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REVIEW ON EDUCATION EFFICIENCY IN RELATION TO EQUITY, QUALITY, AND INCLUSION: A BIBLIOMETRIC ANALYSIS

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ABSTRACT

The role of education in transforming individuals, communities, and the country qualifies its public provision. However, the need to evaluate the use of allocated educational resources is of great importance due to competing demands for scarce public funds. Therefore the concept of efficiency in education comes in. This study aimed to explore research output produced on efficiency in education, including that linked efficiency with equity, quality, or inclusion to identify gaps for future research. The analysis used documents from the Scopus database published between 1990 and 2021. Results indicate that a total of 347 papers sourced from 247 journals and produced by 827 authors researched efficiency in education during the study period. The paper also documented frequently explored themes, principal contributing authors, documents, diaries, countries, and the most relevant affiliations and sponsors on efficiency in education studies. The gaps and limitations of the paper identified the recommendations for future research.

Keywords: SDGs, VOSviewer, Data Envelopment Analysis

Introduction

Public authorities and international communities pay special attention to the education sector as it plays a significant role in the country's economic growth (Cordero-Ferrera et al., 2008). Empirical evidence has shown a strong relationship between educational quality and countries' economic growth (Hanushek et al., 2015). The relationship indicates that improving education systems is among the measures that could ensure the realization of development in the country. Moreover, education benefits can be confined to an individual or spread to the community through external returns (Johnes et al., 2017). At an individual level, education is essential in determining lifetime returns (Chevalier, 2011; Walker & Zhu, 2011). A good investment in education brings economic and social transformation to an individual, which may sustain over a lifetime and spread to the family and community surrounding the beneficiary.

With this importance, both Millennium Development Goals (MDGs) and Sustainable Development Goals (SDGs) include education. The main focus of MDGs (Goal 2) was to achieve universal primary education. The goal aims at increasing access to and completion of primary education (United Nations, n.d.). This goal progressed as, by 2015, the enrollment in primary schools in developing regions reached 91%, up from 83% reported in 2000 (United Nations, n.d.). However, these achievements came with several weaknesses in the education sector. For instance, the reports show that in 2015, about 57 million children of school age were out of school, and this mostly affected children from the poorest households and those from countries affected by conflicts (United Nations, n.d.).

Moreover, the increase in school enrollments put pressure on the number of classrooms, books, teachers and other educational resources, which led to the mismatch between the number of pupils and the available teaching-learning resources, thus jeopardizing education quality. Moreover, previous reports highlighted that around 103 million youth worldwide, regardless of enrollment or out-of-school, lacked basic literacy skills, and more than 60% were women. Poor financing in education had been one of the major factors for poor education as primary education was underfunded by USD 26 billion a year (UNESCO, 2012). The problem faced by public schools is that it mainly depends on the government budget. Abolition of fees in public schools made the shortage of funding even worse and thus contributed to a further decline in quality (Bold et al., 2012).

Regarding this, the SDGs shifted the focus, which aimed at ensuring that quality education is inclusive and equitable and promoting lifelong learning opportunities for everyone- Goal 4 (United Nations, 2015). The main objective highlights the first target of the goal as to ensure that all gender categories complete equitable, accessible, and quality education at primary and secondary levels (United Nations, 2015). The target indicates the international community's commitment to emphasizing access and equitable and quality education. The fact that education can contribute to the transformation of the society and a country justifies its public provisions (Johnes et al., 2017). The public authorities finance most countries' education sectors, mainly primary and secondary education. In other countries, even higher

education is either partially or fully financed by public money. The allocation of public funds to finance education brings the importance of assessing its spending in the education sector. The education sectors should use the allocated educational resources efficiently to achieve the desired impacts. The main motive for applying the efficiency concept in education is the competing demand for public funds with other sectors such as health, defense, and infrastructure.

As far as efficiency in education is concerned, it is essential to differentiate between efficiency and effectiveness. Efficiency is the term that refers to "doing things right", which is distinguished from effectiveness which refers to "doing the right things" (Drucker, 1967). Efficient use of resources (whether student ability, school inputs, or financial) is realized when the observed educational output (test scores or value-added) is produced at a minimum level of resources (Johnes et al., 2017) or the desired mix of output is maximized for a given level of resources (Kosor et al., 2019). Effectiveness ensures an appropriate mix of the available resources to achieve the desired outcomes. There is also a difference between quantity and quality generated through education provision. Measuring quantity (number of enrollments, classes, number of students completed, etc.) is not as difficult as determining the quality of education. The latter is more connected to the level of efficiency in education. Likewise, the analysis of efficiency in education is more complex than in other productive sectors for several reasons, including the difficulty in measuring output and constructing the production function (Cordero-Ferrera et al., 2008).

Due to the increased focus on students' teaching-learning environment, the international community has supported data availability and accessibility to ensure smooth assessment and track the progress of SDGs. These datasets are saved as the source for several studies on efficiency in education. These include multi-country reviews of students such as PISA, TIMSS, PIRLS[1], and regional educational assessment datasets in Latin America, West Africa, and Southern and East Africa (Lee, 2018).

There is no consensus among economists and scientists about which approach is the most appropriate for efficiency evaluation. Two significant categories of efficiency measurements; the parametric approach, i.e., stochastic frontier analysis (SFA), developed by (Aigner et al., 1977), and the nonparametric approach, i.e., Data Envelopment Analysis (DEA) introduced by (Charnes et al., 1978) and Free Disposal Hull (FDH) (Deprins et al., 1984) have been employed in efficiency evaluation. However, the most used approach to assessing efficiency in public and private sectors, such as education, is the nonparametric approach due to the existing link between educational inputs and outputs (Ji & Lee, 2010). Several weaknesses and improvements in these approaches have been pointed out and developed to ensure that all education dimensions are getting proper measures and therefore appropriate and effective policies are designed and implemented, thus achieving the SDGs by 2030.

