

RASCH MODEL ANALYSIS ON MATHEMATICS TEST INSTRUMENTS: BIBLIOSHINY (1983-2023)

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Abstract. The Rasch Model is a very useful tool in testing the quality of a measurement instrument, including mathematics tests. The Rasch model is part of item response theory which can classify item and person calculations in one distribution map. This research analyzes research trends regarding Rasch models in mathematics instruments, using bibliometric analysis to understand the current state of research in this field. From the analysis obtained, it can be said that publications regarding Rasch models in mathematical instruments have increased rapidly from 1983 to 2023, with a total of 173 articles. Universiti Kebangsaan Malaysia holds the highest affiliation with 13 articles. The Journal of Applied Measurement is the most prolific publication with 10 articles and 113 citations. Printy (2008) and Clements et al., (2008) are the sources with the most total citations, namely 139 citations. Azrilah Abdul Aziz, Clelia Cascella, Chiara GIBERTI, and Azami Zaharim are the authors with the largest number of articles discussing Rasch models in mathematical instruments with 4 articles. New themes that emerge in this analysis are mathematics education, engineering education, validity, reliability, gender, and differential item functioning so that future researchers can consider the keywords above.

Keywords: *Rasch Model, Biblioshiny, Bibliometric*

1. INTRODUCTION

Education is one of the main pillars of human civilization. Education plays a key role in shaping individuals, society, and even countries [1]–[4]. Education is not only about knowledge but also about forming individual character, morality, and ethics [3], [5], [6]. A strong and effective education system can provide skills and knowledge, enabling economic, scientific, and cultural progress [7], [8]. Apart from that, education also plays a role in forming social values, teaching tolerance, cooperation, and awareness of global problems.

In the educational context, measurement instruments or test instruments are a very important component. The test instrument is one of the measuring tools used to detect student abilities [9]. One example of a measurement instrument in education is a mathematics test instrument. Mathematics test instruments help educators to evaluate students' mathematical understanding and abilities. This test instrument is used to help assess the extent to which students have achieved mathematics learning objectives. With a

deep understanding of student responses to these instruments, educators can design more effective teaching and adapt learning approaches according to individual needs [10]The use of good test instruments will provide appropriate guidance for educators in improving students' understanding and achievement [11].

In ensuring the quality of mathematics test instruments, the Rasch model is one of the statistical methods that can be used. The Rasch Model is a very useful tool in testing the quality of a measurement instrument, including mathematics tests. The Rasch model is part of item response theory which can classify item and person calculations in one distribution map [12]. This model makes it possible to measure the extent to which the test instrument can measure students' abilities well, as well as identify items in the test that may need to be revised or improved [13]. By using the Rasch Model, educators can ensure that mathematics test instruments are of good quality so that they can provide accurate evaluation results and are beneficial for student learning development.

Over time, research regarding the use of the Rasch Model in mathematics test instruments has experienced significant development. Many scientific papers, journals, and related research in various journals and academic platforms. However, there has been no research that comprehensively investigates the development and trends in the use of the Rasch Model in mathematics test instruments using a bibliometric approach. So, this research aims to carry out a bibliometric analysis of these studies to identify trends, the most productive authors, the journals that contribute the most, and dominant research topics. Thus, the results of this research will provide valuable insight into trends and research focus in the application of the Rasch Model to mathematics test instruments. The research questions in this study are as follows.

RQ1. What is the distribution of publications based on year, affiliation, source, most cited articles, and most prolific authors in Rasch models in mathematics instruments?

RQ2. How do recommended keywords and topics appear for further research?

2. RESEARCH METHOD

This bibliometric research aims to evaluate previous academic work that has been carried out in the context of applying the Rasch Model to mathematics test instruments. Bibliometric analysis is an approach to examining the evolution of a research domain, including topics and authors, based on the social, intellectual, and conceptual structure of scientific disciplines [14]. Bibliometric analysis is generally used in scientific disciplines and focuses on the quantitative study of journal papers, books, or other types of written communication [15]. The overall analysis of article mapping was carried out through R-Studio, which is the Bibliometric platform used [16].

