A Scientometric Analysis of Twenty Years Trends in Mobile Learning, Blended Learning, Online Learning, E-Learning and Dental Education Research

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Abstract
The main objective of this study is to determine a scientometric analysis of twenty years of trends in Mobile Learning, Blended Learning, Online Learning, E-Learning, Electronic Learning, and Dental Education research. Papers published on Mobile Learning, Blended Learning, Online Learning, E-Learning, Electronic Learning, and Dental Education research topics were extracted and analyzed using the Web of Science database. VOSViewer software was used to identify and visualize key trends, influential authors, and journals. The 374 filtered documents were selected based on three main criteria which are (i) Topics on Mobile Learning or Blended Learning or Online Learning or E-Learning or Electronic Learning and Dental Education research, (ii) Type of documents on 'Article', and (iii) Year Published within 2000 to 2020. We conducted several types of analyses on the body of research using VOSViewer which are (i) Co-authorship analysis, (ii) Co-occurrence analysis, (iii) Citation analysis, and (iv) Co-citation analysis. The main contribution and motivation for this study is in the form of a conceptual framework of types of Dental Health Education based on stakeholders' orientation in guiding future research in Dental Health Education with interdisciplinary research in Mobile Learning, Blended Learning, Online Learning, or E-Learning and support the UN Sustainable Development Goals agenda on Quality Education. There are five major keyword theme clusters concerning stakeholders-oriented clusters that we had determined based on the clusters which are (i) program provider, (ii) curriculum designer, (iii) dental students, (iv) dental hygiene education provider' and (v) interprofessional education provider themes.
Keywords: Dental Health Education, Mobile Learning, Blended Learning, Online Learning, E-Learning, Electronic Learning, Sustainable Development Goals

Introduction
    There is an ongoing trend in the organization related to Mobile Learning (Deshpande et al., 2017), Blended Learning (Ratka-Krüger et al., 2018), Online Learning (Bridges, 2015), E-

Learning, Electronic Learning (Diniz-Freitas et al., 2017), and Dental Education research and supporting the UN Sustainable Development Goals agenda in Quality Education. Because academic literature on Mobile Learning, Blended Learning, Online Learning, E-Learning, Electronic Learning, and Dental Education is dispersed across domains, a full literature mapping is required. Specifically, we seek answers to the following questions:

- Over the last two decades (2000-2020), how has the amount of study on Dental Health Education with interdisciplinary research in Mobile Learning, Blended Learning, Online Learning, or E-Learning changed?
- What are the key terms associated with Dental Health Education with interdisciplinary research in Mobile Learning, Blended Learning, Online Learning, or E-Learning in the literature (2000-2020)?
- Who are the most prolific researchers and what links do they have to each other in Dental Health Education with interdisciplinary research in Mobile Learning, Blended Learning, Online Learning, or E-Learning literature (2000-2020)?
- Which journals and universities are the most prominent and influential in their publication of Dental Health Education with interdisciplinary research in Mobile Learning, Blended Learning, Online Learning, or E-Learning literature (2000-2020)?
- What is the conceptual framework of types of Dental Health Education based on stakeholders' orientation in guiding future research in Dental Health Education with interdisciplinary research in Mobile Learning, Blended Learning, Online Learning, or E-Learning?

Method

The main objective of this study is to determine a scientometric analysis of twenty years of trends in Mobile Learning or Blended Learning or Online Learning or E-Learning or Electronic Learning and Dental Education research. Using the method of extraction of information from the Web of Science database and VOSViewer software (Van Eck and Waltman, 2010) techniques, analysis, and reporting (Park et al., 2020), papers published on Mobile Learning or Blended Learning or Online Learning or E-Learning or Electronic Learning and Dental Education research topics were extracted and analyzed to identify and visualize main trends, authors (influential), and related journals. The 374 filtered documents were selected based on three main criteria which are (i) Topics on Mobile Learning or Blended Learning or Online Learning or E-Learning or Electronic Learning and Dental Education, (ii) Type of documents on 'Article', and (iii) Year Published within 2000 to 2020. VOSViewer analyses were done which include (i) 'Co-authorship analysis', (ii) 'Co-occurrence analysis', (iii) 'Citation analysis', and (iv) 'Co-citation analysis'. The results are presented in the next section.