[1] PISA- Programme for International Student Assessment, TIMSS- Trends in International Mathematics and Science Study, PIRLS- the Progress in International Reading Literacy Study

Differences in education sector financing have brought substantial inequalities in learning, particularly for public and private institutions. Due to higher fees, private schools provide better teaching conditions and facilities that enable students to perform better than their public counterparts. Nevertheless, fees charged by private schools are not affordable to most students from poor backgrounds. It is also essential to question whether this huge fund is allocated to private schools' efficient utilization to generate the desired educational outcomes. Differences in financial resource allocation may be among the reasons for performance gaps between private and public schools. The debate about which institutional form (general vs. private) performs better over the other has now become one of the main topics in the educational context (Cordero et al., 2016; Rouse & Barrow, 2009). Based on the above facts, efficiency in education is essential in determining the ideal level of resources sufficiently to attain the desired output.

Moreover, due to competing demands for public funds, accountability, and the need for quality improvement, it is crucial to assess the efficiency with which these funds are being utilized (Kosor et al., 2019). However, information and knowledge on efficiency concepts in education are required to be able to undertake such evaluations. This study explores the research output that has produced inefficiency in the education field for the past three decades. The rest of the paper proceeds as follows; section 2 describes the materials and methods of the study. Section 3 presents the analysis, while section 4 provides a discussion. Finally, section 5 concludes by presenting the study's limitations and recommendations for future studies.

Materials and Methods

This study explores research output on efficiency in education published over the past thirty years. A comprehensive analysis was based on the online searched documents retrieved from the Scopus database (https://www.scopus.com) on 22/07/2021. The following terms were typed on the 'search document' field: *"student* efficienc*" OR "school* efficienc*" OR "universit* efficienc*" OR "college* efficienc*" OR "education* efficienc*" OR "*efficienc* and inclusive education*" OR "*efficienc* and *equit* education*" OR "*efficienc* and qualit* education*"*. In the "search within" field "Article title, Abstract, Keywords" was selected to include all documents containing the words in either title, abstract, or keywords. The search items obtained a total of 605 documents. The result was then refined, i.e., on the year of publication to include only documents published between 1990 and 2021; on the document type field to include only articles and reviews to ensure that only peer-reviewed documents on efficiency in education are included. The documents were also restricted to the ones written in the English language. Other fields such as open access options, author name, and source article remained unfiltered. The number of documents was then reduced to 368 after such inclusions and exclusions.

Finally, all documents were selected, and on the field of information to be exported, all items were selected except for the "other information" item. Only the "include references" sub-item was selected and downloaded in CSV excel format. Data cleaning was performed in excel, including checking and removing duplication of documents. The documents that

missed important information like author name, title, year of publication, source, etc., were searched online using either DOI or the document link. The required data was obtained and filled in the respective items. Duplication removed one paper, with 20 articles removed because their context was out of efficiency in education. Thus, after cleaning, 347 documents remained for further analysis.

Biometric Indicators and Mapping Visualizations

The analysis was performed by two software; the VOSviewer for network analysis and visualization; and R package for bibliometric analysis. The following analyses were performed, and information was fetched from the software; annual production (documents published yearly), annual total citations, most global and local cited documents, authors' impact, source impact (journal productivity), most relevant and productive countries, most relevant affiliations and funding sponsors. The quality of the documents published was measured using the Hirsh index (h-index). The Impact Factor (IF) and Journal Rank of 2020 were presented for the most productive journals.

Table 1: Main Information about Data on Efficiency in Education, 1990-2021

Description	**Results**
Timespan	1990:2021
Sources (Journals, Books, etc)	247
Publications	347
Average years from publication	8.61
Average citations per publication	11.36
Average citations per year per publication	1.176
References	13092
Publication type	
Articles	339 (97.7%)
Reviews	8 (2.3%)
Publication contents	
Keywords Plus (ID)	988
Author's Keywords (DE)	880
Authors	
Authors	827
Author Appearances	904
Authors of single-authored publications	86
Authors of multi-authored publications	741
Authors collaboration	
Single-authored publications	95
Publications per Author	0.42
Authors per Publication	2.38
Co-Authors per Publications	2.61
Collaboration Index	2.94

Analysis

Main Information of the Study

Table 1 presents the main information of the dataset used in the analysis. A total of 347 publications on efficiency in education, sourced from 247 journals and written by 827 authors, were produced between 1990 and 2021. The dataset comprised 339 (97.7%) articles and 8 (2.3%) reviews. Authors of multi-authored documents dominated, 741 (90%) with a collaboration index of 2.94.

Trend of Literature

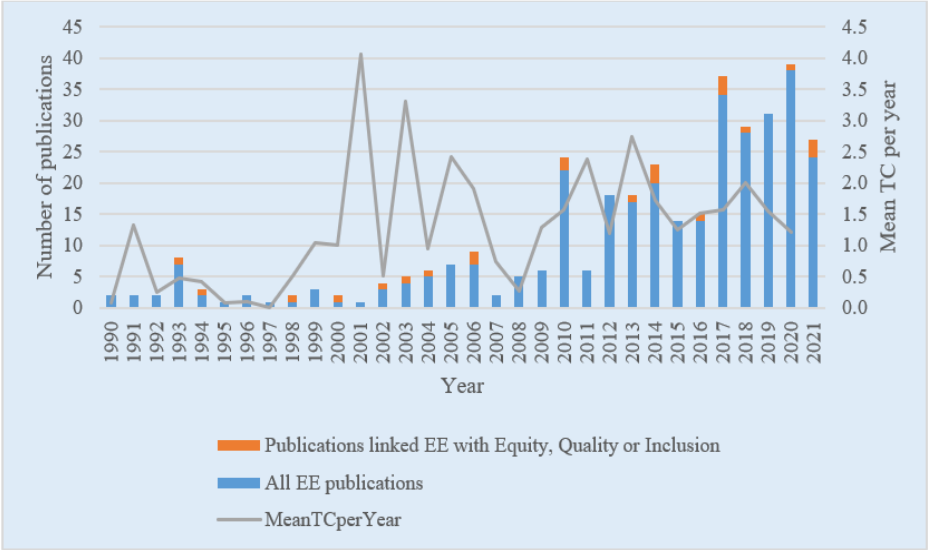

Figure 1: Number of Documents per Year, 1990-2021
Note: EE- Efficiency in Education

Figure 1 presents the annual publications and citation trends of documents published on efficiency in education. The figure shows 347 publications retrieved for 31 years from 1990 to 2021. It also shows the mean total citations of the publications and the number of publications that linked efficiency in education with equity, quality, or inclusion. From 1990 to 2000, the number of documents published ranged from 1 and 3 per year except for 1993, which recorded the highest number of publications (7 papers) during the 1990s. A steady rise in publications is shown from 2002 to 2010, dropped in 2011, and rose further to the highest peak in 2020 (38 documents). The implementation of the MDGs might be among the reasons for growth in papers published from 2002, as more studies were needed in the education sector for formulation and implementation of evidence-based policies, as well as establishing the baseline and tracking the progress of the goal. This also might have been the case for the post-2015 period when the new development goals-SDGs started to be implemented. The highest mean total citation was attained in 2001, which might be due to the same reasons mentioned above.