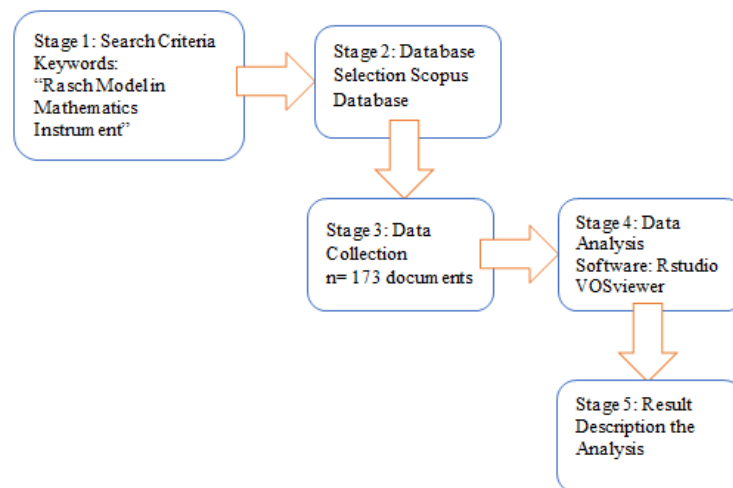


Figure 1. Biblioshiny Rasch Model Research Flow

Stage 1:

In this context, this research must rely on scientific sources related to research on the use of Rasch models in mathematics instruments. Using these keywords provides several benefits. First, ensure that the scientific literature used is relevant to the topic being investigated. Second, these keywords help keep the research focus from being distracted. Many synonyms can be used, and the initial search strategy consists of one main element, the first of which is related to the development of information and communication technology using the term "Rasch model in mathematical instruments".

Stage 2:

Next, in this research, we will search the Scopus database, which is a scientific database that has a high reputation and is respected within the scientific community.

Stage 3:

Then, after searching with predetermined keywords, we obtained 173 documents that were ready to be analyzed.

Stage 4:

The next step after data collection is to evaluate the selected documents by considering the previously chosen method for compiling the data. At this stage, it is necessary to assess the relevance of each study found. The main concepts contained in the texts found are then analyzed to assess the extent of their relevance to the Rasch model in mathematics instruments. For this study, we used open-source software such as the R Package Bibliometrix. This software has strong bibliometric capabilities. In the R programming language, Aria and Cuccurullo have developed a program known as R [17]. This program includes mathematical algorithms, statistics, and scientific mapping. Biblioshiny is a web interface integrated into the latest versions of the R bibliometric program (version 2.0 and above), which allows users with no programming background to perform bibliometric analysis. Data from Scopus can be imported into Biblioshiny in BibTex, CSV, or plain text format, and the Biblioshiny platform will process the data. In this research project, we

chose to import data from Scopus in CSV format. Apart from using Rstudio, researchers also used VosViewer to map keywords to search for the latest topics.

Stage 5:

At this stage, only the results, conclusions, and quantitative assessments of the research are considered after the data has been processed and analyzed. The results section includes an in-depth explanation of the findings as well as a visual representation of the research results.

3. RESULTS AND DISCUSSION

3.1 Results

RQ1. Distribution of publications based on year, affiliation, source, most cited articles, and most prolific authors in Rasch models in mathematics instruments.

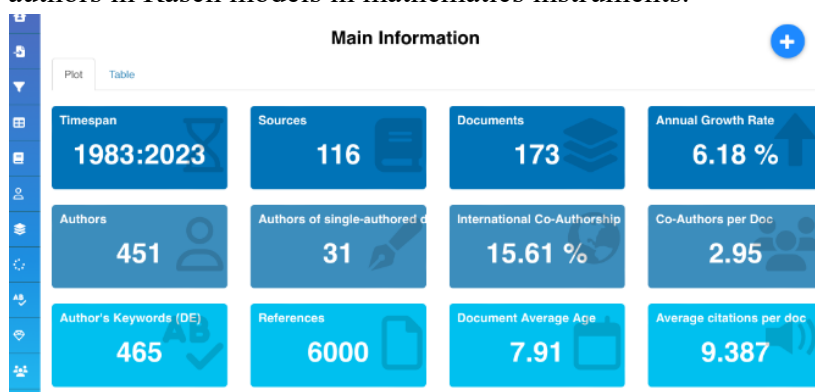


Figure 2. Main Information

Figure 2 provides an overview of the bibliometric analysis carried out on the 173 documents that have been the focus of the research. These documents, published between 1983 and 1 October 2023, come from a variety of sources, including 116 journals, proceedings, and books listed on Scopus. Interestingly, it appears that publication growth has increased by an average of 6.18% each year, reflecting the growing interest in the topic of item analysis in the world of education.

