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The Learning of Mathematics Based on Individual Differences : A Topic Trend Bibliometric Analysis Using VOSviewer

M. J. Dewiyani Sunarto*, Julianto Lemantara
Universitas Dinamika, Indonesia.
*****Corresponding Author. Email: dewiyani@dinamika.ac.id

Abstract: This study aims to establish a foundation for the development of differentiated learning through an analysis of trends in articles related to personality type differences in the field of mathematics education. The research method used was descriptive, using Bibliometric Analysis. These 422 data from Scopus have been from Scopus-indexed journals and were obtained by defining search keywords, namely "individual differences." These articles were then filtered based on the highest citation, resulting in 100 articles that were analyzed using Vos Viewer and Microsoft Excel to display the necessary data for analysis. The results of this study indicated that from many articles that had been analyzed, individual differences have a wide meaning, it could be gender, characteristics, thinking process, fear, attitude, and others. Those differences should be taken into consideration by the teacher and cannot be neglected because they can influence the learners. From the data that has been analyzed, the topic above has been increasing after 2017 with the United States and the United Kingdom as the most recent country that published this topic. *Cognition* is the journal that has the most publications on this topic, with Engle, R. W. as the most productive writer. The most trending article was about Mathematics in general, mathematics concepts, and the phenomena in teaching and learning math. The next piece of advice is about the development of the individual learning model, its evaluation, and its utilization in creating a differentiated learning model.

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Introduction

Individual differences can be translated as the individual characteristics that differ from one learner to another in the teaching and learning process. Learners are a unique individual who brings a package of prominent differences in every learning situation, including the differences in indicators of potential in the past time (Şimşek, 2012). Research from (Killingsworth et al., 2015) states that analyses of individual differences indicated that certain threshold inhibitory control abilities may be necessary to benefit from self-explanation in games. Some individual differences influence the performance and the attitude of learners during the teaching and learning process, such as gender, age, interest, learning style, and motivation. Besides, there are many hidden differences, such as intelligence, skill, characteristics, the way of thinking and learning (Jamian et al., 2019; Williams et al., 2018). Other researchers (Dewiyani et al., 2017) in her research has differed the thinking process based on characteristics so that it can be developed to be a better teaching and learning process. The differences in learning style have been studied by (Susilo, 2022), it was about critical thinking in finishing a mathematical problem, and the result was a group of kinesthetic is better than others at finding solutions to a mathematical problem. The research from (Lestariningsih et al., 2021) concluded that male students use fewer symbols and

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algorithms in finishing the PISA problem in order to shorten the time. At the same time, female students use more detailed descriptions and a more mathematical style in finishing the problem based on algorithms and procedures. Still about gender (Al-Hamad, 2022; Hashim et al., 2022; Huang, 2022; Kurniadi et al., 2021) conducted research on constructing mathematical models, with male students getting more chances than female students to answer the question.

The importance of understanding the learners has become the main topic in educational issues some articles, (Kubat, 2018) stated that by understanding the differences in individual characteristics, a more effective teaching and learning process can be planned before so that it will result in more active learners. While (Al-Seghayer, 2005) in his research has found a learning method based on the differences in individual characteristics. (Sanders & Conti, 2012) emphasize the collaboration between the cognitive, decision-making style, and learning approach at the career center in Yokohama, Japan. (Kubat, 2018) highlighted the gender differences in statistical problems, and it showed that females are better in this case. In mathematics (Efklides et al., 2018) found that the afraid of mathematics subject in high school also depends on individual differences, and women are worse in this case.