Publications linked Efficiency in Education with Equity, Quality or Inclusion

The first publication that researched efficiency, access, and quality in the education sector was published in 1993 (Hinchliffe, 1993). The study mainly focused on the status of education and training systems, particularly on efficiency, quality, and access in Caribbean nations. Since then, the number of publications that linked efficiency with equity, quality, or inclusion in education ranged between 0 and 2 per year except for 2014, 2017, and 2021 which both recorded three publications. Specifically, studies linked efficiency in education with equity in the past three decades include; Husted and Kenny (2000), Hanushek and Luque (2003), Cherchye et al. (2010), Woessmann (2010), Lauri & Põder (2013), Benito et al. (2014), Fethke (2017), Ferraro and Põder (2018) and Delprato and Antequera (2021). At the same time, Hinchliffe (1993), Riddell (1998), Heyneman (2004), and Nordstrum (2006) linked efficiency in education with either quality or inclusion.

Top 10 Most Productive Journals

Table 2: Journals Contribution of the Countries to the Literature contribution to Efficiency in Education, 1990-2021

S/N	Journal	h_index	TC	NP	PY_start	IF (2020)	Journal Rank
1	Economics of Education Review	10	426	10	2003	2.238	Q1
2	Socio-Economic Planning Sciences	5	86	10	2016	4.923	Q1
3	International Journal of Educational Management	5	65	7	2009	1.605	Q2
4	Education Economics	4	172	4	2006	1.162	Q2
5	European Journal of Operational Research	4	182	5	2001	6.02	Q1
6	Journal of the Operational Research Society	4	82	5	2002	2.65	Q2
7	Applied Economics	3	133	4	2005	1.81	Q2
8	International Journal of Educational Development	3	46	7	1993	1.8	Q1
9	Journal of Productivity Analysis	3	100	3	2006	2.76	Q1
10	Higher Education	2	64	3	1996	4.64	Q1

Note: TC- Total citation, NP-number of publications, PY_start- the year started, IF- impact factor

The top 10 most productive journals on efficiency in education are presented in Table 2. The Economics of Education Review was the most influential journal with an h-index of 10, a total citation of 426, 10 publications on efficiency in education, an impact factor of 2.238, and ranked as quartile 1 (Q1). Other productive journals were Socio-economic Planning Sciences and International Journal of Educational Management, each with an h-index of 5, Education Economics, European Journal of Operational Research, and Journal of the Operational Research Society, each with a four h-index. The rest of the top 10 journals had an h-index of 3 except the last in the top ten, which had an h-index of 2. The journal with

the oldest document among the top 10 journals was the International Journal of Educational Development.

Table 3 presents the most productive countries on efficiency in education, based on the countries of the corresponding authors. The United States of America was the most influential country with 14 (13.9%) publications and 262 total citations, of which 12 documents were single-country, and only two documents were multiple-countries publications. Spain was the second country on the list with 11 (10.9%) publications, all single-country documents, and 302 total citations (the most on the list). Italy was the third with 8 (7.9%) publications, followed by the United Kingdom with 7 (6.9%) and Turkey with 6 (5.9%). Other contributing countries include; China, France, Iran, Australia, and Brazil. Single-country publications dominated, with all countries except for the United Kingdom having more (or equal) single-country than multiple-country publications.

Table 3: Top 10 Most Relevant and Productive Countries, 1990-2021

S/N	Country	NP	%	TC	SCP	%	MCP	%
1	USA	14	13.9	262	12	11.9	2	2.5
2	Spain	11	10.9	302	11	10.9	0	0.0
3	Italy	8	7.9	113	7	6.9	1	1.3
4	United Kingdom	7	6.9	140	2	2.0	5	6.3
5	Turkey	6	5.9	6	6	5.9	0	0.0
6	China	5	5.0	2	4	4.0	1	1.3
7	France	4	4.0	38	2	2.0	2	2.5
8	Iran	4	4.0	10	4	4.0	0	0.0
9	Australia	3	3.0	29	3	3.0	0	0.0
10	Brazil	3	3.0	4	3	3.0	0	0.0

Note: NP-number of publications, TC- total citations, SCP-single country publications, MCP- multiple country publications. % represents the percentage of the total number of publications (i.e., 101) by which the countries of the corresponding authors have been recognized

Main Authors to the Field

The main contributors to efficiency in the education field were Agasist T., who had ten publications, 191 total citations, an h-index of 8, followed by De Witte K (6 publications, 212 total citations-the most in the list, and an h-index of 5). Others include Barra C, Essid H., Johnes J., and Zotti R (all had four publications each). The rest of the top 10 most productive authors had three publications each. The interesting results of this analysis are that Italy and Spain were the dominant countries of origin, of which 6 out of 10 most productive authors come from these countries. The rest came from institutions in Belgium, Tunisia, the United Kingdom, and Iran.