In addition, this bibliophily analysis also reveals several important facts about the author's contribution and international collaboration in this research. Of the total 451 authors involved, interestingly 31 of them were sole authors. This shows the diversity in author collaboration in this field. However, only about 15.61% of author collaborations are international, with an average of 2.95 authors per document. Additionally, it was found that there were 465 keywords and 6000 references relevant to this topic, reflecting the diversity and depth of research. These documents also had a significant impact, with an average of 9,387 citations per document, indicating their relevance in the broader scientific literature.

Distribution of Article by Years

This research describes the distribution of publications each year in Scopus. Data distribution starts from the year the article was first published to the year the article was

ready to be published. The results of the distribution of the number of article publications each year are presented in Table 1.

Table 1. Distribution of Articles by Years

No	Year	Articles	Percentage	Year	Articles	Percentage
1	1983	1	0.58%	2010	3	1.73%
2	1992	1	0.58%	2011	8	4.62%
3	1993	1	0.58%	2012	13	7.51%
4	1995	1	0.58%	2013	6	3.47%
5	1998	1	0.58%	2014	5	2.89%
6	1999	1	0.58%	2015	7	4.05%
7	2000	1	0.58%	2016	11	6.36%
8	2003	3	1.73%	2017	8	4.62%
9	2004	4	2.31%	2018	13	7.51%
10	2005	2	1.16%	2019	10	5.78%
11	2006	3	1.73%	2020	16	9.25%
12	2007	2	1.16%	2021	18	10.40%
13	2008	7	4.05%	2022	13	7.51%
14	2009	3	1.73%	2023	11	6.36%

Source: RStudio

Table 1 presents interesting information regarding research trends in Rasch model research in mathematical instruments. This data shows that the number of articles related to this topic continues to increase over time, with a significant spike occurring in 2012 with 13 articles or 7.51%, and then decreasing again. The peak trend was seen in 2021, where 18 articles, or around 10.40% related to this topic were published. These results indicate that research on Rasch models in mathematical instruments remains a relevant topic for future research.

Top Affiliate with the most articles

The following presents data related to the most productive affiliations in the Rasch model theme in mathematical instruments. The results of the bibliometric analysis can be seen in Table 2.

Table 2. Top Affiliation Article Based On Country

Affiliation	Country	Articles
Universiti Kebangsaan Malaysia	Malaysia	13
Nanyang Technological University	Singapore	12
Universiti Sains Malaysia	Malaysia	10
Universitas Pendidikan Indonesia	Indonesia	9
American Institutes for Research	United States	7
Universitas Muhammadiyah Prof. Dr. Hamka	Indonesia	6

University of San Diego	United States	6
The University of Hong Kong	Hong Kong	5
Universidad De Bogotá Jorge Tadeo Lozano	Colombia	5
Universiti Teknologi Mara	Malaysia	5

Sumber: RStudio

According to Table 2, Universiti Kebangsaan Malaysia is the most productive affiliation in publishing articles related to the Rasch model in mathematical instruments. This university has published more than 13 articles, a significant number compared to other affiliations. This indicates that Universiti Kebangsaan Malaysia has a substantial number of researchers actively engaged in this domain and has made a significant contribution to the advancement of knowledge in the Rasch model within mathematical instruments. Additionally, Nanyang Technological University also appears to be quite active in publishing articles in this field. The university has published over 12 articles related to the Rasch model in mathematical instruments, making it the second-ranked affiliation in terms of the highest number of publications. In addition to these two affiliations, several other affiliations are also among the top ten with the highest number of publications in the field of the Rasch model in mathematical instruments, such as Universiti Sains Malaysia, Universitas Pendidikan Indonesia, American Institutes for Research, Universitas Muhammadiyah Prof. Dr. Hamka, University of San Diego, The University of Hong Kong, Universidad De Bogotá Jorge Tadeo Lozano, and Universiti Teknologi Mara. This indicates that the research interest in the Rasch model in mathematical instruments has attracted numerous researchers from various universities worldwide.

The Most Productive Sources

Below are presented the ten most cited articles obtained from various sources and authors. Table 3 reveals the results of the bibliometric analysis highlighting the articles that have received the highest number of citations from various sources. This data provides an important overview of works that have had a significant impact on the scientific literature, identifying the contributions of the authors and sources that have been most influential on the topic in question.

