ASEAN Journal of Community and Special Needs Education

Journal homepage: https://ejournal.bumipublikasinusantara.id/index.php/ajcsne

Digital Transformation in Special Needs Education: Computational Bibliometrics

*Dwi Fitria Al Husaeni, W. Wahyudin**

Pendidikan Ilmu Komputer, Universitas Pendidikan Indonesia, Indonesia
*Correspondence: E-mail: wahyudin_sanusi@upi.edu

ABSTRACT

The research aims to analyze literature and bibliometric studies of digital transformation in the field of education, especially special needs education. Bibliometric and theoretical analysis methods were used in this research. Data was taken from the Google Scholar database. The search keywords are "Digital Transformation, Special Needs Education". The year of publication is not limited. The search results found 995 published documents indexed by Google Scholar from 1975 to 2023. 2021 is the year with the highest number of publications regarding digital transformation in special needs education. The results of the mapping visualization analysis show that 78 research topics are usually discussed in previous research regarding the themes raised. The topics of machine learning, artificial intelligence, emergency remote teaching, online teaching, digital skills, performance, and digital platforms are the topics with the highest novelty which are connected to the research theme regarding digital transformation in special needs education. Digital transformation opens new windows for future generations, eliminating geographical barriers, providing access to more inclusive education, and preparing them to face an increasingly connected and technology-dependent world. Digital transformation prepares students to face global challenges. Digital transformation also encourages creativity and innovation in education. It is hoped that this research will provide an overview of digital transformation in education, resulting in the emergence of awareness among educators to apply digital technology in the learning process, especially in special needs education.

ARTICLE INFO

Article History:
Submitted/Received 10 Jul 2023
First Revised 12 Aug 2023
Accepted 29 Nov 2023
First Available online 30 Nov 2023
Publication Date 01 Sep 2023

Keyword:
Bibliometrics,
Digital transformation,
Digitalization,
Special needs education.

1. INTRODUCTION

Digital transformation is a change in the use of technology from analog systems to digital systems (Hess *et al*., 2016). Digital transformation covers various aspects and scientific fields, one of which is education. Digital transformation in the education sector is the use of information and communication technology to support the improvement of the learning and teaching process (Dermatini *et al*., 2020). Digital transformation of education refers to the use of digital technology and innovation in the educational context to improve the learning, teaching, and management of educational institutions. Digital transformation in the world of education involves the application of information and communication technology (ICT) as well as new approaches to integrating technology into all aspects of education.

The real form of digital transformation based on Anshori's (2017) research is the concept of e-learning. E-learning influences the process of transforming conventional education into digital form, both in content and system. Apart from that, this digital transformation was increasingly felt when the COVID-19 pandemic occurred between 2019 and 2022 (Muskania & Zulela, 2021). All learning is done online. Educators and students learn without meeting face-to-face in the same room. Various platforms or applications are starting to be used at this time to support the learning process, such as Google Classroom, WhatsApp Group, Zoom Meeting, and Google Meet (Salsabila *et al*. 2020). Apart from the applications used for the learning process, the learning evaluation process is starting to be widely implemented digitally, one of which is through Google Form, Kahoot, Quizzes, and so on (Syahrijar *et al*., 2023). Apart from that, the use of e-learning as a learning management system media is also often carried out (Al Husaeni *et al*., 2022).

This digital transformation process also has an impact on education in special schools or special needs education. The existence of applications and software as a form of digital transformation to support students with special needs (Sych *et al*., 2021), such as voice writing applications for students with writing difficulties or translation software for students with hearing impairments. Digital platforms facilitate collaboration and communication between students, teachers, and parents (Hutchison *et al*., 2020). Digital platforms can increase parents' involvement in their children's education, including children with special needs.

Currently, there has been a lot of research on digital transformation in special needs education, including sustainable management and policy for stakeholders in inclusive education practices in digital transformation (Ari *et al*., 2022), education and digital transformation through the "riconnessioni" project (Demartini *et al*., 2020), digital transformation towards education 4.0 using the TADEO method (Oliveira & de Souza, 2022), and research on academics' views on digital transformation in education (Balyer & Öz, 2018).

