A Systematic Literature Review with Bibliometric Meta-Analysis of Text Visualization in Education

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***Abstract*—The Covid 19 pandemic has changed education globally. Technology has become the primary medium in accessing education by educators. In addition, education has endured innumerable developments and variations according to the development of technology and science. The use of the current technology as big data, data mining and text visualization has become an inclination in 21st-century education in providing learning aids that are technological and digital. Therefore, the purpose of this systematic survey is to identify peer-reviewed literature on text visualization in education. Scopus and Web of Science and IEEE citation databases are used in the data-gathering phase. PRISMA approach and keyword search were extracted and analyzed. This bibliographic data of articles published in the journals over the five years were extracted. VOS viewer was used to analyzing the data contained in all journals. The findings show that reviews are showing the utilization and acknowledgement of text visualization in education. Additionally, shows that the utilization of text visualization positively affects enhance understanding of the subject among students. However, there is still space to elevate its ease of use in education, which is presently in the 4.0 education shift following the improvement of the Industrial Revolution (IR) 4.0.**

Keywords—Text Visualization, Word Mining, Education, Natural Language, Bibliometric Analysis, Big Data

I. INTRODUCTION

The world of education is currently undergoing dramatic changes as a result of the COVID-19 pandemic. Communities around the world are affected by this pandemic phenomenon. New norms in the education system now include three teaching approaches, namely face-to-face, online and hybrid. All three of these approaches require technology to support the teaching and learning process. Combining technology and visualization can help produce good human beings who will be future leaders in line with the current educational context [1].Visualization is information in a visual form that can demonstrate in graphic form [2]. The term visualization is associated with how the senses of the eye utilize imagination and reflection [2, 3]. Therefore, visualization is essential for the generation of mental image imagery in mind. The primary purpose of information visualization is to render an abstract information space dynamically to expedite human exploration and understanding [4]. The educative impact of visualization encompasses two elements: the intensification of acquiring with visualization, and the deployment of visualization in the classroom

II. TEXT VISUALIZATION

A. Text Visualization

Technology is a catalyst for the development of visual use in information delivery [2]. The use of visuals, especially in education, is becoming increasingly important and highly encouraged. This is because, through the sense of sight, it can scan and easily recognize something through the visual display and recognize the features of the visual display such as shape, colour and arrangement. With that, humans will easily be able to remember information through such visuals [4]. According to [5], visual literacy skill is understanding and translating visual messages into accurate information. [5] define visual literacy skills as the learned ability to interpret visual messages accurately and create such messages.

The use of pictures helps in learning information more effectively than text. For example, pictures of ordinary objects are easier to remember and recognize than their textual names. However, pictures for conceptually similar objects or rapid presentation of pictures is less effective [3]. On the other hand, images cannot be used for abstract concepts such as "freedom" or "amount". The use of pictures was found to be more effective than instructions text or auditory for the communication of spatial information. However, the use of pictures in more complex ways is less effective. Therefore, the use of specific media to communicate certain information is better than other types of media. For verbal information communication, the use of text is preferable to auditory reading. To recall and recognize objects, the use of pictures is better than text. Pictures are also better than text or reading for spatial information communication [4]. The use of pictures also helps students build cognitive connections between verbal and pictorial information. Analysts can apply data processing in real-time by visualizing the results of data processing [5] in performing data visualization to optimize problems in computer science, especially in the academic field. Visualization in the form of graphic reports can optimize

problems in education management [2]. Problems in computer science with Big Data technology can quickly produce analysis that provides new knowledge of Big Data [4].

B. Text Visualization in Education

According to [1], text visualization or even translating the text into graphic form became relatively impossible before artificial intelligence components. Still, it can be made a reality with a combination of some of the latest technological techniques. This statement came true when [6] developed a Bayesian Network approach model to plot the accident scene simply by entering some of the required information. Bayesian Network can predict traffic errors committed by road users by connecting nodes from text input.

In addition, [7] states that text visualization has evolved over the past ten years; however, translating text to graphics has become problematic in software engineering. According to [7], specific techniques can be easily applied to the domain but have difficulty making it actual. Reference [8] state that text mining and text visualization is an approach that can generate maps from the inputted text. And [9] found a VOSviewer application that can generate the information desired by a researcher related to the study conducted. The VOSviewer application can generate semantic maps, reference/author maps and bibliographies.