From several previous studies discussing the importance of individual differences in learning, no articles summarize individual differences in education trends, how far this has been discussed, and what topics can still be developed, especially in understanding mathematics. Therefore, the purpose of this research is to analyze the article published in the journal that has been registered in Scopus with the topic the individual differences in learning mathematics so the trend can be found by using the Bibliometric analysis Vos Viewer application. This analysis is crucial considering that, currently, differentiated learning is being promoted in the middle school level under the Merdeka Belajar curriculum (Pitaloka & Arsanti, 2022). The foundation of differentiated learning lies in individual differences based on learning styles, personality types, gender, basic abilities, and others, which have not been scientifically examined so far. Understanding individual differences will provide a stronger rational basis for the formation of differentiated learning.

Research Method

The research method used was a descriptive using Bibliometric Analysis. Bibliometric Analysis is the quantitative method that uses mathematical and statistical aspects to measure the reciprocal correlation and the effect of publication in a particular research area (Donthu et al., 2021). This Bibliometric Analysis can be used accurately to explore and analyze scientific papers. Some researchers used Bibliometric analysis, for example, (Drijvers et al., 2020) who successfully identified five main groups in mathematics education, they are; (1) managing the complexity of teaching, (2) planning resources (3) teaching using technology (4) adult learner (5) interact with the computer. Mathematical thinking has also been analyzed with Bibliometrics, and it resulted from the analysis that 2019 is the year with so many numbers of research on this mathematical thinking (Supriyadi, 2022). In this research, the data has been taken from Scopus; the access comes from Kementerian Pendidikan, Kebudayaan, Riset dan Technology / Ministry of Research, Technology and Higher Education Indonesia. Scopus was chosen because it is the basic data for the biggest publication and is reputable (Admoko et al., 2021; Deta et al., 2021; Mishra et al., 2021) so that it can give quotation with abstracts from various scientific literature and trusted research, and kit can be used to visualize, track, and analyze publication.
This research uses steps adopted from (Prahani et al., 2021);

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Step 1: Initial Stage

The first step was collecting data from Scopus and deciding the keywords. In this research, the keyword used was 'individual differences, which resulted from 70.057 documents; the next was filtering with the subject area 'social science,' which came up with 13.945 documents. The next keyword was 'learning', which resulted in 422 documents, and the keyword 'article' resulted in only 401 documents. In short, the command given was: TITLE-ABS-KEY ("individual differences") AND (LIMIT-TO (SUBJAREA, "SOCI")) AND (LIMIT-TO (EXACTKEYWORD, "Learning")) AND (LIMIT-TO (DOCTYPE, "ar")). In this research, there was no year limitation because it focused on the development of individual differences until the last time the data were collected, which was September 14, 2023. Besides, the teaching-learning process is still being reviewed generally.

Step 2: Initial Research Results

Findings on step 1 were downloaded with the type file .ris dan .csv as many 422 documents

Step 3: Refinement of Search

The downloaded .csv file would be processed by using Open Refine which can be used as open source so that the researcher can refine the keywords, writer, agency, and country.

Step 4: Data Analysis

The data that had been organized with Open Refine will be applied in Vos Viewer, an application that can be used as open source; this is the product of the Centre for Science and Technologies Studies, Leiden University, Netherlands, an application that can construct and visualize bibliometric system just like journal, title, author, writer, publication, etc.(Dhian Nur Rahayu & Lila Setiyani, 2022). Vos Viewer can also map many kinds of bibliometric analysis, and resulted from a sophisticated visualization with visual labelling (Nurul Zakiyyah & Winoto, 2022). Data results would be analyzed further and use MS Excel to make it more detailed dan understandable and be able to answer the learning objectives. Besides, there was review literature on some articles especially about teaching mathematics in order to be more understanding about the trend of that subject.

Results and Discussion

Analyzed The Year of Publication, The Number of Articles Based on Country, and the Language Used in Developing the Topic of Individual Differences in Teaching.

Firstly, the year of publication will be analyzed with the topic used 'individual differences' since 2000 as displayed in Figure 2.