Results and Discussion

Fig. 1 shows the number of documents features' search terms – Mobile Learning or Blended Learning or Online Learning or E-Learning or Electronic Learning and Dental Education (2000-2020). The following discusses the results and discussion for (i) 'Co-authorship analysis', (ii) 'Co-occurrence analysis', (iii) 'Citation analysis', and (iv) 'Co-citation analysis'. A conceptual framework was also being developed.
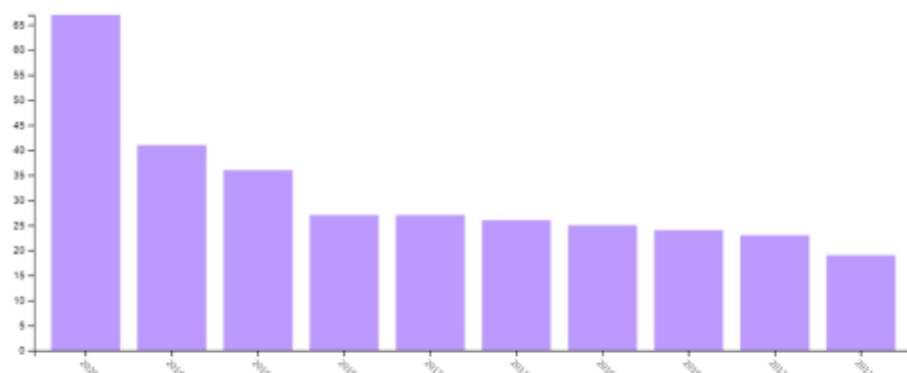
Fig. 1. Number of documents feature search terms – Mobile Learning or Blended Learning or Online Learning or E-Learning or Electronic Learning and Dental Education (2000-2020)

Co-authorship Analysis

In general, 'co-authorship analysis can be described as the greater the number of co-authored papers, the higher the relatedness of authors, institutions, and countries' (Van Eck and Waltman, 2010) (Park et al., 2020). In total, 1451 authors were involved in writing the 374 articles that comprised the Web of Science results related to Mobile Learning or Blended Learning or Online Learning or E-Learning or Electronic Learning and Dental Education research from the year 2000 to 2020. By using VOSviewer, the minimum number of documents published by an author was set to one and the minimum number of citations of an author to 50. 65 authors who met this threshold. Subsequently, the result of co-authorship analysis is shown in **Fig. 2** which includes three prominent clusters (authors). The first cluster (green node) comprise of authors Kavadella, A., Lionarakis, A., Tsiklakis, K. and Vougiouklakis, G. The second cluster (blue node) comprise of Mattheos, N., Perryer, D. G. and Walmsley, A. D. The third cluster (red node) comprise of Apse, P., Attstrom, R., Brown, P., Buchanan, J., Camilleri, A., Care, R., Fabrikant, E., Gundersen, S., Honkala, S., Johnson, I., Jonas, I., Moreira, J., Peroz, I., Seemann, R., Stefanovic, N., Tansy, M., Thomas, H. F., Tsuruta, J., Uribe, S., Urtane, I., Walsh, T. F., Zimmerman, J.
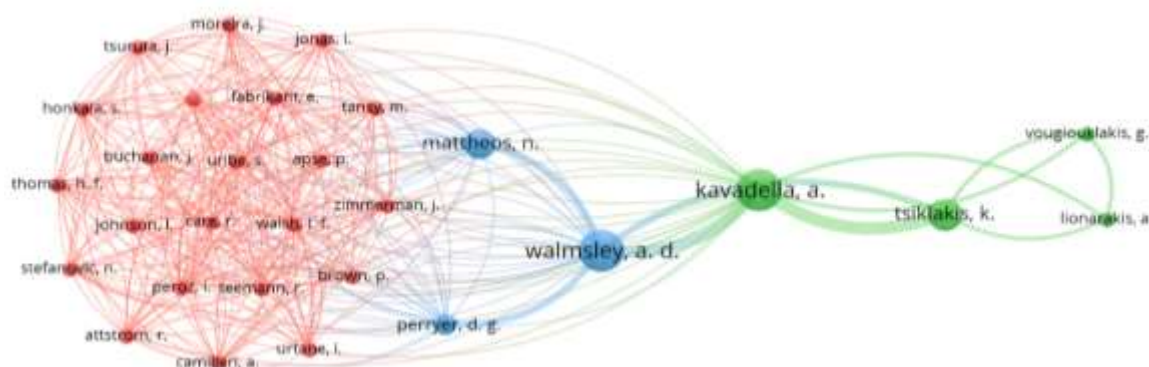

Fig. 2. Co-authorship diagram (Generated by VOSviewer)

The top six countries in terms of the number of papers published are listed in **Table 1**. Scholars from the United States of America (USA), England, and Australia have the most papers and have the most citations (by country).