III. Significance And Objective

So, this systematic survey is to identify peer-reviewed literature on the field of text visualization in education through the Scopus, the Web of Science and IEEE database. The research work precisely by summarized the research objective as shown in Table I.

TABLE I. Research Question with its significance

Research Objective	Significance of research question
Analyse literature related to the use of text visualization in Education.	Contributed in identifying clusters that are frequently studied and be able to improve their related studies in the future.
Identify trends in literature review of text visualization in education.	Using the PRISMA approach and Bibliometric methods to identify research trends in the field.
Analyse the impact text visualization in education based on literature review.	Recommend the effectiveness of the use of text visualization in education, especially on student understanding and behaviours.

IV. Material And Method

A systematic literature review is desirable for research on this topic. PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) and Bibliometric analysis have been applied to answer the research questions. PRISMA method used to shortlist and selects the 1983 works from Scopus, Web of Science and IEEE databases with explicit inclusion and exclusion criteria as below:

- The article period of 2017 to 2021
- The article focusses on text visualization in education
- Duplicate article with same author and topic removed

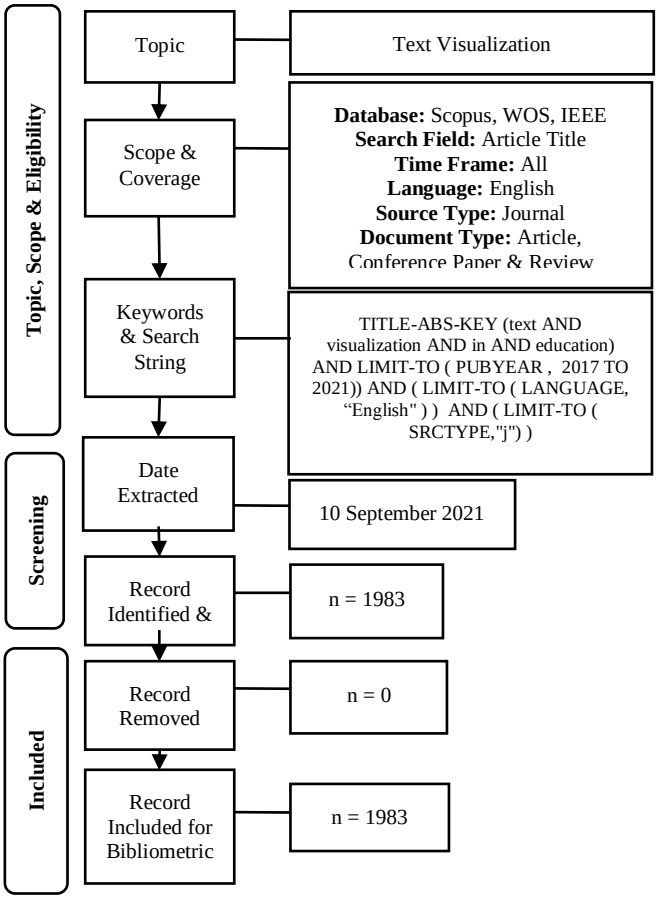

Fig. 1. PRISMA flowchart for systematic review of text visualization

V. Result And Discussion

To inscribe the research questions created in the previous section, the study of this paper appropriated the accompanying parts of scholarly works. A total of 1983 articles were analysed in this bibliometric and SLR based on Scopus, IEEE and WOS databases. VOSViewer was used to analyse and answer the objectives of the study. The analysis was conducted to identify the frequency of publication of studies in text visualization in Education. Among the aspects identified are publications issued from 2017 to 2021. Next, subject area and publication trends are also analysed in this literature review.

A. Current publication state of text visualization in education

The analysis conducted shows in Table I the data of the types of publications published in the database selected from 2017 to 2021 for text visualization. The findings showed that 904 (45.59%) posted were articles, while the publication of conference papers was 921 (46.44%), and conversely, the publication of review papers was 73 (3.68%) Table II.