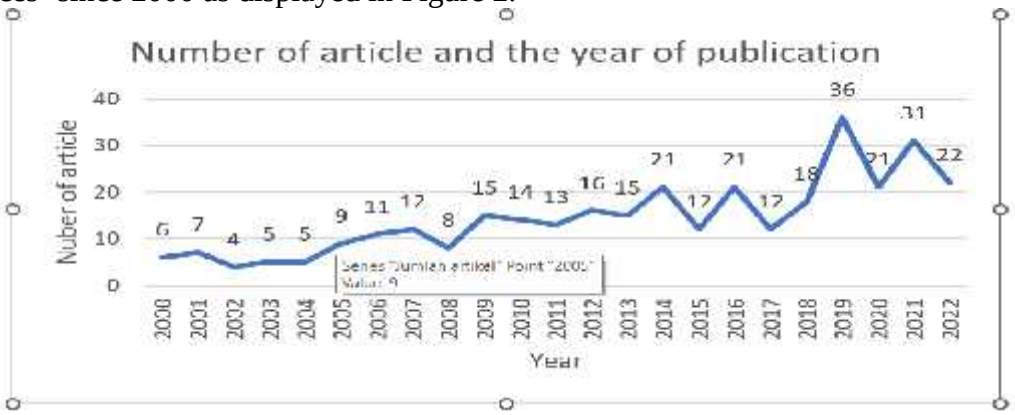

Figure 1. The number of articles and the year of publication

Figure 1 shows the development of the article from 2000 until the data was taken. The year taken started from 2000 with the consideration of the novelty of the article. There are 15 articles on average annually on this topic, with the limitation on 'social science' and the

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keyword 'learning'. 2019 is the year with the highest number of publications, with 36 articles, and the next was 2021, with 31 articles. In those years the topic of individual differences has become a trend, with the sub-topic 'human' as the highest one. (Qi, 2019) showed that the stress level of learners toward mobile technology in learning depends on the individual itself. In 2021, 'human' still became the most trending sub-topic, and in that year, Covid-19 has spread out, so many articles were also talked about it. After the year that is analyzed, the next is the language used to get the data on what languages are commonly used in this topic. English dominated the usage in this topic with 399 articles, others are Spanish and Arabic. From language, we move to what country contributed a lot to the topic of individual differences with the limitation on social science and keyword learning. Ten countries have the highest number, as displayed in Figure 3. From Figure 3 the United States dominated the spread of articles, followed by the United Kingdom as the first country that published this topic in 196 (Warren, 1961). However, in 1964, the United States followed the UK in the publication of the article until today, starting from the publication by Mulholland in 1964 (Mulholland, 1964) and followed by Richard E Snow in 1965 (Snow et al., 1965). From Figure 2, we can see that the topic of individual differences has been spread out in 44 countries, including Indonesia. There was 1 article in 2019 in the Universal Journal of Educational Research.

Figure 2. Ten Countries with the Highest Analyzed the Document Article and Highest Agency on the Topic of Individual Differences and Learning