Table 1
The top six countries in terms of the number of papers published

Country	Documents	Citations
USA	147	1738
England	52	635
Australia	28	353
Canada	22	142
Germany	21	304
Saudi Arabia	18	156

By using VOSviewer, the threshold for analysis was set for one document published per country with 50 citations. As a result, 31 of the 64 countries in our data met this criterion. The United States of America (USA) is the largest node because it has the most papers published. These clusters, when analyzed further, comprise five networks (clusters) of countries that work together, as shown in **Fig. 3**. The first cluster (in blue node) comprises Canada, England, India, Jordan, China, Scotland, and the USA. The second cluster (green node) comprises Croatia, Finland, Greece, Ireland, Latvia, Netherlands, Sweden, and Wales. The third cluster (in red node) comprises Brazil, Germany, Japan, Malta, Norway, Portugal, Russia, Serbia, Spain, Switzerland. The fourth cluster (yellow node) comprises Australia, Egypt, Pakistan, Saudi Arabia. The fifth cluster (purple node) comprises Chile and Indonesia.
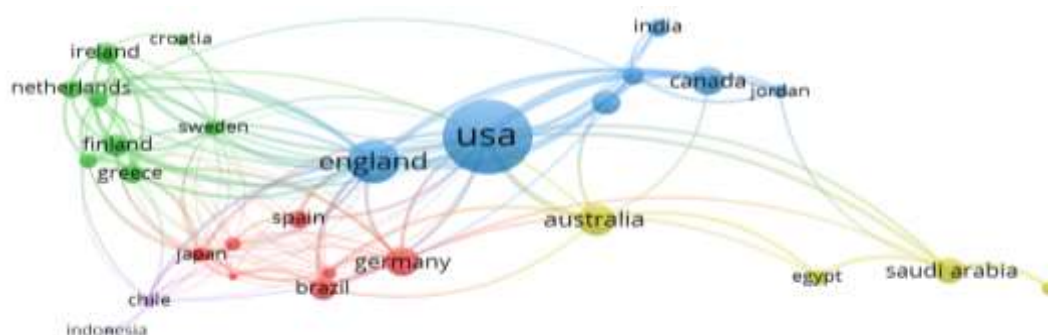

Fig. 3. Co-authoring countries are shown on the mapping (Generated by VOSviewer)

Co-occurrence Analysis

In general, 'the bigger the number of papers in which two keywords appear together, the higher the relatedness of these keywords, according to co-occurrence analysis' (Van Eck and Waltman, 2010) (Park et al., 2020). VOSViewer collects 'co-occurrences of both author keywords and all other keywords, demonstrating their frequency and relatedness' (Van Eck and Waltman, 2010) (Park et al., 2020). Co-occurrence analysis includes 'measuring the number of documents in which two terms or words are found together' (Van Eck and

Waltman, 2010) (Park et al., 2020). VOSWiever was set for a threshold of ten documents in which a keyword had to appear for it to be included. Out of 1338 keywords, the data subsequently resulted in 42 keywords with accord to the aforementioned threshold. Table 2 lists the ten most commonly occurring keywords that appeared in our sample of 374 papers. The top five most commonly occurring keywords are 'Dental Education', 'Education', 'E-Learning', 'Students', 'Dentistry'.

There are five major keyword clusters concerning user-oriented clusters that we had determined based on the clusters which are (i) program provider, (ii) curriculum designer, (iii) students, (iv) dental hygiene education provider' and (v) interprofessional education provider themes. **Fig. 4** shows the mapping of the keyword co-occurrences and also depicts the dominant links between keywords and clusters. First, the shown in red that we classify as 'program provider' oriented keywords —'assessment', 'continuing professional development', 'dental students', 'dentists', 'education', 'information', 'knowledge', 'learning', 'online', 'social media', and 'technology'.

