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EXPLORING THE LITERATURE: AN OVERVIEW OF PHYSICS EDUCATION PUBLICATIONS

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ABSTRACT:
A publication trend in Physics Education by employing bibliometric analysis leads the researchers to describe current scientific movement. This paper tries to answer “What do Physics education scientists concentrate in their publications?” by analyzing the productivity and development of publications on the subject category of Physics Education in the period 1980–2013. The Web of Science databases in the research areas of “EDUCATION - EDUCATIONAL RESEARCH” was used to extract the publication trends. The study involves 1360 publications, including 840 articles,503 proceedings paper, 22 reviews, 7 editorial material, 6 Book review, and one Biographical item.Number of publications with “Physical Education” in topic increased from 0.14 % (n = 2) in 1980to 16.54 % (n = 225) in 2011. Total number of receiving citations is 8071, with approximately citations per papers of 5.93. The results show the publication and citations in Physic Education has increased dramatically while the Malaysian share is well ranked.
Keywords*:* Physics Education, Bibliometrics, Citation analysis, Performance evaluation

1. INTRODUCTION

Bibliometrics assists scholars in determining field influence (Uzun, 1996). "The study of the quantitative aspects of the production, dissemination, and use of published information" (Moed & Glänzel, 2004, p. 343). Bibliometrics has been widely utilized by information scientists to investigate the distribution and growth of scholarly publications (Tsai, 2011). Web of Science, a monopolist data approach, provides bibliometrics data for non-expert rating judgments (Weingart, 2005). Eugene Garfield's 1979 ISI innovation enabled large-scale statistical analysis of scientific literature (Moed & Glänzel, 2004). It focuses on bibliometrics in science. Trends, correlation, and relationships in author keywords are discovered using bibliometric analysis (Chiu & Ho, 2007; Mao, Wang, & Ho, 2010), Keywords Plus® indexed by ISI (Garfield & Sher, 1993; Tan, Fu, & Ho, 2014; Wang, Wang, Zhang, Cai, & Prabhakaran, 2013). Citation counting is part of bibliometrics (Craig, Plume, McVeigh, Pringle, & Amin, 2007). Citations are increasingly being used to express gratitude. Citations show the impact of a publication (Lai, Darius, & Lerut, 2012). Citation analysis is critical for determining the success of research (Bornmann, Schier, Marx, & Daniel, 2012). Citation indices are important to academic institutions and scholars worldwide (Farhadi, Salehi, Yunus, Aghaei Chadegani, Fooladi, & Ale Ebrahim, 2013).

Physics education research, according to Bodin (2012), investigates how physics is understood, taught, learned, and applied. Physics Education Research (PER) serves as the foundation for physics instruction in high schools, colleges, and universities (Andre'e Tiberghien, Jossem, & Barojas, 1998; Yeo & Treagust, 2000). The majority of physics education research focuses on physics instruction (Heron & Meltzer, 2005). The study of physics education integrates social studies, psychology, and academic physics. Physics education may be approached differently depending on the application (Bodin, 2012). General culture (Kapitsa, 1982), "hands-on" exhibits (Read, 1989), gender issues (Stewart, 1998), classroom-based innovation (Tobias, 2000), multimedia (Wagner, Altherr, Eckert, & Jodl, 2003), IT-based (Akizo, 2004), e-Learning (Stoeva & Cvetkov, 2005), language (Michinel, 2006), used images (Bulbul, 2007), computational

Numerous national and international conferences on physics education research have been held (McDermott & Redish, 1999). In 2003, Vollmer investigated physics education with 22 European specialists and discovered a rise in interest. Over the last 20 years, the global network of physics education researchers has increased (McDermott & Redish, 1999). Many groups are researching physics education, and the literature is substantial (McDermott, 2001). The majority of early physics education research focused on how students used principles from beginning university physics courses successfully.

Finally, few bibliometric research on education publication trends have been conducted (Cheng, Wang, Morch, Chen, Kinshuk, & Spector, 2014; Chiang, Kuo, & Yang, 2010; Gomez-Garcia, Ramiro, Ariza, & Granados, 2012; Marshakova-Shaikevich, 2005; Piotrowski, 2013). Two of them (Anduckia, Gomez, & Gomez, 2000; Jacobs & Ingwersen, 2000) are about physics education and were published over a decade ago. As a result, a comprehensive and up-to-date bibliometrics study on physics education is required. From 1980 to 2013, bibliometrics were used to examine the productivity and progress of Physics Education publications.