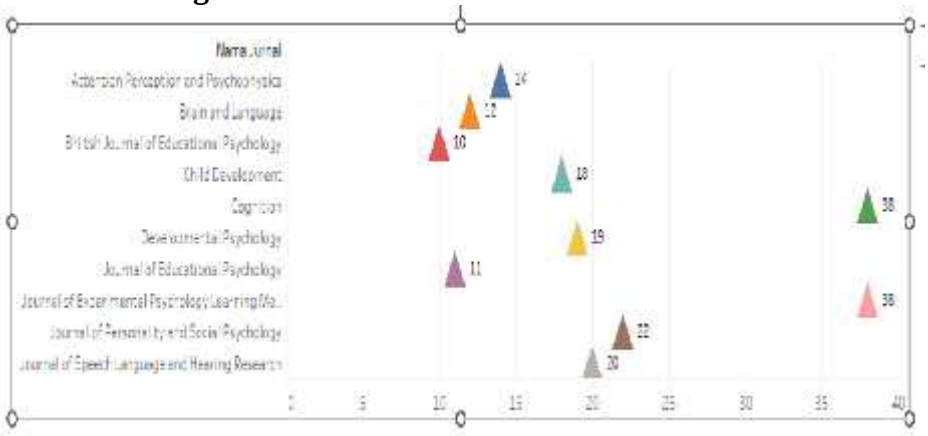

Figure 3. Ten Highest Journal that Published Individual Differences Article

With this abundant of data, the researcher can develop research with the same topic, with the assistant from this journal. Journal Cognition have published so many articles of this topic since 1981 entitled 'Building Theories of reading ability: On the relation between individual differences in cognitive skills and reading comprehension' written by Thomas H Carr and

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were talked about individual differences on the reading skill (Carr, 1981) until the latest article in 2022 entitled 'Auditory precision hypothesis-L2: Dimension-specific relationships between auditory processing and second language segmental learning' which talked about the differs in seeing and taking the advantage information that has been delivered specifically in acoustic dimension (Saito et al., 2022).

Besides the articles that have been analyzed, it is also important to know how many affiliations were published on the topic of Individual differences so that it can be a reference for other researchers to develop this topic. The ten universities with the highest number of published articles have been displayed in Figure 4. From Figure 4, we can see that University College London has the highest university in publishing articles; they have published articles from 2001 until 2022. In 2022, the researcher who published that article was Kazuya Saito; he wrote that individuals may vary in terms of how they see and take benefit information that is delivered specifically (Saito et al., 2022).

Ten Highest Universities that Published Individual Differences Article

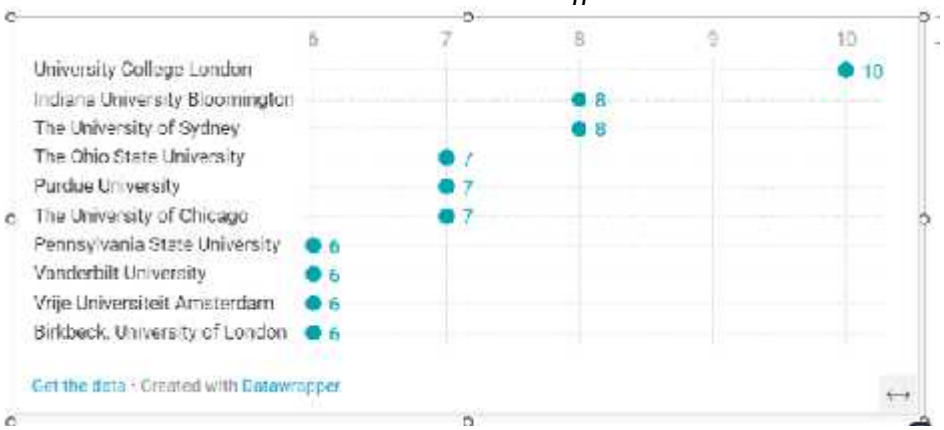

Figure 4. Ten Highest Universities that Published Individual Differences Article Identified Six of the Most Productive Researchers and How Many Citations They Made on the Topic of Individual Differences in General Learning

The elaboration of the researcher has become interesting, along with several articles on a certain topic. These citations have resulted in an article and findings and recommendations from that article to be studied in the future. Figure 6 shows the five most productive researchers and their citations based on the data taken from Scopus. As we all know, the ranking of many articles is not the same as the ranking of many articles.