Second, the keywords that are shown in green that we classified as 'curriculum designer' oriented keywords are 'curriculum', 'dental education', 'educational methodology', 'flipped classroom', 'medical-education', 'model', 'performance', 'problem-based learning', 'skills' and 'students'. Third, the terms, that are shown in blue that we classified as student-oriented keywords, are 'anatomy', 'attitudes', 'dental', 'dentistry', 'impact', 'instruction', 'medical education', 'perceptions', 'school'. Fourth, the terms that are shown in yellow that we classified as dental 'hygiene education provider'-oriented keywords are 'blended learning', 'dental hygiene education', 'distance learning', 'educational technology', and 'online learning'. Fifth, the terms that are shown in purple that we classified as 'interprofessional education provider' keywords are 'care', e-learning', 'health', 'interprofessional education', 'online education', 'program'.

Table 2
Most Commonly Occurring Keywords

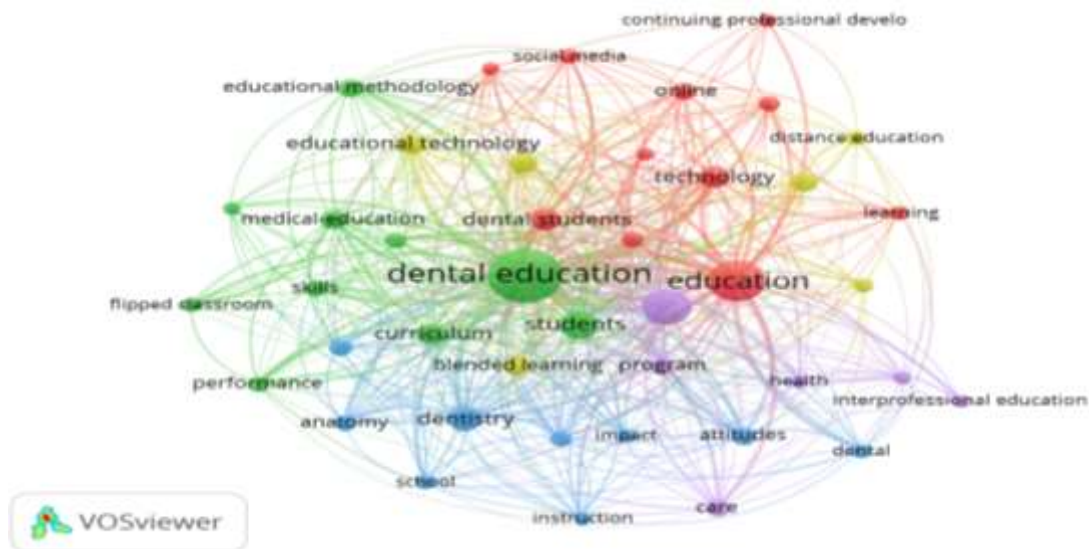| Keyword	Number of Occurrences
Dental Education	177
Education	103
E-Learning	76
Students	49
Dentistry	38
Technology	31
Dental Students	30
Curriculum	27
Educational Technology	26
Online Learning	25

Fig. 4. Keyword co-occurrences are shown on the mapping (Created by VOSviewer)