2. MATERIALS AND METHODS

The majority of bibliometrics research relies on citation data from the Web of Science (WoS) (Bakri & Willett, 2011). WoS, the oldest citation database, has extensive bibliometrics data dating back to 1900 (Aghaei Chadegani, Salehi, Yunus, Farhadi, Fooladi, Farhadi, & Ale Ebrahim, 2013). The Institute of Scientific Information (ISI), often known as Thomson Reuters, has a subscription to the Web of Sciences Core Collection, a well-known database that provides high-quality, interdisciplinary research data.

To acquire data for our sample and to align with past studies, we ran a search in the WoS database. From 1980 to December 25, 2013, this database shows the publishing tendencies in the discipline of Physics Education. Using the search term "Physics Education*," the databases Science Citation Index Expanded, Social Sciences Citation Index, and Arts & Humanities Citation Index were queried, yielding a total of 3,770 papers. The WoS category "Education Educational Research" was used to refine the search, which contains 1,360 papers. From the time of publishing until 2013, bibliometric data, including both references and citations, was collected for each book.

The most commonly cited works in the field of Physics Education are identified using citation analysis. Citation figures created within three years may not be credible due to the limited time for papers in the Web of Science databases to accumulate a constant amount of citations (Webster, Jonason, & Schember, 2009; Adams, 2005; UZUN, 2006). As a result, 813 publications were chosen from the period 1980 to December 25, 2010, accounting for 60% of the whole sample. Publications that were not referenced were removed. We counted the number of citations acquired by our sample papers once the final sample was chosen. The time that has gone since the publishing of an article has a considerable impact on its citation count (Eshraghi, Osman, Gholizadeh, Ali, & Shadgan, 2013). To compensate for this bias, we calculated an average annual citation index for each work. This statistic was used to analyze our sample research and select the top ten papers with the most citations each year.

Physics education scientists write about the distinct areas of study in which they specialize. Keyword Plus® and author keywords were extracted from 1360 published works between 1980 and 2013. Author Keywords are words or phrases chosen by the author to express the main idea of the material, whereas Keywords Plus® are terms or phrases that appear frequently in an article's references but not in its title. Thomson Reuters' auto indexing system may create Keywords Plus® for publications that lack author keywords or do not include critical terms in the title, abstract, or author keywords (Ale Ebrahim, 2013).

3. RESULTS AND DISCUSSIONS

To quantify evaluations, bibliometric studies statistically examine textual texts. Bibliometric studies can be used to examine the performance of research subfields and influence scientific policies for funding allocation and input-output comparison (Debackere & Glanzel, 2004).

The percentage ranges for author keyword analysis and Keyword Plus® Keywords Plus® analysis for 1980-2013 data were calculated (Table 1). Regardless of the year, physics was a popular Keywords Plus® (n = 4562). In paper titles, two of the top 20 Keywords Plus® (n=1726, 37.83% of total) were used. KNOWLEDGE, SCIENCE-EDUCATION, and ACHIEVEMENT were all new words. Keywords like ACHIEVEMENT, CONCEPTUAL CHANGE, MODEL(S), and INSTRUCTION have also grown in popularity. As seen in the table, Keywords Plus® is critical for future research.

Table 1 Top 20 Keywords Plus®

NO.	Keyword	Frequency	Percentage of Total
1	Physics	295	6.47%
2	Education	214	4.69%
3	Science	196	4.30%
4	Students	144	3.16%
5	Knowledge	143	3.13%
6	Science-education	91	1.99%
7	Achievement	68	1.49%
8	Conceptual change	67	1.47%
9	Model(s)	60	1.32%
10	Instruction	59	1.29%
11	Classroom	52	1.14%
12	Conceptions	48	1.05%
13	Teachers	42	0.92%
14	Beliefs	37	0.81%
15	Chemistry	37	0.81%
16	Misconceptions	37	0.81%
17	Performance	37	0.81%
18	Attitudes	35	0.77%
19	Curriculum	34	0.75%
20	Views	30	0.66%

Author Keywords data analysis is shown in Table 2. The top 20 author keywords (589, 14.86%) are drawn from a database of 3963 Author Keywords. As a result, Table 3 contrasts Top ten Keywords Plus® and Author Keyword. The similarities between Author Keyword and Keywords Plus® are somewhat varied. Each article's author provides keywords. Web of Science, on the other hand, allocates Keywords Plus® to each paper. Table 3 shows the top ten Keywords Plus® and Author Keywords in terms of frequency and rank in the article. Keywords Plus® is only used for half of the top ten author keywords. Although problem solution, physics education research, and secondary education are not in 20 Keywords Plus®, physics education is ranked first (n = 295) in the authors' keyword list (n = 118). Keywords Plus® examines high-frequency terms in paper titles, whereas the author keyword represents the author's current ideas regarding the work. Future research topics will be guided by the authors' keywords: Physics education, Physics, Science education, Physics education research, Education, Gender, Conceptual shift, Misconceptions, and Secondary education.