Based on several previous studies, there has been no research that discusses the development of digitalization in education, especially in special needs education, using bibliometric methods. Many previous studies using bibliometric analysis have been carried out as shown in **Table 1**. Therefore, this research was carried out to analyze literature and bibliometric studies of digital transformation in the field of education, especially special needs education. It is hoped that this research will provide an overview of digital transformation in education, resulting in the emergence of awareness among educators to apply digital technology in the learning process, especially in supporting the education of children with special needs.

DOI:
p- ISSN 2828-3236 e- ISSN 2828-3309

Tabel 1. Previous studies on bibliometric.

No	Title	Reference
1	Involving Particle Technology in Computational Fluid Dynamics Research: A Bibliometric Analysis	Nandiyanto *et al*. (2023a)
2	Bibliometric Computational Mapping Analysis of Trend Metaverse in Education using VOSviewer	Muktiarni *et al*. (2023)
3	The Use of Information Technology and Lifestyle: An Evaluation of Digital Technology Intervention for Improving Physical Activity and Eating Behavior	Rahayu *et al*. (2023)
5	Mapping of nanotechnology research in animal science: Scientometric analysis	Kumar (2021)
6	Scientific research trends of flooding stress in plant science and agriculture subject areas (1962-2021)	Nurrahman *et al*. (2023)
7	Introducing ASEAN Journal of Science and Engineering: A bibliometric analysis study	Nandiyanto *et al*. (2023b)
8	A bibliometric analysis of chemical engineering research using VOSviewer and its correlation with Covid-19 pandemic condition	Nandiyanto *et al*. (2021)
19	A bibliometric analysis of materials research in Indonesian journal using VOSviewer	Nandiyanto and Al Husaeni (2021)
10	Bibliometric analysis of engineering research using Vosviewer indexed by google scholar	Nandiyanto and Al Husaeni (2022)
11	Bibliometric computational mapping analysis of publications on mechanical engineering education using VOSviewer	Al Husaeni and Nandiyanto (2022b)
12	Research trend on the use of mercury in gold mining: Literature review and bibliometric analysis	Nandiyanto *et al*. (2023c)
13	Domestic waste (eggshells and banana peels particles) as sustainable and renewable resources for improving resin-based brakepad performance: Bibliometric literature review, techno-economic analysis, dual-sized reinforcing experiments, to comparison with commercial product	Nandiyanto *et al*. (2022)
14	Bibliometric analysis of educational research in 2017 to 2021 using VOSviewer: Google scholar indexed research	Al Husaeni *et al*. (2023)

2. METHODS

We conducted a literature review of previous research regarding digital transformation in education, especially in special needs education. Bibliometric and theoretical analysis methods were used in this research. We carried out five research stages, namely (i) determining the study topic, (ii) collecting publication data, (iii) processing article text and bibliometric data, (iv) visualization of bibliometric data mapping, and (v) analysis of bibliometric data visualization results.

In this study, we use the analysis results provided by Google Scholar. Google Scholar is used because articles indexed by Google Scholar are more general without limitations. Mapping visualization is produced through computational processing in the VOSviewer application. Detailed information for installing and using the software (VOSviewer) and the step-by-step process for processing bibliometric data are described in our previous research (Al Husaeni & Nandiyanto, 2022).

Data was taken from the Google Scholar database and obtained on December 14, 2023. The keywords used to search for article data were "Digital Transformation AND Special Needs Education". Data searches were limited to articles of the journal type and in English. We did not specify a year limit for the study. Meanwhile, the search process using the Publish or

DOI:
p- ISSN 2828-3236 e- ISSN 2828-3309

Perish 7 application results in a maximum number of articles found being limited to 1000 articles. Found 995 related articles from 1975 to 2023.

Network and overlay visualization are used to illustrate the relationship between terms that are usually used in digital transformation research in special needs education. Data mapping based on text data found 5148 terms or keywords that matched. The terms found were selected again based on the number of occurrences at least 5 times. Thus, the keyword terms found were 299 terms. After that, we take terms with at least 60% relevance. The final stage is term filtering. Therefore, the number of terms used in the mapping analysis is 78 terms.

