eurasian Journal of Educational Research, Hacettepe Journal of Education, Turkish Online Journal of Distance Education-TOJDE) has changed. Therefore, they are included in more than one index. With the launch of ESCI in 2015, Eurasian Journal of Educational Research and Hacettepe Journal of Education started to be indexed in ESCI instead of SSCI. Turkish Online Journal of Distance Education-TOJDE was only indexed in ERIC before it started indexing in ESCI in 2015.

The most preferred journals among the journals indexed only in ERIC are the United Kingdom (33), China (Hong Kong) (23), Turkey (22) and the United States (22), respectively. Journals in Turkey were generally preferred for the journals indexed in ESCI. The most preferred journals among the journals indexed in SCI-Exp./SSCI/AHCI are Turkey (56), the United Kingdom (28), the United States (15), respectively.

Table 5.
*Number of Papers Published in Top 20 Journals*

| Rank | Journals* | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Physics Education | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 7 | 5 | 4 | 32 |
| 2 | Asia-Pacific Forum on Sci. Learning and Teaching | 4 | 2 | 2 | 4 | 1 | 2 | 2 | 1 | 5 | - | - | 23 |
| 3 | Hacettepe J. of Educ. | 1 | 4 | 3 | 6 | - | 2 | 3 | 1 | 1 | - | 2 | 23 |
| 4 | European J. of Physics | 1 | 1 | - | - | 1 | 1 | 5 | - | 2 | 1 | - | 12 |
| 4 | J. of Baltic Sci. Educ. | 2 | - | 1 | 1 | - | 1 | 1 | 3 | 1 | 1 | 1 | 12 |
| 6 | Education and Science | 1 | - | 1 | - | 5 | 2 | - | - | - | 1 | 1 | 11 |
| 6 | Eurasia J. of Math. Sci. and Tech. Educ. | - | - | - | 1 | 4 | 2 | 3 | - | 1 | - | - | 11 |
| 8 | Educational Res. and Rev. | - | 2 | - | 4 | 1 | 2 | 1 | - | - | - | - | 10 |
| 9 | Energy Educ. Sci. and Tech. Part B-Soc. and Educational Studies | - | 4 | 5 | - | - | - | - | - | - | - | - | 9 |
| 9 | European J. of Physics Educ. | - | - | 1 | 1 | - | 4 | 2 | 1 | - | - | - | 9 |
| 9 | J. of Educ. and Training Studies | - | - | - | - | - | 1 | 2 | 3 | 3 | - | - | 9 |
| 9 | Sci. Educ. Int. | - | - | 1 | - | 2 | 2 | 1 | - | 1 | 2 | - | 9 |
| 13 | Canadian J. of Physics | - | - | - | - | - | - | - | - | 4 | 2 | 1 | 7 |
| 13 | Eurasian J. of Educational Res. | 1 | - | 2 | 1 | - | - | 1 | 1 | - | - | 1 | 7 |
| 15 | Physical Rev. Phy. Educ. Res. | - | - | 1 | - | 1 | - | 1 | - | - | 2 | 1 | 6 |
| 15 | Res. in Sci. Educ. | 2 | 1 | - | 1 | - | - | - | - | - | 2 | - | 6 |
| 17 | J. of Sci. Educ. and Tech. | 3 | - | - | - | - | - | 1 | 1 | - | - | - | 5 |
| 17 | Res. in Sci. & Technological Educ. | - | 1 | - | 1 | - | 1 | 1 | - | 1 | - | - | 5 |
| 19 | Int. J. of Sci. Educ. | - | - | 2 | - | - | - | - | - | - | 1 | 1 | 4 |
| 19 | The Physics Teacher | - | - | - | - | - | 1 | - | - | - | 2 | 1 | 4 |

* Educ.: Education; J.: Journal; Math.: Mathematics; Phy.: Physics; Res.: Research; Rev.: Reviews; Sci.: Science; Soc.: Social; Tech.: Technology.

Physics Education indexed in ERIC is the most preferred journal. It is followed by Asia-Pacific Forum on Science Learning and Teaching, which is also indexed in ERIC. Following that, Hacettepe Journal of Education is a journal that was indexed in SSCI until 2015, but after 2015 in ESCI. Approximately 27% of all papers are published in these three journals only. Similarly, Prahani (2022) found that the most preferred journal in the field of physics education worldwide is Physics Education. Exactly half of all papers were published in the top 9 journals ranked in Table 5. It will be useful to examine in which country the journals are located. Scimago Journal & Country Rank database was used for this. The data can be seen in Table 5.