Table 4: Main Contributing Authors to the Field, 1990-2021

S/N	Author	Institution	NP	TC	h_index	PY_start
1	Agasisti T	Department of Management, Economics and Industrial Engineering, Politecnico di Milano, Milano, Italy	10	191	8	2006
2	De Witte K	University of Leuven (KUL), Naamsestraat 69, 3000 Leuven, Belgium	6	212	5	2010
3	Barra C	Department of Economics and Statistics, University of Salerno, Salerno, Italy	4	57	3	2016
4	Essid H	Institut Supérieur de Gestion, 41, Rue de la liberté, Cité Bouchoucha 2000, Le Bardo, Tunis, Tunisia	4	50	4	2013
5	Johnes J	Department of Economics, Lancaster University, Lancaster LA1 4YX, United Kingdom	4	76	3	2006
6	Zotti R	Department of Economics and Statistics, University of Salerno, Fisciano, SA, Italy	4	57	3	2016
7	Cordero J.M	University of Extremadura, Departamento de Economía, Av. Elvas s/n, Badajoz, 06071, Spain	3	58	3	2017
8	Santín D	Universidad Complutense de Madrid, Spain	3	86	3	2014
9	Ameri A	School of Management and Medical Information Sciences, Kerman University of Medical Sciences, Kerman, Iran	2	10	2	2020
10	Aparicio J	Center of Operations Research (CIO), University Miguel Hernandez of Elche (UMH), Elche (Alicante), 03202, Spain	2	32	2	2018

Note: NP-number of publications, TC- total citations, PY_start- year started

Most Cited documents

The study also explored the most global and local cited documents' inefficiency in education. Results show that the investigation by Hanushek and Luque (2003), who wrote on "Efficiency and Equity of Schools around the World," received the highest number of global citations (171) but a low number of local citations (2) during the study period. Other documents which received high citations include; Hu (2005), De Witte and Kortelainen (2013), Portela et al. (2001), Jimenez et al. (1991), Berbegal-Mirabent et al. (2013), Katharaki and Katharakis (2010), Grosskopf et al., (1999), McMillan and Chan (2006) and Perelman and Santin (2011) as indicated on table 5.

Table 5: Most Cited Documents on Efficiency in Education, 1990-2021

S/N	Document	Global Citations	Local Citations	Document Type
1	Hanushek and Luque (2003). Efficiency and Equity in Schools around the World. Economics of Education Review, 22(5), pp. 481-502.	171	2	Article
2	Hu, G. (2005). English Language Education in China: Policies, Progress and Problems. Lang Policy 4, 5–24.	150	0	Review
3	De Witte and Kortelainen (2013). What explains the performance of students in a heterogeneous environment? Conditional efficiency estimation with continuous and discrete environmental variables. Applied Economics, pp. 2401-2412.	87	2	Article
4	Portela and Thanassoulis (2001). Decomposing school and school-type efficiency. European Journal of Operational Research, July, 132(2), pp. 357-373.	81	3	Article
5	Jimenez et. al., (1991). The relative efficiency of private and public schools in developing countries. World Bank Res. Obs. Volume 6(2); 205 - 218	76	1	Article
6	Berbegal-Mirabent et al., (2013). The pursuit of knowledge transfer activities: An efficiency analysis of Spanish universities. J. Bus. Res. 66(10); 2051-2059	69	5	Article
7	Katharaki and Katharakis (2010). A comparative assessment of Greek universities' efficiency using quantitative analysis. Int. J. Educ. Res. 49 (4-5); 115-128	65	3	Article
8	Grosskopf et al., (1999). Anticipating the Consequences of School Reform: A New Use of DEA. Manage Sci. 45(4); 608-620	65	1	Article
9	McMillan and Chan (2006). University Efficiency: A Comparison and Consolidation of Results from Stochastic and Non-stochastic Methods, Education Economics, 14:1, 1-30	63	5	Article
10	Perelman and Santin (2011). Measuring Educational Efficiency at Student Level with Parametric Stochastic Distance Functions: An Application to Spanish PISA Results. Education Economics, 19:1, 29-49	62	4	Article

Note: Global citations include all citations of the respective publication from the documents in the Scopus database but are not included in the pool of documents (347) used for analysis. Local citations include only citations of the respective publication from the documents downloaded for this analysis.

Word cloud

Figure 2 presents the most occurred authors' keywords on efficiency in education documents. Apart from "efficiency", "education", and "educational efficiency" which mainly appeared due to inclusion in search terms, higher education was another most frequent word, which suggests that more studies on efficiency in education have been conducted at higher education institutions. "School efficiency" was also among the most occurred words indicating that at the school level, the efficiency of the institution (i.e., school) was the most researched as compared to the efficiency of students, staff (teachers), or management. Results also indicate that Data Envelopment Analysis (DEA) –one of the nonparametric (non-stochastic) approaches was the most employed method in efficiency analysis. Malmquist index and boot-strap techniques indicate that some of the studies augmented DEA with these techniques to improve the analysis results. Other studies used Stochastic Frontier

Analysis (SFA), as shown in the figure. Few documents have studied efficiency concerning equity, quality, and inclusion. Different themes which have been frequently explored with education efficiency include; management, academic achievement, e-learning, evaluation, accountability, human capital, teacher education, technology, distance learning, machine learning, and knowledge transfer.