3. RESULTS AND DISCUSSION

3.1. Current Research Developments Bibliometric Analysis

Based on the results of a search for publication data regarding digital transformation in the field of education, especially in the education of children with special needs, a total of 995 documents were found spread from 1975, 1991, 1993, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, and 2023. **Figure 1** shows the annual report on the number of publications regarding digital transformation in special needs education. Based on the data in **Figure 1**, it is known that research on this theme can be said to be fluctuating, although in certain years the increase can be seen to be quite significant. From 1975, 1991, 1993, 1997, 1998, 1999, 2000, and 2001 consistency and an increase in the number of research documents were seen. From 2015 to 2021, the increase in the number of research documents on this theme can also be seen clearly in **Figure 1**, where the number of documents each year is in 2015, there were 23 documents, 2016 there were 26 documents, 2017 there were 35 documents, 2018 there were 48 documents, 2019 there were 80 documents, in 2020 there were 154 documents, and in 2021 there were 208. However, in 2022 and 2023 there was a significant decrease, especially in 2023 there were only 78 documents from a total of 208 documents in 2021 and 159 documents in 2022. In 2021 there were the years with the highest number of publications regarding digital transformation in special needs education.

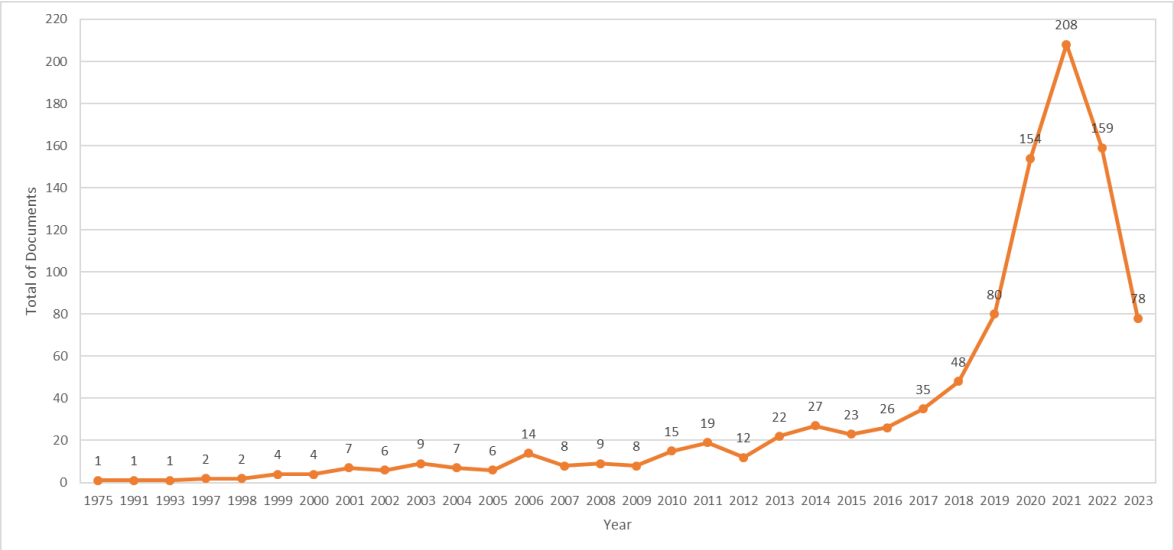

Figure 1. Annual Report number of publications regarding digital transformation in special needs education.

DOI:
p- ISSN 2828-3236 e- ISSN 2828-3309

3.2. VOSviewer Mapping Analysis

Figure 2 shows the network visualization. Network visualization describes the connections between topics or terms that are often used in the research themes being analyzed (Al Husaeni & Nandiyanto, 2022). Network visualization depicts 78 frequently discussed research topics and divides them into 8 clusters. Each cluster is distinguished by the color of its nodes or colored circles.