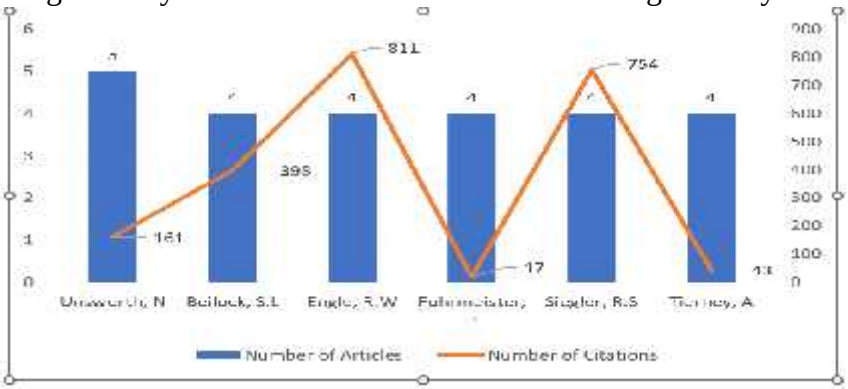

Figure 5. Top Six Authors with the Most Articles and Citations

From Figure 5 it can be seen that even Unsworth, N has the highest number of articles, but the fact that Engle, R. W has the most citations. It can be concluded that the article written by

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Engle has become a reference for other writers. Based on that data, it is interesting to analyze the article written by him.

Table 1. Findings & Recommendations from Top Three Articles

Researcher	Title of Article	Name of Journal	Year of publication	Number of Citation	Findings	Recommendations
Engle, R.W (Martin, J. D., Shipstead, Z., Harrison, T. L., Redick, T. S., Bunting, M., & Engle, 2020)	The role of maintenance and disengagement in predicting reading comprehension and vocabulary learning	Journal of Experimental Psychology: Learning Memory and Cognition	2020	10	The research on reading comprehension on Harrison and Angel shows that the differences in 'reading comprehension and 'vocabulary' take their role in holding the information and filtering the relevant information. Besides, this research also shows that 'fluid intelligence' has better performance than memory capacity.	It needs to build 'fluid intelligence in the frame of learning in order to increase the reading comprehension
Siegler, R.S (Braithwaite et al., 2019)	Individual differences in fraction arithmetic learning	Cognitive Psychology	2019	9	This research uses FARRA learning computation (Fraction Arithmetic Reflects Rules and Associations) to investigate learning mathematics for children. The result is: there are four patterns, 24% classified as the right strategy, 26% as 'whole number preservation, 15% defined as 'addition/substraction preservation,	In the future, the research should explore various sources as parameters in learning by children, to see the consistency. In addition, use findings to help children in learning material.

Researcher	Title of Article	Name of Journal	Year of publication	Number of Citation	Findings	Recommendations
					and 'none' if there are no criteria.	
Beilock, S.L. (Lyons & Beilock, 2009)	Beyond quantity: Individual differences in working memory and the ordinal understanding of numerical symbols	Cognition	2009	46	This research tests the hypothesis of the individual difference in work memory in the correlation of numerical symbol	It is better if the researcher has a source that can stimulate the interaction between the ordinal process and work memory

After analyzing the writer, it is also important to analyze the keyword. By using VoSviewer, as displayed in Figure 7, the relation between keyword and topic resulted in 7 clusters with 121 links on the article individual differences; there are 4 similar keywords in every article. The keyword individual differences have the most connection with the keyword in cluster 1, the red cluster. Cluster 1 consists of executive function, language, learning, mathematics, motivation, reading and self-regulation. Cluster 2, connected with the green link, consists of keywords bilingualism, fluid intelligence, narratives, personality, second language acoustic, and working memory capacity. In cluster 3, the keywords individual differences come up with implicit learning, language acquisition, prediction, sentence processing, and statistical learning.

Figure 7 shows that the keyword individual differences come up with the keyword mathematics, located in cluster 1 with a red link. It means that individual differences and mathematics are more often used with other keywords than other keywords. It is interesting to be discussed to achieve the goals of this research. However, before we go further, we need to look at the keyword that is usually used together with keyword individual differences. However, it needs to be considered in its novelty, as displayed in Figure 8. Figure 8 shows a keyword with a bright color that indicates the year, the brighter the color, the newer the year. If we see Figure 8, it can be concluded that the keyword mathematics has a bright color compared with other keywords, even if the color is not the brightest one. It means that the keyword mathematics is still young and can be more developed.