Table 6.
*Distribution of Papers According to the Country Where the Journals are Located*

| Country | Number of Papers (NP) | Number of Journals (NJ) | NP/NJ |
|---|---|---|---|
| Turkey | 99 | 22 | 4.50 |
| United Kingdom | 62 | 11 | 5.64 |
| USA | 39 | 10 | 3.90 |
| China (Hong Kong) | 23 | 1 | 23.00 |
| Netherlands | 16 | 5 | 3.20 |
| Lithuania | 12 | 1 | 12.00 |
| Kenya | 10 | 1 | 10.00 |
| Canada | 9 | 3 | 3.00 |
| Nigeria | 3 | 2 | 1.50 |
| Greece | 2 | 1 | 2.00 |
| Indonesia | 2 | 2 | 1.00 |
| Romania | 2 | 2 | 1.00 |
| Cyprus | 1 | 1 | 1.00 |
| India | 1 | 1 | 1.00 |
| Ireland | 1 | 1 | 1.00 |
| Italy | 1 | 1 | 1.00 |
| Philippines | 1 | 1 | 1.00 |
| Russia | 1 | 1 | 1.00 |
| Spain | 1 | 1 | 1.00 |
| Switzerland | 1 | 1 | 1.00 |
| **Total / Mean** | 286 | 69 | 3.94 |

22 of 69 journals are in Turkey and 99 papers have been published in these journals. It makes an average of 4.50 papers. It is noteworthy that 23 publications were made in only one journal (Asia-Pacific Forum on Science Learning and Teaching) from China (Hong Kong). This is followed by a journal (Journal of Baltic Science Education) from Lithuania, where 12 papers are published. 10 papers were published in a journal in Kenya (Educational Research and Reviews). However, the most preferred countries after Turkey (99 papers) are the United Kingdom (62 papers) and the USA (39 papers).

Physics Education, which is the journal originated in the United Kingdom and publishes more in-class practical applications over theoretical and experimental studies, has become the most preferred journal. This journal is indexed in ERIC. Asia-Pacific Forum on Science Learning and Teaching is the second most preferred journal which originated in Hong Kong, also indexed in ERIC. These two journals published almost half (46.22%) of the articles indexed in ERIC. The reason for choosing the first one may be that it covers more practical applications within the classroom. Physics education research findings carried out in education faculties can be reflected in the content of the secondary education physics education and physics teacher education program, thus contributing to the practice in a more local sense (Kaltakçı Gürel & Didiş Körhasan, 2018). Therefore, the number of papers for practical classroom applications is quite high. This may affects the journal preference. The reason for choosing the second one may be that, unlike many journals, it has no page limitation. Academic writing habits in Turkey make it easy to publish an article. Because Turkish researchers have a habit of writing relatively long articles. After the United Kingdom and China, the most preferred journals indexed in ERIC are originated in Turkey. That supports this preference.

Hacettepe Journal of Education which is indexed in SSCI until 2015 and in ESCI after 2015 is the most preferred journal in WoS. The reason why this journal is preferred may be that it has been allowing to publish Turkish articles until recently. Although most of them were published in international journals, 80% of the physics education articles published in Turkey between 1995 and 2015 were published in Turkish (Kaltakçı Gürel, et. al. 2017b). Nowadays, most of WoS indexed journals that is originating in Turkey allows to be published articles in English only. With the change made in 2018 in the criteria for promotion to associate professorship, the required foreign language proficiency has been reduced. English proficiency of academics in Turkey and their graduate students to study with may be said to be effective in their preference of journals. However, most preferred the two countries after Turkey originated journals is the United Kingdom and the United States origins. Most of these publications are relatively recent. This situation can be interpreted as English proficiency problems have started to be solved, especially in recent years.

## 3.4. Institutions

The number of papers included in the curriculum vitae of each academic staff and the rate of contribution to these publications were considered. By calculating the averages on the basis of institutions, the rate of contributions of the institutions to the papers were determined. These data are presented in Table 7.