Table 3. The Most Productive Sources

Source	N	TC	h-index
Journal of Applied Measurement	10	113	4
Educational and Psychological Measurement	5	39	4
International Journal of Science and Mathematics Education	3	87	3
African Journal of Research in Mathematics, Science and Technology Education	2	16	2
Annals of the Institute of Statistical Mathematics	2	22	2
Applied Measurement in Education	2	86	2

Applied Psychological Measurement	2	93	2
Education Sciences	2	9	2
Educational Research and Evaluation	2	15	2
Egitim Ve Bilim	2	10	2

Source: Rstudio

Table 3 provides information about the most productive journals and sources of publication in terms of the number of publications and citations related to research on the Rasch model in mathematical instruments. According to the table, the "Journal of Applied Measurement" is the most productive publication with 10 articles and 113 citations. This is followed by "Educational and Psychological Measurement" with 5 publications and 9 citations. Although the "International Journal of Science and Mathematics Education" has 3 articles, it has a substantial number of citations at 87, indicating that the quality and impact of articles in this journal are quite high. Table 3 also offers essential information about the most productive and influential sources of publication in the field of item response theory in the realm of education. Furthermore, the information in this table demonstrates that as the number of citations for a journal or source increases, its h-index value also rises. This indicates that journals or sources with high citation counts have a significant impact on research concerning the Rasch model in mathematical instruments and are widely recognized by researchers in the field.

Top Most Article Citations

Below are presented the ten most cited articles obtained from various sources and authors. The table below reveals the results of a bibliometric analysis highlighting the articles that have received the highest number of citations from various sources. This data provides an important overview of works that have had a significant impact on the scientific literature, identifying the contributions of the most influential authors and sources on the topic in question.

Table 4. Top 10 Most Article Citations

Authors	DOI	TC	TC/Y	N TC
Printy (2008) [18]	10.1177/0013161X07312958	139	8.69	3.07
Clements et al., (2008) [19]	10.1080/01443410701777272	139	8.69	3.07
Huang & Peng (2012) [20]	10.1016/j.tourman.2011.05.006	90	7.5	3.98
Lamb et al., (2012) [21]	10.1007/s10763-011-9314-z	77	6.42	3.4
Martín & Boeck (2006) [22]	10.1177/0146621605282773	73	4.06	2.11
Delgado & Prieto (2003)	-	68	3.24	1.82
Liu & Wilson (2009) [23]	10.1080/08957340902754635	58	3.87	2.56
Andrich (1995) [24]	10.1007/BF02294426	49	1.69	1
Smith (2003)	-	43	2.05	1.15
Beswick et al., (2012) [25]	10.1007/s10857-011-9177-9	40	3.33	1.77

Description: TC= Total Citation, TC/Y = Total Citation/Year, N TC= Normalized TC

Table 4 presents information about the authors and their highest number of citations tracked by Scopus. Based on the data in Table 4, articles written by Printy (2008) and Clements et al., (2008) have received the highest number of citations (139) among all articles about Rasch models in mathematical instruments [18]. This article is followed by articles written by Huang & Peng (2012), Lamb et al., (2012), and Martín & Boeck (2006) which are among the five most cited articles on the topic [20]–[22]. It is noted that Printy (2008) is the most cited author, indicating that his research has had a significant impact on Rasch models in mathematical instruments. However, keep in mind that a high number of citations does not always reflect the quality of the research, because there are other influencing factors, such as the popularity of the topic or the availability of the research.

The Most Productive Authors

Below is presented the data of the most productive authors with the theme Rasch Models in Mathematical Instruments. Analysis of bibliometric results can be seen in Table 5. This data provides information about the contribution of the main authors in the domain of artificial intelligence in the field of education, as well as providing an overview of the impact and significance in the field of education, as well as providing an overview of the impact and significance in the field of education. science.

Table 5. The Most Productive Authors

Authors	Country	Articles	Articles Fractionalized
Azrilah Abdul Aziz	Malaysia	4	1.03
Clelia Cascella	Italy	4	2.67
Chiara GIBERTI	Italy	4	1.33
Azami Zaharim	Malaysia	4	1.03
Giorgio Bolondi	Italy	3	1
Ifdil	Indonesia	3	0.4
Ahmad Zamri Khairani	Malaysia	3	1.75
Caroline Long	South Africa	3	0.92
Zulkifli Mohd Nopiah	Malaysia	3	0.59
Itsar Bolo Rangka	Indonesia	3	0.4