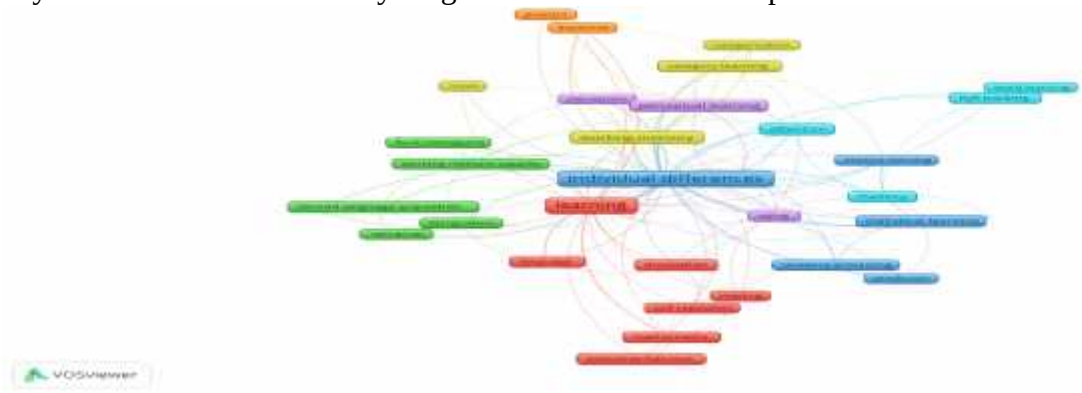

Figure 6. The Correlation between Keywords about Individual Differences

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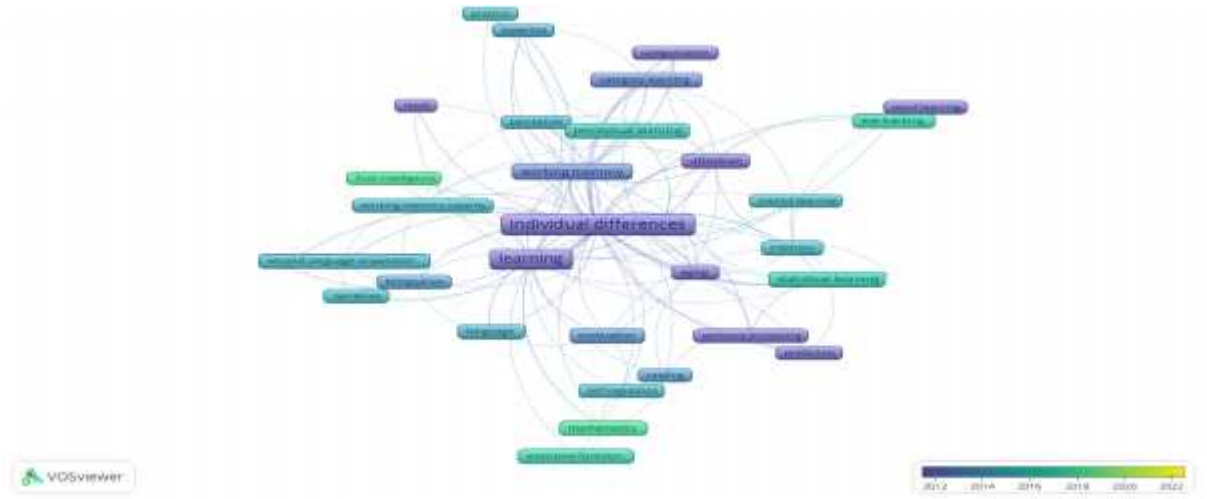