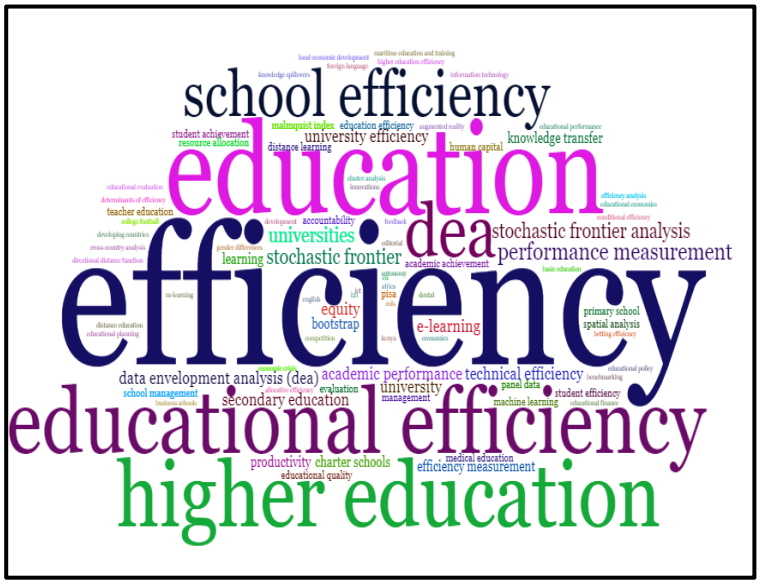

Figure 2: Wordcloud of Authors Keywords, 1990-2021

Most Appeared Themes/Keywords

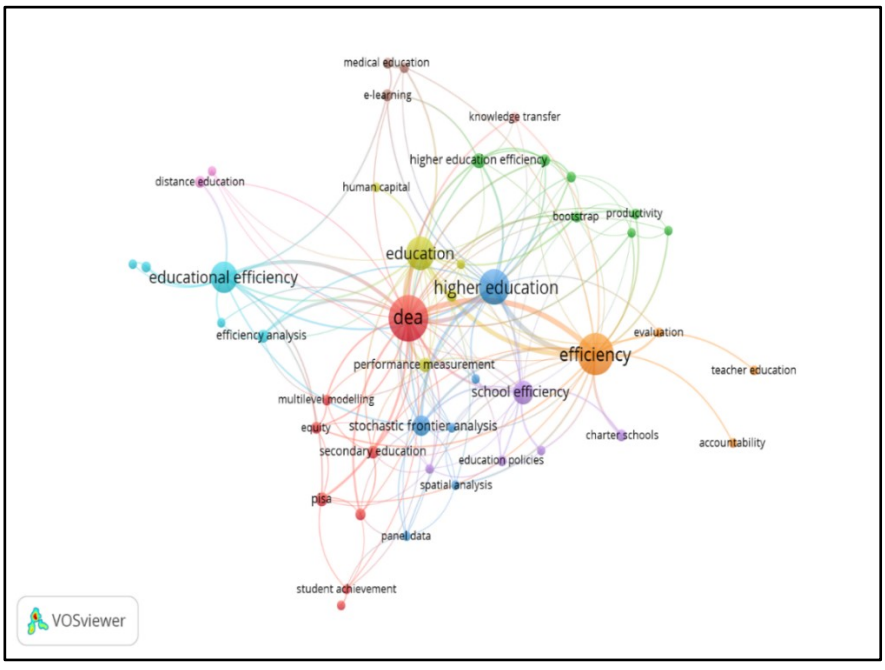

Figure 3: Co-word Network Map, 1990-2021

The paper also intended to explore more common themes, frequently appearing and most researched on efficiency in education from 1990 to 2021. These words typically had been included in a document's title, keywords, or abstract. To assess which words have been

related to efficiency in education or most appeared together, the VOSviewer tool was employed. Co-occurrence and author keywords were selected as type and unit of analysis, respectively, whereas fractional counting was specified as the counting method. The Thesaurus file was uploaded to clean up some typos. The minimum number of occurrences of a keyword was defined as 3, making 46 out of 880 words meet the threshold. Results show that Data Envelopment Analysis- DEA (68), efficiency (57), higher education (40), education (35), educational efficiency (32), and stochastic frontier analysis (14) are the words with the most occurrences on efficiency in the education field. DEA is of great interest, apart from the other four words which have a substantial number of occurrences because of the search codes which involved at least one of these words. The most significant number of occurrences imply that DEA is the most employed analysis technique for efficiency in education. Network analysis also shows that the DEA approach is linked with boot-strap and Malmquist index, which are augmented to improve the DEA approach. Another observation from the co-word network map is that higher education is the level of education where efficiency in education research is mainly conducted. Fewer or no occurrences of educational equity, quality, and inclusion indicate few studies on educational efficiency concerning equity and quality in the education sector. Likewise, few studies have analyzed student efficiency (compared to school efficiency), and no pre-primary education is indicated in Figure 3.

Higher education research was linked to technology, e-learning, knowledge transfer, management, and education policies. Secondary level education research was linked with performance measurement. Equity, though little research was done on this, is connected to efficiency, developing countries, and PISA data. Moreover, the co-word network map indicates that PISA and TIMSS have frequently used in efficiency analysis.

Conceptual Structure

The common conceptual frameworks from the documents researched on efficiency in education are presented in Figure 4. The Factorial Analysis and Corresponding Analysis methods were used. Two clusters were identified to form concepts frequently linked to efficiency in education, one with four and another with 41 words. Results show that cluster 1 focused on concepts such as student achievement, panel data, technical efficiency, and PISA. In contrast, cluster 2 focused on productivity, boot-strap, Malmquist index, school efficiency, learning, educational quality, and equity.

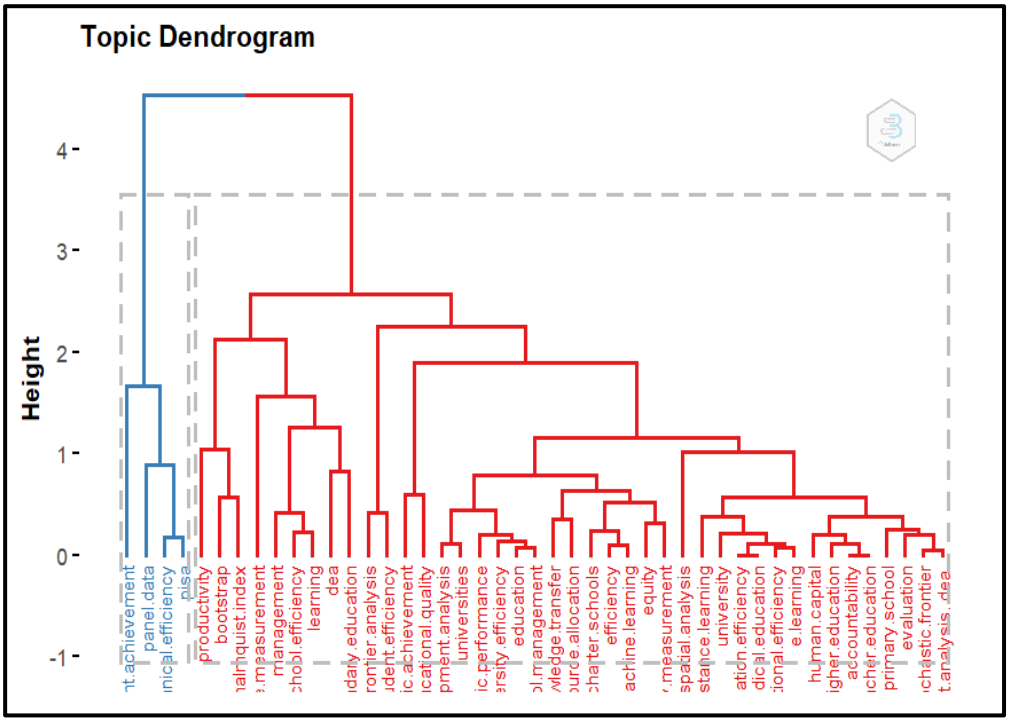

Figure 4: Conceptual Frameworks Associated with Efficiency in Education, 1990-2021