Source: RStudio

In Table 5, it can be seen that Azrilah Abdul Aziz and Azami Zaharim from Malaysia, and Clelia Caselladari, and Ciara Giberti, both from Italy, are the most productive authors with 4 articles on Rasch models in mathematical instruments. Meanwhile, Giorgio Bolondi, Ifdil, Ahmad Zamri Khairani, Caroline Long, and Zulkifli Mohd Nopiah were ranked fifth to 10th with 3 articles. This data indicates that Malaysia and Italy contributed significantly to writing articles about Rasch models in mathematical instruments. It should be remembered that the level of productivity of authors does not

always reflect the quality of their writing, but the number of articles written by Azrilah Abdul Aziz indicates that this topic is the focus of their research and may be an indication that the Rasch model in mathematical instruments has important relevance in the educational context in Brazil. The results from Table 5 also provide valuable information for readers who are interested in researching Rasch models in mathematical instruments. In this case, they can refer to articles written by Azrilah Abdul Aziz as an initial reference source for understanding developments and contributions in this field.

RQ2. How do recommended keywords and topics appear for further research?

Before carrying out the analysis with VOSviewer, researchers set a threshold for determining the use of shared keywords, namely a minimum of 6 keyword uses. This means that one keyword must appear in at least 6 different documents that appear in the VOSviewer visualization as shown in the image below.

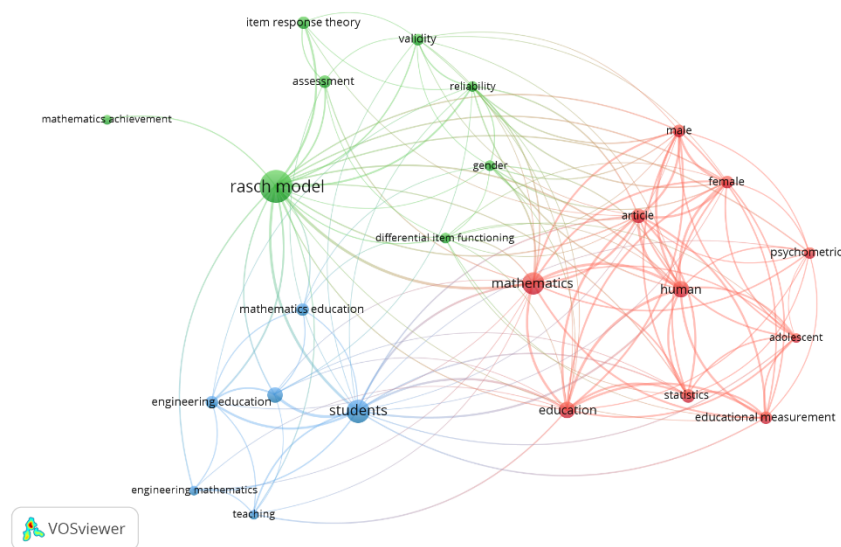


Figure 3. Network visualization of the occurrence of shared keywords

In the picture above, there are 3 color groups, with green consisting of *the Rasch model*, *mathematical achievement*, *item response theory*, *assessment*, *validity*, *reliability*, *gender*, and *differential item functioning*. The next color is red which consists of *mathematics*, *education*, *human*, *statistics*, *educational measurement*, *adolescent*, *psychometrics*, *article*, *male*, and *female*. Meanwhile, the third color is blue which consists of *students*, *mathematics education*, *engineering education*, *engineering mathematics*, and *teaching*. From the picture above, it can be seen that the words "Rasch Model, Students, Mathematics" are keywords with large circle sizes, which are the three keywords that are most often used in research on Rasch models in mathematical instruments.