Table 2 Top 20 Keywords

No.	Keywords	Frequency	Percentage of Total
1	Physics education	118	2.98%
2	Physics	85	2.14%
3	Science education	79	1.99%
4	Physics Education research	47	1.19%
5	Education	31	0.78%
6	Gender	26	0.66%
7	Conceptual change	25	0.63%
8	Misconceptions	18	0.45%
9	Secondary education	18	0.45%
10	Problem solving	17	0.43%
11	Learning	14	0.35%
12	Chemistry	13	0.33%
13	Higher education	13	0.33%
14	Teacher education	13	0.33%
15	Teaching	13	0.33%
16	Technology	13	0.33%
17	Women in physics	12	0.30%
18	Constructivism	12	0.30%
19	Science	11	0.28%
20	Simulations	11	0.28%

Table 3 Comparison of Top ten Keywords Plus® and Author Keyword

Keywords Plus®	N	R	Authors Keyword	N	R
Physics	295	1	Physics education	118	1, 2
Education	214	2	Physics	85	1
Science	196	3	Science education	79	6
Students	144	4	Physics education research	47	NIL
Knowledge	143	5	Education	31	2
Science-education	91	6	Gender	26	41
Achievement	68	7	Conceptual change	25	8
Conceptual change	67	8	Misconceptions	18	16
Model(s)	60	8	Secondary education	18	NIL
Instruction	59	10	Problem solving	17	87

N: Frequency of Keywords Plus®; R: Rank in Keywords Plus®

Characteristics of publication output

Despite Figure 1, the number of physics education papers published grew between 1980 and 2013. There were 114 publications as of December 25, 2013, up from two in 1980. With 225 publications in 2011, it was the most ever. In 2007, 61% more publications were launched than in 2006.

The findings were sorted by the WoS category "Education Educational Research" (1,360 publications, 100%). However, over 30% of physics education research publications were published in Education Scientific Disciplines and Computer Science Interdisciplinary Applications. Table 4 shows a range of 3%-1% for the other group. Less than 1% are in Computer Science Theory Methods, Management, Artificial Intelligence in Computer Science, Electrical and Electronic Engineering, Multidisciplinary Social Sciences, Business, Software Engineering, Economics, Materials Science Multidisciplinary, and Mechanical Engineering.

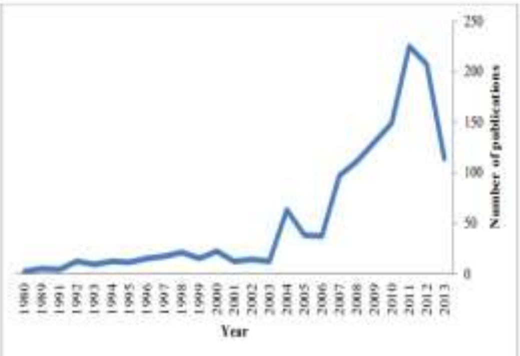

Figure 1 Physics Education publication per year since 1980

Table 4 Web of Science Categories

No	Web of Science Categories	Records	Percentage of 1360
1	Education educational research	1360	100
2	Education scientific disciplines	318	23.3
3	Computer science interdisciplinary applications	107	7.8
4	Computer science information systems	42	3.0
5	History philosophy of science	39	2.8
6	Physics applied	31	2.2
7	Psychology educational	28	2.0
8	Physics multidisciplinary	27	1.9
9	Women s studies	27	1.9
10	Engineering multidisciplinary	14	1.0
11	Information science library science	14	1.0

From 1980 to 2013, 70% of Physics Education publications were published by researchers from the top ten countries (Figure 2). Around half of the publications came from the United States, Turkey, Spain, and England. Malaysia was placed second (0.8%), and Turkey was ranked 24th—both emerging countries.