Most Relevant Affiliation

Institutions with the most in publishing documents on efficiency in education are the University of Thrace (Greece) and the University of Paris (France) were the most relevant and productive affiliations with eight publications each, followed by the Tehran University of Medical Sciences (Iran) with seven publications, Universidad de Sevilla (Spain), Politecnico di Milano (Italy) and Dana-Farber Cancer Institute/Brigham and Women's Hospital (USA), both with six documents. Others are the University of Malaga (Spain), University of Jaén (Spain), University of Alcalá (Spain), Universitat Politècnica de Catalunya (Spain), King Abdulaziz University (Saudi Arabia), Kazan Federal University (Russia), and Columbia University (USA) both with five publications. Spain dominated as the home country for the most relevant affiliations (5 institutions), and collaborations from the countries considered as developing, i.e., Iran and Saudi Arabia, also featured in the list.

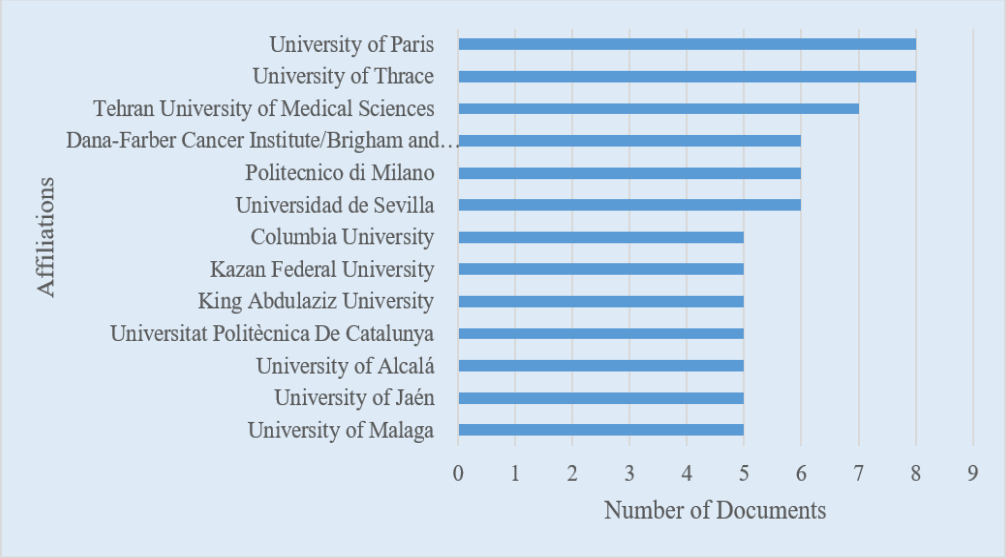

Figure 5: Top 10 Most Productive Affiliations on Efficiency in Education, 1990-2021

Most Funding Sponsor

The most funding agencies in the field of efficiency in education are presented in figure 6. The figure indicates that the National Institute of Health (USA) is the leading institution that sponsored four documents, followed by European Commission (Europe), Junta de Extremadura (Spain), Ministarstvo Prosvete. Nauke i Tehnološkog Razvoja (Serbia) and Ministerio de Economía y Competitividad (Spain), both sponsored three documents. Others are Agencia Estatal de Investigación (Spain), Conselho Nacional de Desenvolvimento Científico e Tecnológico (Brazil), Economic and Social Research Council (UK), European Regional Development Fund (Europe), and KU Leuven (Belgium) with each sponsoring 2 documents each. Results indicate that Spain is home to three institutions out of ten, followed by the European Union.