Table 7.
*Number of Papers and Rate of Contribution to Paper by Institutions*

| Institutions* | | Number of Papers | | | | | | Rate of Contribution | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Web of Science (WoS) | | | | ESCI | ERIC | Web of Science (WoS) | | | | ESCI | ERIC | Total |
| | | SCI-Exp. / SSCI / AHCI | | | | | | SCI-Exp. / SSCI / AHCI | | | | | | |
| | | Q1 | Q2 | Q3 | Q4 | | | Q1 | Q2 | Q3 | Q4 | | | |
| AU | Per person | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | Total | - | - | - | - | - | - | - | - | - | - | - | - | - |
| BU | Per person | .17 | - | - | 1.00 | .33 | 1.83 | .17 | - | - | .43 | .14 | .65 | 1.39 |
| | Total | 1 | - | - | 6 | 2 | 11 | 1.00 | - | - | 2.58 | .83 | 3.92 | 8.33 |
| BOU | Per person | .25 | 1.50 | 1.00 | .75 | - | .50 | .08 | .83 | .52 | .46 | - | .50 | 2.39 |
| | Total | 1 | 6 | 4 | 3 | - | 2 | .33 | 3.33 | 2.08 | 1.83 | - | 2.00 | 9.57 |
| DEU | Per person | - | .56 | .11 | 1.89 | .44 | 3.11 | - | .31 | .06 | 1.02 | .33 | 1.69 | 3.41 |
| | Total | - | 5 | 1 | 17 | 4 | 28 | - | 2.83 | .50 | 9.17 | 3.00 | 15.17 | 30.67 |
| DU | Per person | - | - | - | - | .14 | 3.71 | - | - | - | - | .05 | 1.78 | 1.83 |
| | Total | - | - | - | - | 1 | 26 | - | - | - | - | .33 | 12.48 | 12.81 |
| GU | Per person | .07 | .13 | .33 | 1.20 | .40 | 2.20 | .02 | .07 | .14 | .67 | .20 | 1.37 | 1.93 |
| | Total | 1 | 2 | 5 | 18 | 6 | 33 | .25 | 1.00 | 2.13 | 1.08 | 3.00 | 20.50 | 28.96 |
| HU | Per person | .08 | - | .67 | 2.42 | 1.25 | .83 | .04 | - | .32 | 1.42 | .41 | .37 | 2.56 |
| | Total | 1 | - | 8 | 29 | 15 | 10 | .50 | - | 3.83 | 17.00 | 4.88 | 4.40 | 30.61 |
| MU | Per person | - | .33 | 1.67 | .33 | - | 2.33 | - | .17 | .83 | .17 | - | 1.17 | 2.34 |
| | Total | - | 1 | 5 | 1 | - | 7 | - | .50 | 2.50 | .50 | - | 3.50 | 7.00 |
| METU | Per person | .33 | .67 | .89 | .67 | .33 | .67 | .13 | .37 | .39 | .35 | .17 | .28 | 1.69 |
| | Total | 3 | 6 | 8 | 6 | 3 | 6 | 1.17 | 3.33 | 3.50 | 3.17 | 1.50 | 2.50 | 15.17 |
| NEU | Per person | - | - | - | .56 | - | .56 | - | - | - | .23 | - | .56 | .79 |
| | Total | - | - | - | 5 | - | 5 | - | - | - | 2.03 | - | 5.00 | 7.03 |
| OMU | Per person | .20 | .20 | .20 | .60 | .20 | 1.40 | .20 | .07 | .10 | .50 | .20 | 1.17 | 2.24 |
| | Total | 1 | 1 | 1 | 3 | 1 | 7 | 1.00 | .33 | .50 | 2.50 | 1.00 | 5.83 | 11.16 |
| TU | Per person | - | .67 | 1.67 | 1.67 | 1.00 | 2.33 | - | .44 | .78 | .89 | .50 | 1.08 | 3.69 |
| | Total | - | 2 | 5 | 5 | 3 | 7 | - | 1.33 | 2.33 | 2.67 | 1.50 | 3.25 | 11.08 |
| VYYU | Per person | - | - | - | - | 1.00 | 3.50 | - | - | - | - | .42 | 1.75 | 2.17 |
| | Total | - | - | - | - | 2 | 7 | - | - | - | - | .83 | 3.50 | 4.33 |
| ZBEU | Per person | .67 | 1.33 | .33 | 1.67 | - | 1.00 | .44 | .75 | .17 | .83 | - | .44 | 2.63 |
| | Total | 2 | 4 | 1 | 5 | - | 3 | 1.33 | 2.25 | .50 | 2.50 | - | 1.33 | 7.91 |
| **Total** | **Per person** | .09 | .24 | .36 | .85 | .26 | 1.34 | .10 | .20 | .20 | .60 | .20 | .93 | 2.11 |
| | **Total** | 8 | 22 | 33 | 77 | 24 | 122 | 5.58 | 14.92 | 17.88 | 54.03 | 15.22 | 84.55 | 192.18 |

* The explanation of institution abbreviations can be found in Table 1.

A total of 286/91 = 3.14 articles per person were published. It makes 0.29 articles per person per year. Academic staff at AU have no papers on physics education. Those at the AU study only pure physics. Physics education is also studied, although there are some staff who wrote pure physics papers at other institutions. DEU, HU and GU are the institutions that contributed the most to the physics education paper. The rate of contribution of these three institutions constitutes approximately 47% of the total (see Figure 4). The other twelve institutions share the remaining rate of contribution. METU comes after these three institutions. However, its rate of contribution is about half of any of these three institutions. These data can indicate that these three institutions are effective and pioneering in the international physics education paper activities in Turkey. In total, the least contribution came from VYYU after AU. Kaltakçı Gürel, et. al. (2017a) states that GU, TU, MU, METU were the institutions where the most postgraduate theses were conducted between 1990-2016, respectively. Today, the contribution of GU and METU is still relatively high in articles.