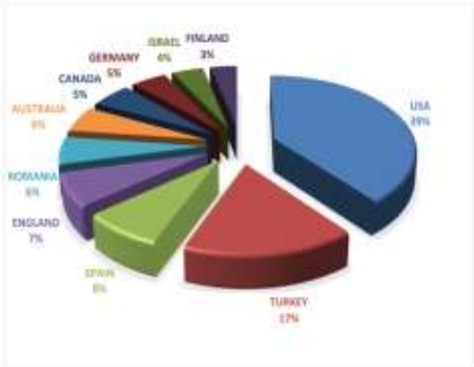

Figure 2 Top 10 active countries on Physics Education publications

Highly published paper and journal According to the methodology, highly cited papers are restricted to the time period from 1980 to 25 December 2010. Due to the volatility of citation statistics, those from a period of less than three years may be unreliable (Adams, 2005; UZUN, 2006). The annual citation impact is determined by analyzing the year of publication and the journal. Table 5 presents a compilation of the most highly cited Physics Education research papers, ranking them in order of importance. The most frequently referenced publication in the field of Education & Educational Research; Education, Scientific Disciplines is (Azar, 2010), which receives an average of 81 citations per year. It is closely followed by (Kurnaz & Calik, 2009).

Table 5 List of top 10 papers with highest citation per year

Authors	Title	Citation per year
Azar, A	A comparison of the effects of two physics laboratory applications with different approaches on student physics achievement	81
Kurnaz, MA; Calik, M	A thematic review of 'energy' teaching studies: focuses, needs, methods, general knowledge claims and implications	32
Hazari, Z; Sonnert, G; Sadler, PM; Shanahan, MC	Connecting High School Physics Experiences, Outcome Expectations, Physics Identity, and Physics Career Choice: A Gender Study	31
Karamustafaoglu, O	Active learning strategies in physics teaching	27

Trundle, KC; Bell, RL	The use of a computer simulation to promote conceptual change: A quasi-experimental study	22
Pea, RD	The social and technological dimensions of scaffolding and related theoretical concepts for learning, education, and human activity	21
Taber, KS; Garcia-Franco, A	Learning Processes in Chemistry: Drawing Upon Cognitive Resources to Learn About the Particulate Structure of Matter	19
Brewe, E; Sawtelle, V; Kramer, LH; O'Brien, GE; Rodriguez, I; Pamela, P	Toward equity through participation in Modeling Instruction in introductory university physics	18
Crawford, BA	Learning to teach science as inquiry in the rough and tumble of practice	17.75
Maltese, AV; Tai, RH	Eyeballs in the Fridge: Sources of early interest in science	17

Table 6 lists the top ten Physics Education journals in terms of publication and citations. From 1980 to 2010, the International Journal of Science Education published the most Physics Education research (123). Four journals were among the top ten most widely published. Publication frequency does not guarantee quality based on citations each year. Eleven articles, one opinion, and four reviews are among the most frequently cited pieces.

Table 6 Top 10 highly published and highly cited Journals

Highly Published journal	NoP (n=1360)	Rank	Highly Cited	CPY	NoP (n=16)	Rank
International Journal of Science Education	123	1	Energy Education Science and Technology Part B-Social and Educational Studies	81, 32, 27.5	3	34
Journal of Research in Science Teaching	59	2	Journal of Research in Science Teaching	31, 17.75	2	2
Science Education	43	3	Computers & Education	22	1	11
Physical Review Special Topics-Physics Education Research	40	4	Journal of the Learning Sciences	21, 19, 14.40	3	26
Women in Physics	27	5	Physical Review Special Topics-Physics Education Research	18	2	4
Research in Science Education	23	6	International Journal of Science Education	17	1	1
Teaching and Learning of Physics in Cultural Contexts	21	7	Review of Educational Research	15.78	1	54
Innovation and Creativity in Education	19	8	Journal of Computer Assisted Learning	15	1	29
Journal of Science Education and Technology	15	8	Learning and Instruction	13.67	1	40
Teaching and Teacher Education	8	10	Science Education	13.22	1	3

*NoP: Number of Publications; CPY: Citation Per Year

4. CONCLUSION

For the first time, bibliometrics are used to examine the publishing trends and research productivity of physics education. We examined a total of 1360 papers from the Web of Science (WoS) database. Several indices were used to rank the best authors, articles, and academic journals. The temporal distribution and trajectory of publications increased, with the United States becoming as the leading nation in terms of publishing Physics Education articles. The study also shows that the amount of citations received each year does not always represent the quality of an article, as it is influenced by the regularity with which journals are published. According to the journal's rating, the journal "ENERGY EDUCATION SCIENCE AND TECHNOLOGY PART B-SOCIAL AND EDUCATIONAL STUDIES" has 34 publications. The magazine published three articles that garnered a high number of citations per year: 81, 32, and 27.5. As Physics Education research grows in popularity, bibliometric analysis can help academics find essential characteristics and characterize the literature. As a result, it is critical that all industries devote more resources to bibliometric research.

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