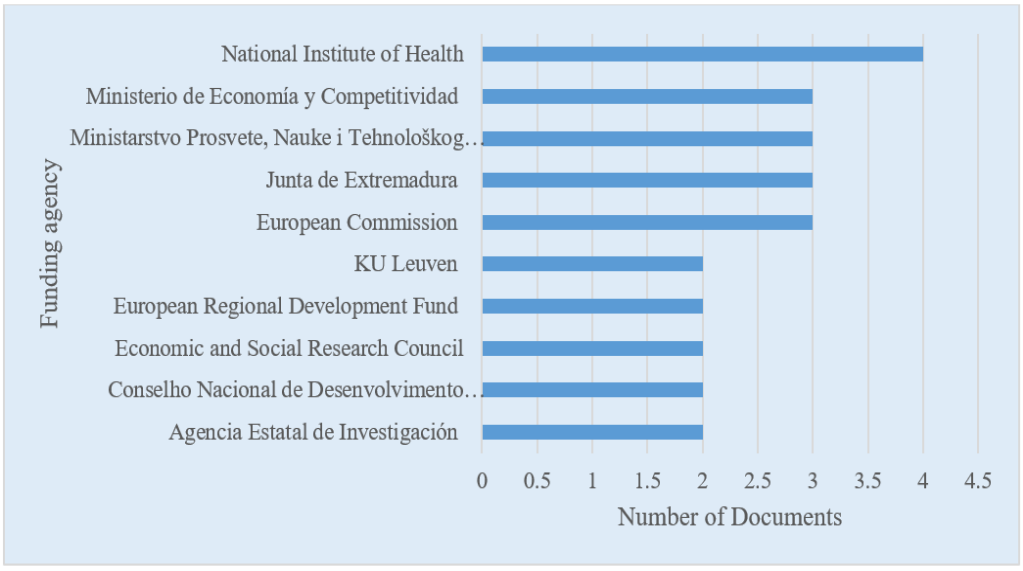

Figure 6: Top 10 Funding Agencies, 1990-2021

Discussion

The main objective of this paper was to explore research output that has been produced on efficiency in education for the past three decades. The study also examined the number of publications written on efficiency in education with either equity, quality, or inclusion to respond to the international community's commitment to the development goals put in place from 2000 to 2015 (MDGs) and from 2016 to 2030 (SDGs). This study used the Scopus database to examine the number and contribution of the documents in the field. Search words like student efficiency, school efficiency, college efficiency, university efficiency, educational efficiency, efficiency, inclusive education, efficiency, equity education, and efficiency and quality education were used to search the documents. After filtering different categories and data cleaning based on the requirement of this study, a total number of 347 publications authored by 827 authors published from 1990 to 2021 were retrieved from the database. Analysis of publications trends, most cited documents, most productive authors, contributing countries, most productive journals, and central themes on efficiency in education was undertaken.

Results from the trend of the literature revealed that between 1990 and 2017 there was a steady increase in publications from 1 to 34 documents per year. However, the rise was an unstable and experienced rise and fall during the period. Although results indicate a recent increasing trend, there is a need for more studies on efficiency in education, thus calling for additional support, especially in funding, to boost production and publication in this field. Journals' contribution was also examined in this study. Results show that Economics of Education Review was the most cited journal, followed by Socio-economic Planning Sciences, International Journal of Educational Management, Education Economics, European Journal of Operational Research, and Journal of Productivity Analysis. From the analysis, it is shown that there were fewer publications related to efficiency in education. Although the number of journals was decently high (247), the number of publications from each journal was relatively small. Thus, the study suggests interventions aim to increase the number of publications.

Concerning countries involved in producing articles related to efficiency in education, the study indicates that the USA had the most significant number of documents during the period under analysis. Corresponding authors from the USA produced about 14% of all publications. Other countries that significantly contributed to this field were Spain, Italy, the United Kingdom, Turkey, China, France, Iran, Australia, and Brazil. Generally, each of these countries' contribution to efficiency in education literature is relatively low compared to other fields of education. Moreover, apart from China, Iran, and Brazil, which have both features of developing and developed countries, publications from this field have been concentrated in the developed world. There is a need to boost research from developing countries, where the public sector mostly dominates education and the majority of schools depend on government funds for their operations which is the main reason for poor education quality. The government, development partners, and other stakeholders need to be informed

on how the resources allocated in the education sector can be efficiently utilized to generate the desired impact on educational attainment in the developing communities.

Regarding the main contributors and most cited documents, the study explored the authors who had produced many articles and received a significant number of citations from their works. Results indicate that there were about 827 authors who either co-authored or single-authored 347 documents from the Scopus database during the study period. Among these, Agasisti was the author with the most significant number of papers on efficiency in education, followed by De Witte, Barra, Assid, and Johnes. Others were Zotti, Cordero, Santin, Ameri and Aparicio. Given that some of these publications were co-authored, there is still a need to increase the number of publications in the field. Therefore, the literature that will provide information to the policymakers and decision-makers in the education sector is rising. Apart from the number of publications, the assessment was done on the number of article citations based on the author. Again, results indicate that De Witte had the most significant citations, followed by Agasisti, Santin, Johnes, and Cordero. Other authors who had substantial contributions were Barra, Zotti, Essid, Aparicio, and Ameri. However, the paper by Hanushek and Luque (2003) received the highest number of citations when it comes to the greatest number of citations based on a published document. Other documents with high citations include; Hu (2005), De Witte and Kortelainen (2013), Portela et al. (2001), and Berbegal-Mirabent et al. (2013). By looking at the titles of the most cited documents, most of these articles based their studies on school efficiency, except for papers by De Witte and Kortelainen (2013) and Perelman and Santin (2011) , which mainly focused on the student efficiency. Although, based on these results, we may argue that most of the researchers or stakeholders might be more interested in school efficiency than other levels of efficiency evaluation such as student and education systems, however, the fact that few studies have been conducted in this specific area might have been the cause for fewer or no citations in other levels of efficiency analysis. The study suggests a need to focus on increasing the number of works focused on the efficiency of students, education systems, and non-discretionary factors surrounding schools and homes (De Witte & López-Torres, 2017).

The study also explored themes that mainly researched efficiency in education by counting the number of occurrences or co-occurrence using the VOSviewer software. Results indicated that about 46 words were frequently included in publications. DEA, efficiency, higher education, and stochastic frontier analysis were found to have the most occurrences on efficiency in the education field. An interesting observation in this finding is that DEA was the technique primarily used to determine education efficiency in the period under study. The reason for the most frequent occurrence might be that the method has proven to be the best in analyzing efficiency in the education context. Or the research has not gone further to explore other analysis tools which might be as effective as or more effective than DEA. This study suggests the use of other advanced techniques which have shown to be more effective than DEA, such as Free Disposal Hull (FDH), order-*m,* and order-alpha (partial frontier analysis). Moreover, the Network analysis shows that the DEA approach is linked with boot-strap and Malmquist index, mostly regarded as augmented approaches to improve the DEA

method. This indicates that improving the DEA approach by combining it with other techniques is one of the reasons most researchers prefer the approach in efficiency analysis.

Another observation from the co-word network map is that higher education was the level where efficiency in education research was primarily conducted. Higher education research was linked with technology, e-learning, knowledge transfer, management, and education policies. On the other hand, secondary level education research was linked with performance measurement, while research on pre-primary education was not featured in the network analysis. This indicates that little research has been conducted on pre-primary education. The study suggests that the focus should be on this educational level which is very crucial for children's educational foundation. The link between early education and themes like e-learning, Information, Communication, and Technology (ICT) has recently gained popularity due to the outbreak of pandemics that restricted students from attending physical classes. Studies on these topics will provide valuable information for a country- and institutional-level decision-making and planning for educational quality improvement.