TABLE II. Document Type

Document Type	Total Publications (TP)	Percentage (%)
Article	904	45.59
Conference Paper	921	46.44
Review	73	3.68
Conference Review	55	2.77
Erratum	21	1.06
Data Paper	6	0.30
Total	**1983**	**100.00**

TABLE III. YEAR OF PUBLICATION

Year	TP	NCP	TC	C/P	C/CP	*h*	*g*
2021	301	63	146	0.49	2.32	5	7
2020	439	216	641	1.46	9.7	9	12
2019	449	276	4913	10.94	17.80	23	64
2018	432	321	3320	7.69	10.34	27	43
2017	362	249	4042	11.17	16.23	28	56
Total	**1983**						

Notes: *TP*=total number of publications; *NCP*=number of cited publications; *TC*=total citations; C/*P*=average citations per publication; *C/CP*=average citations per cited publication; *h*=h-index; and *g*=g-index.

Next, an analysis is conducted to see the publication by trend or landscape of the study is conducted. Findings show for 2017, a total of 362 studies were published and 4042 times referenced in other studies. The average citation value per cited publication for the year was 16.23, and a total of 28 studies recorded the index h, and 56 studies recorded the index value g. Meanwhile, for the year 2018 found that a total of 432 were published. Still, 321 articles in the total number were not referenced, and 27 studies recorded the value of the index h, and 43 studies recorded the value of the index g. The total number of study publications in the three databases showed an increase for 2019 and 2020, which recorded the number of studies of 449 and 439, respectively. However, the number of studies that documented the index h and g decreased for these two years in Table III.

B. Themes and trends of text visualization in education

Meanwhile, the objective of this review study also emphasizes identifying trends or landscapes of studies conducted in the field of text visualization in education. Table IV shows the analysis of the subject area of the study conducted in as many as 1983 studies conducted. The table below shows a total of 26 subject areas frequently studied between these five years. In that, many studies were done in the field of computer science, which is 1337 (67.42%), followed by engineering subjects with a total of 558 (28.14%), and studies in the field of text visualization in the issue of Mathematics is 243 (12.25 %). On the other hand, medicine subjects were performed once (10.04%). It can be concluded that the subject area of computer science conducted many studies published in the database analyzed in this review paper in Table IV.

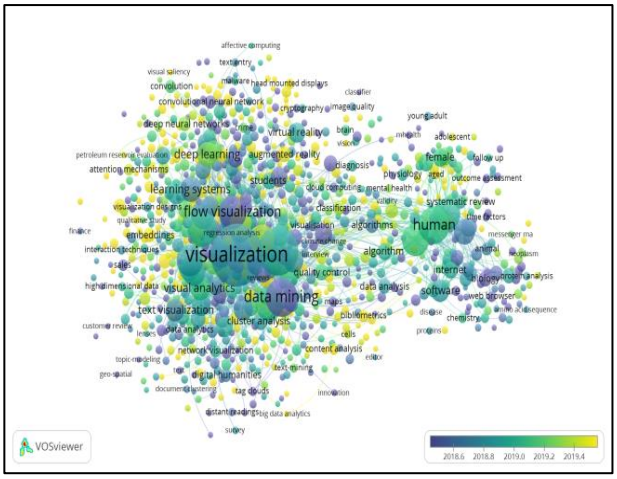

Fig. 2. Network visualisation map of the author keywords

TABLE IV. SUBJECT AREA

Subject Area	Total Publications (TP)	Percentage (%)
Agricultural and Biological Sciences	40	2.02%
Arts and Humanities	71	3.58%
Biochemistry, Genetics and Molecular Biology	126	6.35%
Business, Management and Accounting	80	4.03%
Chemical Engineering	31	1.56%
Chemistry	27	1.36%
Computer Science	1337	67.42%
Decision Sciences	143	7.21%
Dentistry	3	0.15%
Earth and Planetary Sciences	58	2.92%
Economics, Econometrics and Finance	18	0.91%
Energy	44	2.22%
Engineering	558	28.14%
Environmental Science	68	3.43%
Health Professions	21	1.06%
Immunology and Microbiology	11	0.55%
Materials Science	95	4.79%
Mathematics	243	12.25%
Medicine	199	10.04%
Multidisciplinary	30	1.51%
Neuroscience	40	2.02%
Nursing	15	0.76%
Pharmacology, Toxicology and Pharmaceutics	12	0.61%
Physics and Astronomy	156	7.87%
Psychology	26	1.31%
Veterinary	3	0.15%