Citation Analysis

In general, 'the more the number of times authors, journals, and publications cite each other, the more connected these items are, according to citation analysis' (Van Eck and Waltman, 2010) (Park et al., 2020). Citation analysis is 'based on the relatedness of entities like authors and journals, which is determined by how many times they cite each other'(Van Eck and Waltman, 2010) (Park et al., 2020). Which documents in the field of Mobile Learning or Blended Learning or Online Learning or E-Learning or Electronic Learning and Dental Education research cite each other? We use VOSviewer and set the threshold that a paper is cited at least fifteen times. Out of 374 documents, only 94 documents met this threshold which created nine clusters as shown in **Fig. 5**.
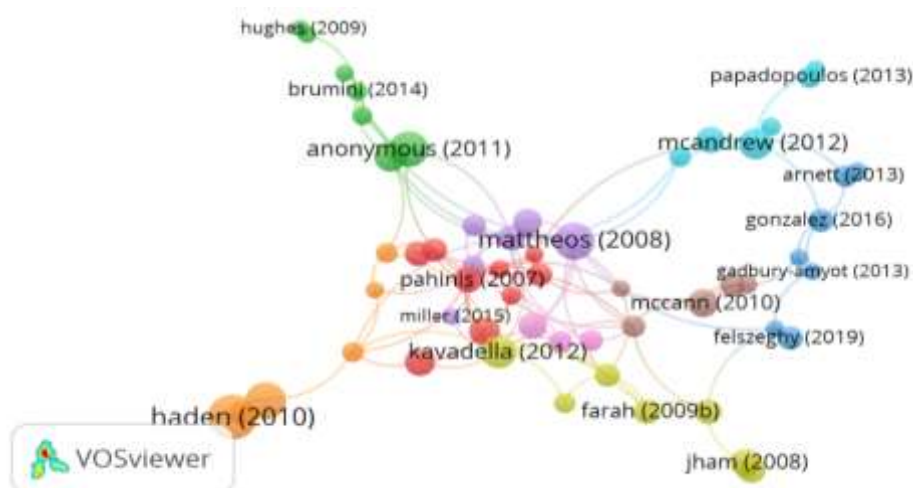

Fig. 5. Citations by paper are shown on the mapping (Created by VOSviewer)

The threshold was set in VOSviewer that a journal had to be cited at least five times to be included in the map and the minimum number of a document of a source is three. 12 journals out of 107 sources met this criterion and of these and created eight main clusters as shown in **Fig. 6**. First, the cluster comprises of 'Anatomical Sciences Education', 'BMC Oral Health', 'Journal of Dental Education'. Second, the cluster comprises of 'European Journal of

Dental Education' and 'International Dental Journal'. Third, the cluster comprises of 'Advances in Medical Education and Practice'. Fourth, the cluster comprises of 'British Dental Journal'. Fifth cluster comprise of 'BMC Medical Education'. Sixth Cluster comprise of 'pesquisa brasileira em odontopediatria e clinica integrada'. Cluster seven comprises Journal of Medical Internet Research. Cluster 8 comprises Open Dentistry Journal.

Fig. 6. Citations by the journal are shown on the mapping (Created by VOSviewer)

Co-citation Analysis

In general, 'the greater the number of times authors, journals, and publications are referenced together, the stronger the relatedness of these items, according to the co-citation analysis' (Van Eck and Waltman, 2010) (Park et al., 2020). Co-citation analysis looks at 'how closely elements like authors, journals, and publications are mentioned together and how it has shaped academic discussions in the subject' (Van Eck and Waltman, 2010) (Park et al., 2020). The co-citation analysis was done with all the references cited in the 374 papers in our dataset. The threshold was set in VOSviewer that a reference is cited at least 19 times. Thus, three references met this criterion as shown in **Fig. 7**. The top three most cited papers were (i) Karl et al., 2006 (ii) Mattheos et al., 2008 and (iii) Ruiz et al., 2006.

Fig. 7. Map of co-citations analysis based on the unit of analysis of cited references (VOSviewer)

The co-citation analysis was done on all authors cited in the 374 papers. A threshold of 30 citations per author was set in the VOSviewer. Thus, this subsequently filtered the data to only three authors to be analyzed for the co-citation network map analysis. The top three most-cited authors were and Mattheos, N. (54), Reynolds, P. A. (42 citations), and Ruiz, JG (32 citations). Co-citations by the author are shown on the mapping (**Fig. 8**).