Moreover, various studies have revealed that high-fee schools provide better educational quality than low-fee schools (Kumar & Choudhury, 2021; Shabbir et al., 2014). However, high-fee schools exclude students from a low-income family background (Ferraro & Põder, 2018). Moreover, some studies indicate that low-fee schools have higher efficiency than their counterparts (Johnes & Virmani, 2020). An interesting question here is; is there any tradeoff between efficiency and equity, quality, or inclusion in education? Few studies have examined this problem; for instance, the survey by Husted and Kenny (2000) indicated the existence of an equity-efficiency tradeoff in the education system. The study pointed out that governments strive to reduce inequality in education spending to give more equal education opportunities and thus improve inclusion and equality in performances; however, they reduce school management control which negatively impacts school efficiency. Benito et al. (2014) found that reduction in school segregation positively impacts school educational equality, but the impact on efficiency is not clear. Other efficiency-equity studies include; Woessmann (2010), Cherchye et al. (2010), Lauri and Põder (2013), Fethke (2017), Ferraro and Põder (2018), and Delprato & Antequera (2021).

The study by Riddell (1998) discussed the need for planning, management, and efficiency reforms; and quality reforms in the education system. The study pointed out that such reforms were needed to improve the efficiency and quality of education. Most governments have been implementing educational expansion policies to improve equality and inclusion, with little attention paid to the quality of education systems. Besides, we cannot wholly assume that educational efficiency is strongly linked with academic quality. There is an argument that although high-income nations heavily invest in educational quality, in many instances, middle-income countries' education systems have a higher efficiency rate than high-income countries (Heyneman, 2004). Moreover, policymakers need to be more cautious when using education services to reduce inequality among the communities. As pointed out by Nordstrum (2006) that though education might be a tool, it is neither the only nor the sharpest tool for reducing inequality in society.

Based on this paper's observations, though there are several studies on the efficiency-equity relationship, limited studies exist on the efficiency-quality and efficiency-inclusion relationship. Moreover, most of them were published more than a decade ago. More evidence-based empirical studies are needed, particularly on efficiency-quality and efficiency-inclusion tradeoffs, especially in developing countries. Given that, governments and development partners have recently shifted their focus to educational quality improvement; and inclusion of marginalized groups such as children with disabilities in the education system. These studies will be helpful in the formulation of evidence-based policies with proper balancing of these aspects. Moreover, research output will be beneficial for appropriate planning and management of educational financing, students' enrollment, school facilities, and staffing at the institutional level.

Furthermore, the co-word network analysis revealed that data from PISA and TIMSS had been used frequently in efficiency analysis. The data fetched from these surveys are comprehensive and cover many countries, giving a wide range of analysis dimensions. However, the research could also use other surveys of the same quality and examine efficiency in education like PISA and TIMSS and compare the mode of analysis and results. Datasets such as PIRLS and Young lives Survey (YLS) conducted in developing countries are an example of surveys that can serve the same purpose as PISA and TIMSS, thus increasing the number of publications as well as the coverage to include developing countries.

Lastly, the study explored institutions involved in publishing and sponsoring research on efficiency in education. Concerning the relevant institutions involved in publishing documents on efficiency in education, the University of Thrace (Greece) and University of Paris (France) were the most relevant and productive affiliations, followed by Tehran University of Medical Sciences (Iran), Universidad de Sevilla (Spain) and Politecnico di Milano (Italy). Others were the University of Alcalá (Spain), Universitat Politècnica de Catalunya (Spain), King Abdulaziz University (Saudi Arabia), Kazan Federal University (Russia), and Columbia University (USA). The most funding agencies for efficiency in education research were; the National Institute of Health (USA), European Commission (Europe), Government of Extremadura (Spain), Ministry of Education, Science and Technological Development (Serbia), and Ministry of Economy and Competitiveness (Spain). Results indicate that Spain had many productive institutions in publication and sponsors compared to other countries. An exciting part was that some of the developing countries were homes for institutions featured in the top ten list, i.e., Iran, Saudi Arabia, and Brazil. This is a good indication of the commitment to increasing publications and funding in developing countries.

Conclusion

The objective of this paper was to explore research output produced on efficiency in education to identify gaps for future studies. The study examined the number of research outputs that produced inefficiency in education between 1990 and 2021 in the Scopus database. A total of 347 documents produced by 827 authors were found and retrieved from

the database for analysis. The assessment was based on the trend of publications, most productive journals, countries, authors, and most cited documents. The authors understand that it is essential to consider this study's limitations. The paper was limited to articles retrieved from the Scopus database, and other studies may use other databases such as Web of Science, PubMed, and Google scholar.

Moreover, the study excluded other types of the documents such as conference papers, book chapters, short surveys, and letters. The study was limited to efficiency in education, although there is a wide range of topics in education apart from efficiency, which may equally affect the education sector. However, the study provides an overview of what has been done in this area and draws several recommendations for future studies.

Firstly, the paper revealed that most of the studies have been focusing on the developed world and recommends that there is a need to increase the number of publications in this area, particularly in developing countries. The education sector in most developing countries depends on government financing and is described as poor quality, inequity, and low inclusion. More research on efficiency is needed to inform the government and development partners on how the allocated resources can best be utilized in this vital sector. Secondly, more research on efficiency in education should focus on student efficiency, environmental efficiency, and educational system efficiency. Thirdly, the study recommends using other analysis techniques apart from DEA and compares the results with previous studies done mainly by this technique. Fourthly, increase studies on efficiency in pre-primary and primary schools and link lower-level education with policy, innovations, inequalities, and access to physical and online learning resources. Fifthly, increase the use of other education surveys apart from PISA and TIMSS, which mainly focus on developing countries where little research has been undertaken. Sixthly, a few studies have included more than one country; more cross-country research on efficiency in education is needed to compare the educational systems of different countries. Lastly, several documents have examined the efficiency-equity tradeoff, especially in developed countries. However, few publications exist on the relationship between efficiency and quality; and efficiency and inclusion. More research is needed in this area, particularly in developing countries. This will increase evidence-based research and enable international partners to formulate and implement policies that will bring balance between these educational dimensions.

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