Figure 7. The Relation between Keywords based on Year

From Scopus, we got articles with the keywords mathematic, the highest number in mathematics (17), mathematical concepts (9), and mathematical phenomena (9). The newest article in 2022 with the keyword 'mathematics' entitled Adaptive Individual in Math Courses in the journal Sustainability talked about the anxiety of learning mathematics students in Saudi Arabia are divided into two classes: STEM (Science, Technology, Engineering and Math) and non-STEM at the pandemic Covid-19. The results are: (1) anxiety toward mathematics tests is higher in male students compared to female students, and for the non-STEM, the anxiety does not influence the result of evaluation; (3) On self-efficacy, there is no difference among groups, but the best result comes from Non-STEM male students (Pilotti et al., 2022). From keywords 'mathematical concepts' and 'mathematical phenomena' have the same focus, it is an article entitled 'Linking inhibitory control to math achievement via comparison of conflicting decimal numbers' in the journal Cognition. Coulanges et al.,(2021) do research on differences between Executive Control (group of people that have the cognitive skill) for each learner, especially about teaching mathematics to be more understanding about the trend of that subject.

The scientific findings indicate that individual differences are crucial in developing differentiated learning. Understanding individual differences and their topical trends allows for more precise targeting in the design of instructional materials. It is proven in Figure 8; the figure shows a connection between individual differences and learning, motivation, working memory capacity, and self-regulation in mathematics. All of these factors are significant in developing differentiated learning in mathematics instruction.

The results of this bibliometric analysis have positive implications for the world of education through researchers who can develop further research on the positive effects of paying attention to individual differences in learning mathematics. From the results of other study, policymakers in an educational institution can regulate learning methods in the classroom. Conceptually, bibliometric analysis can provide an overview of the development of the topic of individual differences, including geographic growth, productive authors, and the most widely published journals(Stern, 2024). The results of bibliometric research can offer profound insights into research trends related to individual differences across various fields, particularly in the context of mathematics education. The results enhance the conceptual understanding of the extent of academic attention to variables in scholarly literature. Operationally, the findings of this research assist researchers, practitioners, and policymakers in understanding the dynamics of individual differences (Kramer et al., 2023). For those looking to enhance or modify mathematics learning, information about specific

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trends, influential authors, or frequently published journals can serve as guidance. Bibliometric analysis can also aid in identifying knowledge gaps that need to be addressed for research advancement. Moreover, these findings should be applied in education to design more tailored learning programs that accommodate individual differences and formulate more effective education policies (Wei et al., 2023). It is the operational consequence. The results of bibliometric research contribute to the development of educational methods that take into account individual differences, such as learning styles, personalities, and basic abilities. Overall, the findings of bibliometric research on individual differences provide a conceptual understanding of research trends and practical guidance for application and further development in education and research.

Conclusion

From many articles that have been analyzed, individual differences have a wide meaning; it could be gender, characteristics, thinking process, fear, attitude, etc. Those differences should be taken into consideration by the teacher and cannot be neglected because they can influence the learners. Since the 1900s, the topic of individual differences has existed, increasing gradually after 2017, and it shows that this topic is still interesting. United States is the most rapid development of this topic and United Kingdom was the first country that published this topic. Cognition Journal is the journal that publishes most Individual Differences topics, and it can be a reference for other researchers in developing this topic. While Engle, R.W. is the writer and researcher with the most citations. Mathematics learning has the closest cluster with topic individual differences and is in the pink area, which means it is still new. Mathematics, in general, is the most common article, mathematical concept, and phenomena in learning mathematics. The researcher is still able to develop this topic by conducting a study of literature to understand another topic.

Recommendation

The development of learning mathematics based on individual differences can be directed to the construction of a learning model based on gender, thinking process, or others. It should be equipped with the learning media to be tested. If the learning model has been constructed, the researcher can continue with the model of evaluation based on individual differences. This article also provides recommendations for educators who are planning to implement differentiated learning, urging them to first understand the trends in the topic of individual differences as the foundation for creating differentiated learning models in mathematics lessons. As for policymakers, it is hoped that they can provide training for teachers in developing differentiated learning models for mathematics education, including the creation of teaching materials.

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