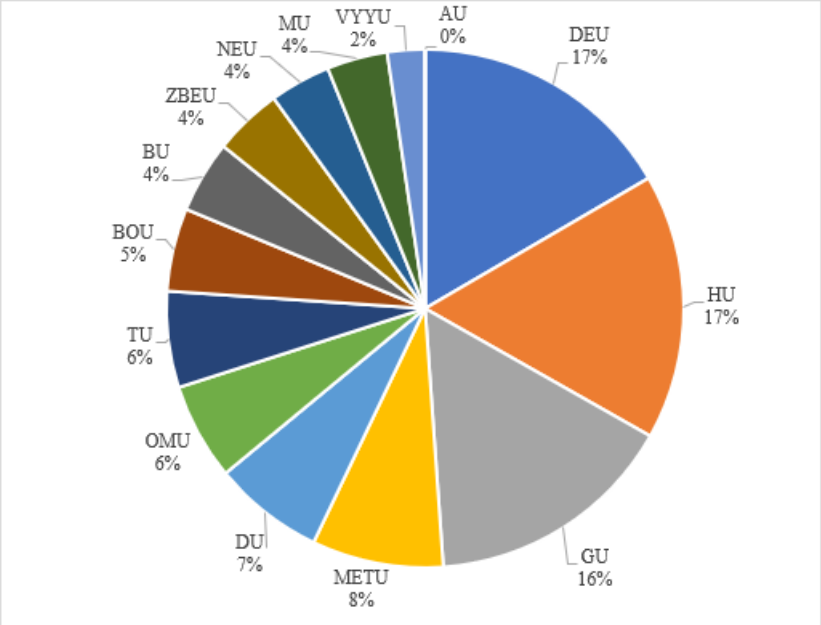


Figure 4. Percentage distribution of rate of total contribution to paper by institutions

The ranking of the rate of contribution per academic staff are: TU, DEU, ZBEU, HU, BOU, MU, OMU... etc. DEU ranked second, HU ranked fourth and GU ninth. Average paper productivity is higher at DEU in these three institutions. However, looking at the rate of contribution per person, TU and then DEU take the lead (see Figure 5).

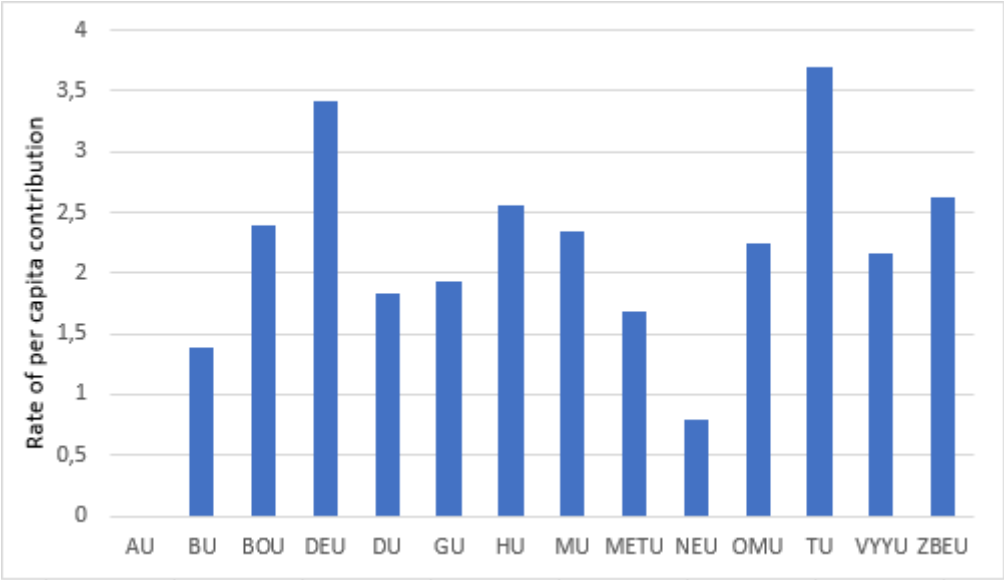


Figure 5. Percentage distribution of rate of per capita contribution to paper by institutions

If we consider these data in terms of indexes, HU, DEU and METU are the institutions that contribute the most to the papers in the SCI-Exp., SSCI or AHCI indexes (see Figure 6). No paper has been contributed to these indexes from DU and VYYU. The largest contributor to papers in ERIC is GU. It is followed by DEU and DU. The fewest contributions to the papers in the ERIC were made by ZBEU.