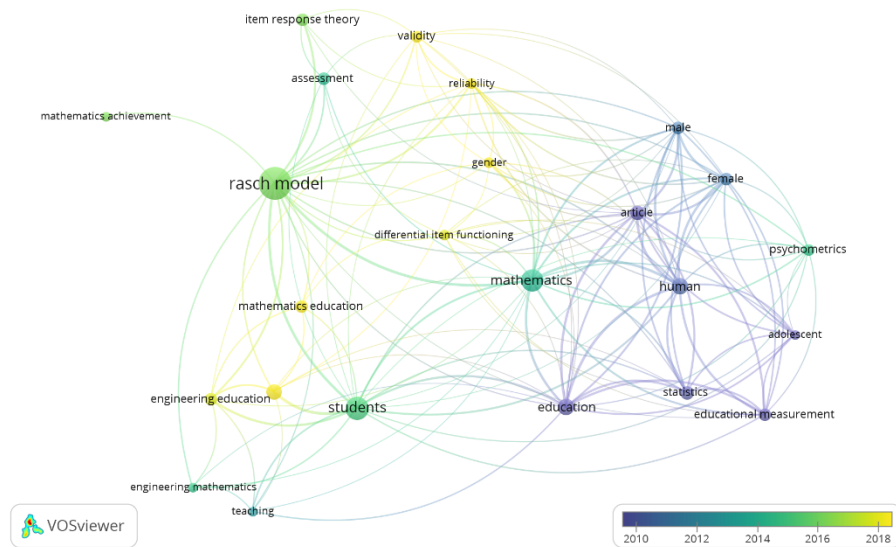


Figure 4. Overlay visualization of the occurrence of keywords together based on the year of publication

There are three different time categories in this research, marked in blue which refers to the 2010-2012 period, which reflects research from 2014 to 2016, and most prominently in yellow, representing research conducted after 2018. Research focuses on the yellow category and discusses key issues in mathematics and engineering education. Keywords such as "mathematics education", "engineering education", "validity", "reliability", "gender", and "differential item functioning" are the main highlights of this analysis. The findings from this yellow study have the potential to be a valuable contribution for future researchers interested in developing Rasch models in the assessment of mathematical instruments.

3.2 Discussion

Rapid development throughout the world has driven developments in various aspects of life, including economic growth and technological progress. In the education sector, significant developments have been seen which are not only marked by increased access and learning opportunities but also by the approaches used to improve their quality [26]–[28]. One of the striking trends in the world of education is the use of the Rasch Model in research. The results of research that utilizes the Rasch Model not only provide support in developing a more adaptive and responsive curriculum but also encourage improvements in teaching strategies that are more focused and effective, according to individual needs. Thus, developments in research trends using the Rasch Model make an important contribution to improving the quality of education, making it more inclusive and relevant in the face of ongoing changes.

Analysis of publications regarding Rasch models in mathematical instruments from 1983 to 2023 shows significant growth with a total of 173 documents. Universiti

Kebangsaan Malaysia was recorded as the most affiliated with 13 articles, while Jurnal Applied Measurement was the leading publication source with 10 articles and 113 citations. The work of Printy (2008) and Clements et al., (2008) received the highest number of citations, reaching 139 [18], [19]. Authors such as Azrilah Abdul Aziz, Clelia Cascella, Chiara GIBERTI, and Azami Zaharim have the four most articles in research on Rasch models for mathematical instruments. The increasing interest in this research highlights the important role of Universiti Kebangsaan Malaysia and shows a promising direction in the understanding of Rasch models in the context of mathematical instruments, making significant contributions in the fields of education and statistics.

From the analysis carried out, it can be seen that new themes have emerged about the use of the Rasch Model. These themes include issues related to *mathematics education*, *engineering education*, *validity*, *reliability*, *gender*, and *differential item functioning*. The existence of these themes indicates that there are areas that can be explored further in the context of using the Rasch Model in educational research. Issues such as validity and reliability are important because they emphasize the need for accurate and reliable measurements in the context of educational evaluation. Meanwhile, gender and differential item functioning highlight the importance of research that is sensitive to individual variations and certain characteristics in the evaluation process.

Therefore, future researchers are expected to pay deeper attention to these themes as the focus of their research regarding the Rasch Model. Further understanding of mathematics education, engineering education, validity, reliability, gender, and differential item functioning in the context of this model can help enrich knowledge about how this measuring tool can be applied more effectively in the world of education. By considering these keywords, it is hoped that future research can make a greater contribution to the development and understanding of the use of the Rasch Model in improving the quality of education.

4. CONCLUSION

From the analysis conducted, it can be observed that publications on the Rasch model in mathematical instruments have seen a rapid increase from 1983 to 2023, with a total of 173 documents. Universiti Kebangsaan Malaysia holds the highest affiliation with 13 articles. The Journal of Applied Measurement stands out as the most prolific publication, contributing 10 articles and receiving 113 citations. Printy (2008) and Clements et al., (2008) are the most cited sources, with a total of 139 citations. Authors such as Azrilah Abdul Aziz, Clelia Cascella, Chiara GIBERTI, and Azami Zaharim have the highest number of articles, each contributing four articles that delve into the Rasch model in mathematical instruments. New themes emerging from this analysis include *mathematics education*, *engineering education*, *validity*, *reliability*, *gender*, and *differential item functioning*. Thus, future researchers may consider these keywords for their studies.

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