Fig. 8. Co-citations by the author are shown on the mapping (Created by VOSviewer)
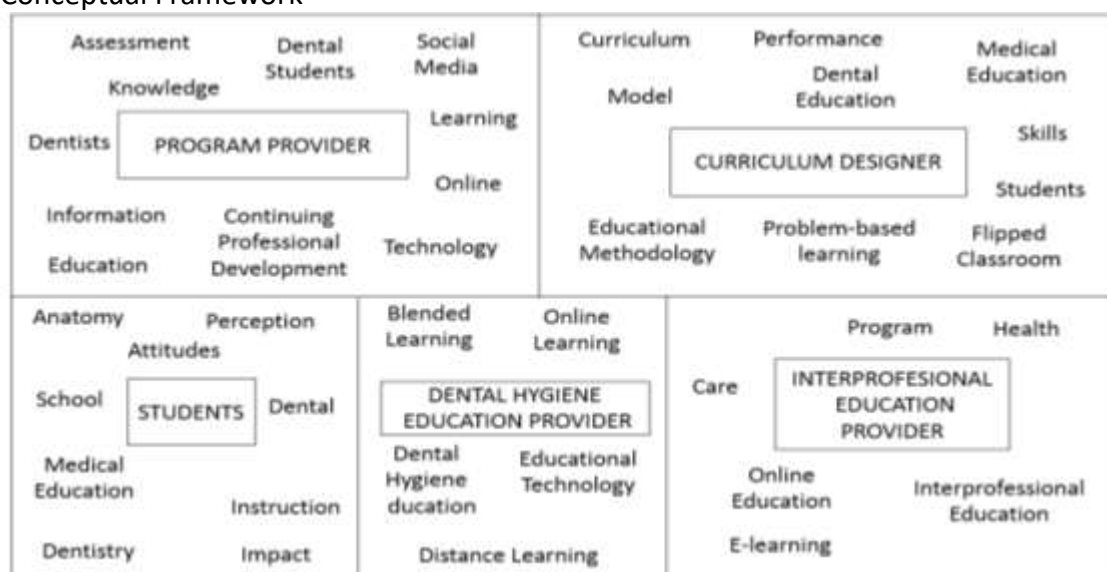
Conceptual Framework

Fig. 9. A conceptual framework of types of Dental Health Education based on stakeholders' orientation in guiding future research in Dental Health Education with interdisciplinary research in Mobile Learning, Blended Learning, Online Learning, or E-Learning.

Based on the Scientometric Analysis of the literature, we propose a conceptual framework of types of Dental Health Education based on stakeholders' orientation (see **Fig. 9**) to guide future research in Dental Health Education with interdisciplinary research in Mobile Learning, Blended Learning, Online Learning or E-Learning.

There are five major keyword theme clusters concerning stakeholders-oriented clusters that we had determined based on the clusters which are (i) program provider, (ii) curriculum designer, (iii) dental students, (iv) dental hygiene education provider' and (v) interprofessional education provider themes. **Fig. 4** shows the mapping of the keyword co-occurrences and also depicts the dominant links between keywords and clusters. First, the shown in red that we classify as the first main theme which is program provider theme which associated with eleven sub-themes keywords, which are 'assessment', 'continuing professional development', 'dental students', 'dentists', 'education', 'information', 'knowledge', 'learning', 'online', 'social media', and 'technology'.

The second main theme, we had classified as 'curriculum designer' main theme which associated with ten sub-theme keywords, which are 'curriculum', 'dental education', 'educational methodology', 'flipped classroom', 'medical-education', 'model', 'performance',

'problem-based learning', 'skills' and 'students'. The third main theme, which we had classified as students theme is associated with nine sub-themes which are 'anatomy', 'attitudes', 'dental', 'dentistry', 'impact', 'instruction', 'medical education', 'perceptions', 'school'. Fourth, the terms that are shown in yellow that we classified as 'dental hygiene education provider'-oriented main theme keyword which is associated with sub-themes such as 'blended learning', 'dental hygiene education', 'distance learning', 'educational technology', and 'online learning'. Fifth, the terms that are shown in purple that we classified as 'interprofessional education provider' keywords are 'care', e-learning', 'health', 'interprofessional education', 'online education', 'program'. The theme and sub-themes as shown in **Fig. 9** are important to be referred for future possible research in Dental Health Education with interdisciplinary research in Mobile Learning, Blended Learning, Online Learning, or E-Learning.

Conclusion

The theme and sub-themes as shown in **Fig. 9** are important to be referred for future possible research in Dental Health Education with interdisciplinary research in Mobile Learning, Blended Learning, Online Learning, or E-Learning. The main contribution and motivation for this study is in the form of a the conceptual framework of types of dental health education based on stakeholders' orientation in guiding future research in Dental Health Education with interdisciplinary research in Mobile Learning, Blended Learning, Online Learning, or E-Learning and support the UN Sustainable Development Goals agenda on Quality Education.

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