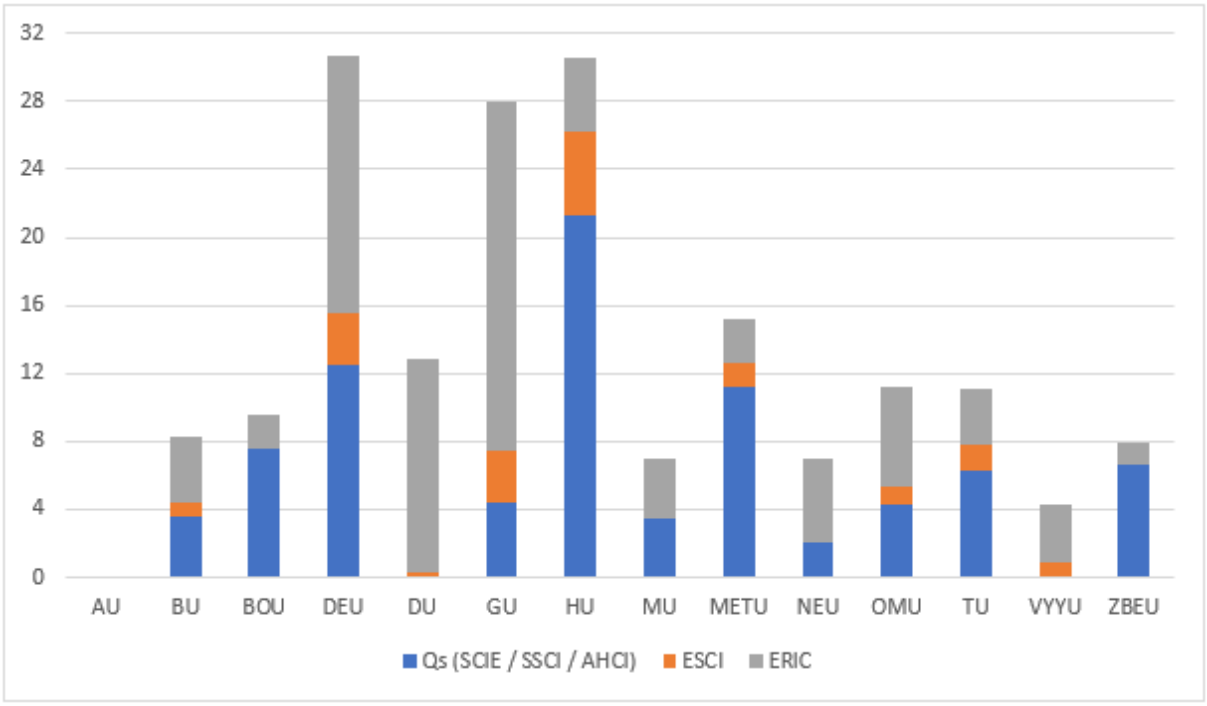


Figure 6. Rate of total contribution to paper of institutions by indexes

AU does not contribute. The least contribution comes from VYYU after AU. DEU, HU and GU are the institutions that contributed the most to the physics education paper. The rate of contribution of these three institutions constitutes approximately 47% of the total. The reason why almost half of the contribution to the papers comes from the three institutions may be that the number of academic staff of these three institutions is higher than the other institutions. The total number of academic staff of these three institutions is 15 + 12 + 9 = 36. The number of the total number of academic staff in Turkey is almost one third. However, their contribution is almost half. This situation can be understood by looking at the mean rate (per person) of contribution. This number is the rate of contribution per academic staff in an institution. Looking at the rate of contribution per person, TU and then DEU take the lead. HU and GU are falling behind. If we consider the data in terms of indexes, HU, DEU and METU are the institutions that contribute the most to the papers in the SCI-Exp. / SSCI / AHCI indexes. The largest contributor to papers in ERIC is GU. However, a study examining the papers of Turkish authors published before 2011 in one of the journals indexed in ERIC showed that the contribution from DEU and BU was greater (Önder, et. al., 2013). These are followed by GU and TU. There seems to be an increase in the number of publications indexed in ERIC on GU after 2011. Four institutions in total stand out as trend setters: HU, DEU, GU and METU. These four institutions lead the way with both the large number of researchers and the number of articles in physics education. The institution that contributed the most to National Physics Education Congresses is GU, METU, DEU and TU, respectively (Ünsal, Kızılcık, & Yarımkaya, 2018). Also, a study shows that GU and METU are also among the trend-setters in STEM education (Çevik, 2017).

### 3.5. Main Research Themes Based on Analysis of Author Keywords

Author keywords were used to determine main research themes. The number of author keywords the papers have ranges from 1 to 10. In total, 37.71% of the papers have four, 29.66% of the papers have five and 25% of the papers have three author keywords. All of 239 papers have 998 author keywords in total and they have 4.18 author keywords in average. There is no author keyword on 47 papers. It was seen that there were 604 different author keywords individually. In the papers, 479 keywords were preferred once, 74 keywords were preferred twice and 22 keywords were preferred three times, as the author keyword. The most preferred (more than three times) 30 keywords are presented in Table 8.

Table 8.
*The Most Preferred Author Keywords (Top 30)*

| Rank | Author keywords | N | Rank | Author keywords | N |
|---|---|---|---|---|---|
| 1 | physics education | 54 | 16 | argumentation | 6 |
| 2 | physics | 21 | 16 | learning styles | 6 |
| 3 | misconceptions | 19 | 18 | achievement | 5 |
| 4 | pre-service teachers | 13 | 18 | conceptual understanding | 5 |
| 5 | science education | 12 | 18 | metacognition | 5 |
| 6 | attitude | 10 | 18 | physics achievement | 5 |
| 6 | high school students | 10 | 18 | physics teaching | 5 |
| 6 | problem solving | 10 | 18 | temperature | 5 |
| 9 | gender | 8 | 24 | concept map | 4 |
| 9 | mental models | 8 | 24 | constructivism | 4 |
| 11 | conceptual change | 7 | 24 | internal energy | 4 |
| 11 | force and motion | 7 | 24 | learning | 4 |
| 11 | heat | 7 | 24 | physics anxiety | 4 |
| 11 | pre-service physics teachers | 7 | 24 | physics laboratory | 4 |
| 11 | teacher education | 7 | 30 | academic achievement | 3 |

Physics education and physics are the first two keywords mostly preferred by authors. Keyword science education ranks fifth. These three are very general keywords. They don't give us enough information about research themes. However, keywords such as misconception, attitude, problem solving, mental models, conceptual change, physics achievement, concept map, etc. gives us information about research trends in Turkey. In addition, keywords such as pre-service teachers, high school students, gender, pre-service physics teachers, teacher education, etc. provide us with information about research groups or samples. In addition, keywords such as force and motion, heat, temperature, internal energy, etc. show us which physics topics and concepts are focused on. To better understand research themes, the main research themes based on author keywords co-occurrences network are visualized (see Figure 7) with the help of VOSviewer.