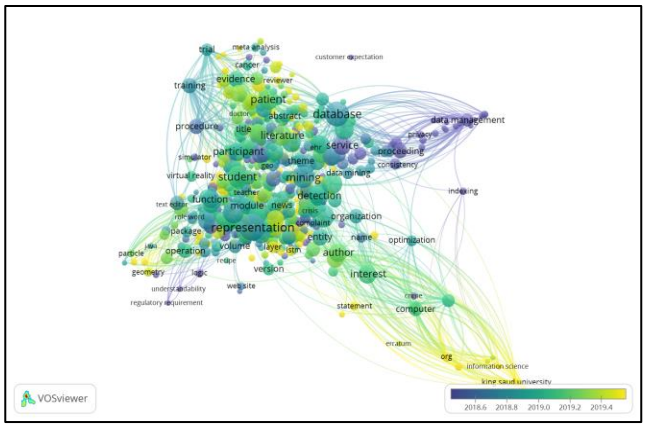

Fig. 3. VOSviewer visualization of a term co-occurrence network based on title and abstract fields (Binary Counting)

C. Discussion on Finding

This systematic survey using PRISMA and bibliometric methods has answered three research questions developed. In total, 1983 studies published in Scopus, IEEE and Web of Science were analyzed. A total of five sets of keywords were published in screening the content of the study. Bibliometric analysis has provided an overview of the trends and effects of text visualization in education on students. Overall, there are many studies conducted related to the use of text visualization in education. Usage trends show that most studies are related to data mining, flow visualization, human-computer interaction in education. Also, the trend shows studies associated with the development of software applications in education. Data visualization is the process of converting raw data into easy-to-read visual data [10].

Reference [11] stated that the use of text visualization can improve the understanding of readers, especially students. Supplementary [9] text visualization in education motivates students to understand the subject being studied (Fig. 2, Fig. 3).

Text visualization also explains the structure of learning and provides variations in teaching [10]. Here Text visualization has a clear function, namely clarifying, facilitating and making interesting curriculum messages that will be conveyed by the teacher to students so that they can motivate their learning and streamline the learning process [3]. The study results indicate that teaching and learning activities will be more effective and accessible when assisted by visual means [2].

Current challenges in the field of education are related to changes in the delivery of teaching and learning. The development of computer technology in the world has led to many changes in the learning system globally. Advances in computer technology have also enabled teaching techniques to be diversified to present teaching materials to students more creatively. In this regard, various plans and efforts need to be made to improve the quality of national education, among them is to increase the effectiveness of the teaching and learning process through computers and information communication technology (ICT).

Studies by [12] show that text visualization patterns affect the construction of mental model structure during learning, influencing the individual's performance patterns after his or her learning. Students seem to construct different mental models from each of the same learning content but depend on the visualization pattern used to produce the mental model [13]. However, the type of text visualization also depends on the situation they have experienced before the learning [13].

VI. CONCLUSION

This review assesses text visualization and its usage in education. The increase in research on text visualization indicates interest in this area of study. This review evaluates the effectiveness and trend of using text visualization. A total of 1983 studies cited from Scopus, Web of Science IEEE were systematically and bibliometrically analyzed. The findings conclude that integrating methods and approaches according to the changing trends in the world of technology by using the latest techniques such as text visualization in education can lead to 21st century education. In line with that, [10] stated external factors are stimuli from outside the students themselves through their senses, especially hearing and sight.

Text visualization of learning as an external factor can increase learning efficiency because it has the potential or ability to stimulate the learning process. Information or text visualization is a potential field in developing information access, processing and management [2]. Information Visualization application is also developed in education as a learning material because of the advantages and uniqueness of information visualization techniques that are capable of improving the comprehension process through the use of visuals [7].

In addition, information visualization applications are also capable of managing large data subs and complex concepts in learning activities. Although information visualization techniques are beneficial for information acquisition and learning activities, constructed visual development is not purely visual but involves constructing material based on theories that support a particular visual understanding. A balance to good visual design can build the perception of human systems to understand concepts and interpret information more easily, quickly and accurately. Based on this theory of visual perception, this study examines its suitability with the need for hadith acquisition to produce an information visualization system design based on visual perception theory.

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