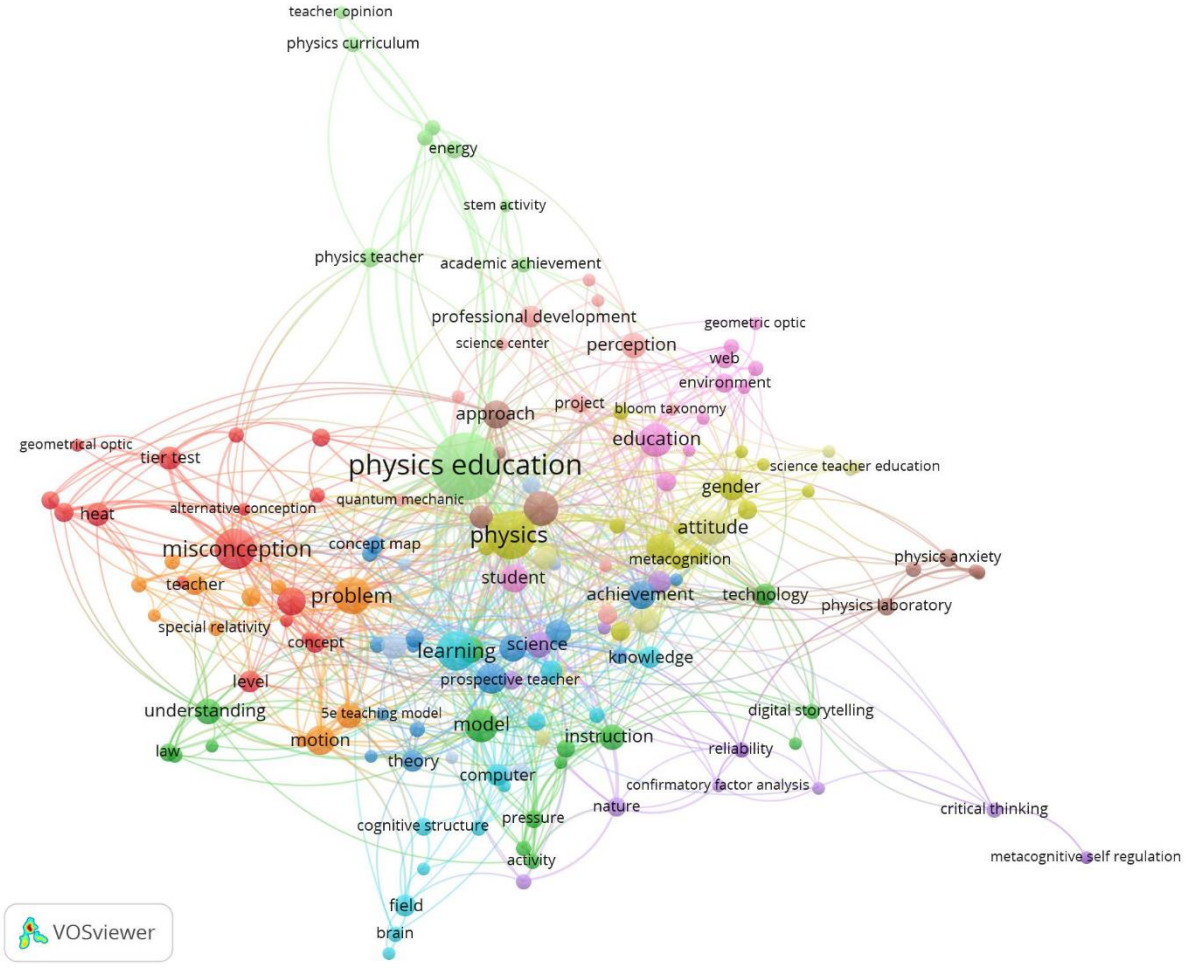


Figure 7. Visualizing the main research themes based on author keywords co-occurrences network

Co-occurrence relationships of keywords are quite complex. In Figure 7, each different colour shows a cluster. For example, the cluster where the keyword misconception is at the centre is related with keywords such as tier test, geometrical optics, heat, concept, level. The cluster where the keyword problem is at the centre is related with keywords such as special relativity, teacher, 5E teaching model, motion. The cluster where the keyword physics education is at the centre is related with keywords such as STEM activity, physics teacher, physics curriculum, energy, academic achievement. The cluster where the keyword education is at the center is related with keywords such as environment, Bloom taxonomy, web, geometric optics. In this way, it is possible to see some relationships such as which physics concepts are focused on in misconception studies, how educational technologies and physics education are associated. Physics education studies were also carried out with distance education, as partly compulsory distance education was started in 2020. Jatmiko et. al. (2021) determined that during distance education, physics education research clustered around the concepts of experiments, online learning, physics teacher, and physics course. This shows that the distance education process radically affects physics education research. The most frequently studied topics in physics education articles published between 1995 and 2015 are "teaching", "learning", "attitude-interest determination" and "curriculum" studies, respectively (Kaltakçı Gürel, et. al. 2017b). Today, it can be said that physics education studies have different foci.

According to the most cited articles and the clusters of author keywords, it is seen that misconception and conceptual learning came to the fore in almost all years. Analysis of the National Physics Education congress organized in 2013, 2015, and 2017 in Turkey show that the research trends are the similar (Ünsal, Kızılcık, & Yarımkaya, 2018). It seems that diagnosing misconception is important. Then keywords such as physics success and attitude stand out. Studies on conceptual learning before 2010 focused more on electricity, dynamics, magnetism and thermodynamics (Kanlı, et. al. 2014; Önder, et. al., 2013; Sağlam-Arslan & Paliç, 2012; Ünsal, Kızılcık, & Yarımkaya, 2018). This research shows that after 2010, emphasis has been placed on misconception diagnosis and improvement studies on various topics such as heat, temperature, geometrical optics, motion, electrical circuits and modern physics. The fact that conceptual change and conceptual learning subjects are very popular supports this situation. Also, the emphasis is on training teachers. The physics education studies in Turkey started the last decade of 20th century and they began adopting constructivism. The popularity of studies on misconception and conceptual learning is the result of constructivism. Emphasis is placed on diagnosing misconceptions and then searching for ways to remediate them. Research trends in science education in the world and in Turkey between 1990 and 2010 also focused on conceptual learning (Chang, Chang, & Tseng, 2010; Kanlı, et. al. 2014; Lee, Wu, & Tsai, 2009; Önder, et. al., 2013; Tsai & Wen, 2005). It seems that this trend has not changed.

Table 9.
*Analysis of the Most Cited Articles*

| Years | N. of Citations | Qs | Author keywords | N. of Authors | Intuitions' rate of contribution* |
|---|---|---|---|---|---|
| 2010 | 82 | 1 | physics laboratory; physics achievement; science process skills; attitude | 1 | ZBEU (1) |
| 2015 | 57 | 3 | diagnostic instruments; misconceptions; science education | 3 | METU (1/3) |
| 2010 | 57 | 3 | physics education; misconceptions; three-tier tests; simple electric circuits | 2 | METU (1/2) |
| 2011 | 47 | 4 | worksheet; misconception of force/motion; science student teachers; science education | 3 | TU (1/3) |
| 2011 | 32 | 4 | biology education; adhesion; cohesion; misconceptions; surface tension | 2 | NEU (1/2) |
| 2014 | 25 | 1 | quantum-mechanics; conceptual change; physics | 3 | METU (1/3); ZBEU (1/3) |
| 2011 | 25 | 4 | physics teaching; guided discussion method; magnetism | 1 | TU (1) |
| 2010 | 22 | 2 | problem-based learning; physics education; achievement; attitude; approaches to learning | 1 | DEU (1) |
| 2012 | 21 | 3 | argumentation; conceptual knowledge; physics | 2 | MU (1/2) |
| 2014 | 16 | 3 | astronomy concepts; misconceptions; three-tier test; pre- and in-service teachers | 1 | GU (1) |
| 2013 | 14 | 3 | gender; metacognition; physics self-efficacy; socioeconomic status; structural equation modeling | 2 | BOU (1/2) |
| 2016 | 13 | 4 | physics education; pre-service training; misconceptions; geometrical optics | 3 | METU (1/3) |
| 2010 | 13 | 4 | physics education; three-tier test; misconception test; heat; temperature | 1 | METU (1) |
| 2010 | 11 | 2 | physics education; physics questions; interest; gender | 2 | BOU (1/2); METU (1/2) |
| 2010 | 11 | 2 | cross-grade; level of understanding; conceptual development; energy concepts | 1 | TU (1) |
| 2014 | 10 | 1 | - | 2 | METU (1/2) |
| 2015 | 10 | 4 | photoelectric effect; blackbody radiation; Compton effect; mental models; model states | 1 | HU (1) |

* The explanation of institution abbreviations can be found in Table 1.

There are 17 articles with more than 10 citations. Three of them were published in journals in Q1 and Q2, five in Q3, and six in Q4. The most cited article was published in 2010. The most recent of the articles with 10 or more citations was published in 2016. The most cited articles of each year from 2010 to 2016 are listed in Table 9. The number of citations is lower in the following years.

Author numbers range from 1 to 3. There are seven articles with a single author, six articles with two and four articles with three authors. Other authors not listed in the table are not from PEDs. The five most cited articles were written by male researchers. The total rate of contributions of the institutions are as follows: METU (3.50), TU (2.33), ZBEU (1.33), DEU, BOU, GU, HU (1.00), MU and NEU (0.50).

Author keywords of the most cited article published in 2010 are physics laboratory; physics achievement; science process skills; attitude. Author keywords of another highly cited article published in the same year are physics education; misconceptions; three-tier tests; simple electric circuits. In addition, four articles with the following author keywords received more than 10 citations in the same year: problem-based learning; physics education; achievement; attitude; approaches to learning - physics education; three-tier test; misconception test; heat; temperature - physics education; physics questions; interest; gender - cross-grade; level of understanding; conceptual development; energy concepts. Author keywords of the most cited article published in 2011 are worksheet; misconception of force / motion; science student teachers; science education. Author keywords of other highly cited articles published in the same year are: biology education; adhesion; cohesion; misconceptions; surface tension - physics teaching; guided discussion method; magnetism. The author keywords of the most cited article published in 2012 are argumentation; conceptual knowledge; physics. Author keywords of the most cited article published in 2013 are gender; metacognition; physics self-efficacy; socioeconomic status; structural equation modeling. The author keywords of the most cited article published in 2014 are quantum-mechanics; conceptual change; physics. The author keywords of another highly cited article published in the same year are: astronomy concepts; misconceptions; three-tier test; pre-and in-service teachers. The

author keywords of the most cited article published in 2015 are diagnostic instruments; misconceptions; science education. The author keywords of another highly cited article published in the same year are: photoelectric effect; blackbody radiation; Compton effect; mental models; model states. Author keywords of the most cited article published in 2016 are physics education; pre-service training; misconceptions; geometrical optics.

Although Turkey ranks fourth among the most cited science education studies, it ranks second in misconception studies (Kurtuluş & Tatar, 2021; Orhan & Aydın, 2022). In this study, among the most cited articles, it is seen that misconception and conceptual learning came to the fore in all years between 2010-2016 except 2013. It seems that diagnosing misconception is important. Then keywords such as physics success and attitude stand out. Rebello and Zollman (2005) state that trending research questions in physics education in 2005 are related to learning difficulties and misconceptions in the world. It is seen that this trend continues today (Kaltakçı Gürel & Didiş Körhasan, 2018). Physics education mainly focuses on misconceptions and ways to remedy them. Physics education studies in Turkey have caught the trend in the world in this context.

## 4. CONCLUSION

Among the science, physics, chemistry and biology education researches, the most studies were published in the field of science education, followed by physics education studies (Orhan & Aydın, 2022). This ranking is proportional to the number of researchers. As the number of physics education researchers increases, the number of studies naturally increases. On the other hand, the quantity of physics education research is affected by change in academic promotion criteria and the interventions of YÖK like in other fields of education (Sözbilir & Kutu, 2018). Changes such as the intervention of YÖK in the curricula of education faculties in 2018 and the change of associate professorship criteria in 2016 seem to be effective in this.

Their citation is influenced by academic promotion criteria. Quantity-based promotion criteria cause a decrease in quality but increase the quantity. In the journal's preferences, criteria such as page limitation of the journal, its being aimed at practical classroom applications, and its permission to publish articles in Turkish come to the fore. However, Turkish academics, after the journal originated from Turkey prefer the UK and the US originated journals in physics education.

Both with the number of academic staff and the number of articles, trend-setting institutions in physics education in Turkey are HU, DEU, GU and METU. The most preferred journal is Physics Education. Similarly, Prahani (2022) found that the most preferred journal in the field of physics education worldwide is Physics Education. After Turkey, journals originating from the UK were preferred the most.

The trends focus on diagnosing and remediating misconception, conceptual learning, and conceptual change. Studies conducted in these institutions are effective in determining these trends. Physics education studies in Turkey have caught the trend in the world in this context. It is seen that the number of articles on conceptual change in WoS increased after 1992 and gained momentum after 2007 in the world and Turkey is the second country with the most articles on conceptual change, after the USA (Kılıçoğlu, 2022). The situation is similar in misconceptions studies. Turkey is also in the second place after the USA in studies of misconceptions (Kurtuluş & Tatar, 2021). Although misconceptions in chemistry have been investigated in more studies than misconceptions in physics, an important part of misconception studies is physics education studies.

There are subjects that physics education researchers neglect as well as the subjects they focus on. For example, Dewi et. al. (2021) determined that there are 905 physics education studies on augmented reality, which has risen in the world literature in recent years. However, they could not find any study from Turkey. Another example is science literacy. Although there is a large literature on science literacy in most of the science fields, there is still a serious lack in physics education studies (Effendi, et. al., 2021).

### 4.1. Limitations and Suggestions

This study is limited to researchers in physics education departments at universities in Turkey only. Only the publications of these researchers related to physics education were considered. In addition, this study is limited to articles made only in the WoS and ERIC indexes.

Other studies can be done, covering both different paper types or indexes, and researchers from other departments. Postgraduate theses in physics education, articles in national indexes and proceedings should be examined. Thus, both local and general research trends and contributions can be revealed in more detail.

Although there are emerging topics in other science fields, it may be beneficial to increase studies in neglected areas such as augmented reality and science literacy in physics education. The number of physics education studies in WoS and ERIC databases should increase. It is important to increase the quality as well as the number. For this purpose, the academic promotion system based on quantity rather than quality should be changed. On the other hand, changes that negatively affect the productivity of academic staff should be prevented. The frequency of change in academic promotion criteria and the interventions of YÖK should be minimized.

**Research and Publication Ethics Statement**

This study complies with research and publication ethics.

**Contribution Rates of Authors to the Article**

This is a single-authored paper.

**Statement of Interest**

The author did not report any conflict of interest or financial support.

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