(i) Cluster 1 is depicted with red nodes and has 14 items, namely 21st century, digital competence, digital divide, digital learning, distance, distance learning, ICT, learner, library, lifelong learning, literacy, secondary school, social transformation, and special needs education.

(ii) Cluster 2 is depicted with green nodes having 12 items, namely big data, digital world, digitalization, enterprise, health, implications, industry, IoT, literature, organizational learning, radical transformation, and virtual reality.

(iii) Cluster 3 is depicted as a blue node and has 10 items, namely ability, characteristic, company, digital skill, digital strategy, digital transition, educational process, employee, information technology, and leadership.

(iv) Cluster 4 is depicted as a yellow node and has 10 items, namely blended learning, content, educational institutions, educational transformation, lessons, online learning, online teaching, performance, solution, and special needs students.

(v) Cluster 5 is depicted as a purple node that has 10 items, namely collaborations, digital, digital native, digital pedagogy, e-learning, emergency remote teaching, learning process, medical education, sustainable development, and teacher education.

(vi) Cluster 6 is depicted by a cyan-colored node having 10 items, namely curriculum, digital platform, digital revolution, disability, emergence, fourth industrial revolution, industrial revolution, institution, internet, and transformation process.

(vii) Cluster 7 is depicted as an orange node and has 7 items, namely application, artificial intelligence, conversion, deep learning, healthcare, machine learning, and marketing.

(viii) Cluster 8 is depicted as a brown node and has 5 items, namely capability, educator, new technology, professional learning, and student learning.

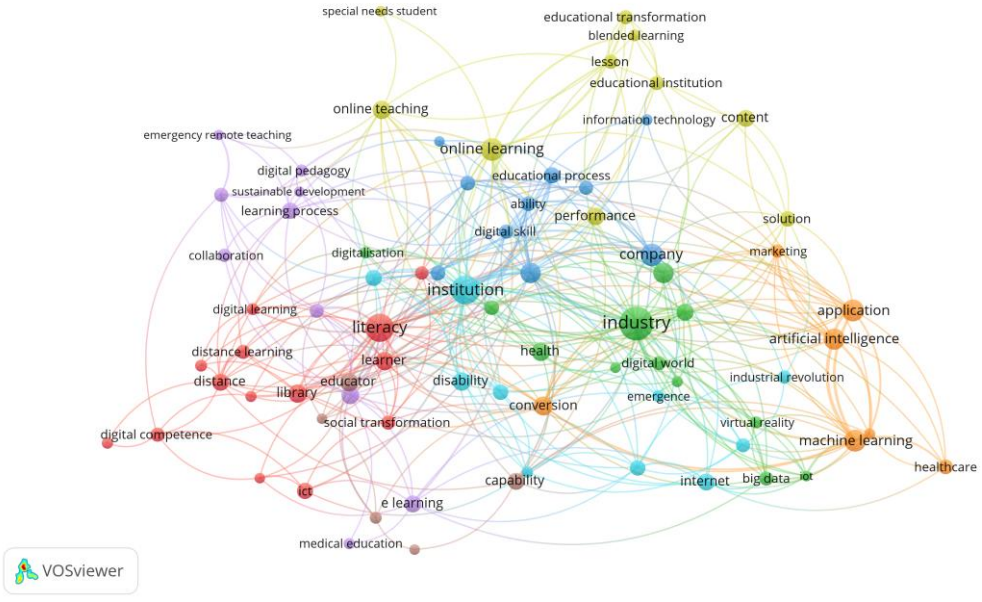

Figure 2. Network visualization.

DOI:
p- ISSN 2828-3236 e- ISSN 2828-3309

Figure 3 shows the visualization overlay. The visualization overlay illustrates the novelty of the discussion of research topics found based on analysis using the VOSviewer application (Al Husaeni & Nandiyanto, 2022). Based on the data shown in **Figure 3**, it is known that the newest topics that are frequently discussed in 2022 with a minimum number of appearances are 5, namely machine learning, artificial intelligence, emergency remote teaching, online teaching, digital skills, performance, and digital platforms. These results indicate that these topics are the topics with the highest novelty which are connected to the research theme regarding digital transformation in special needs education.

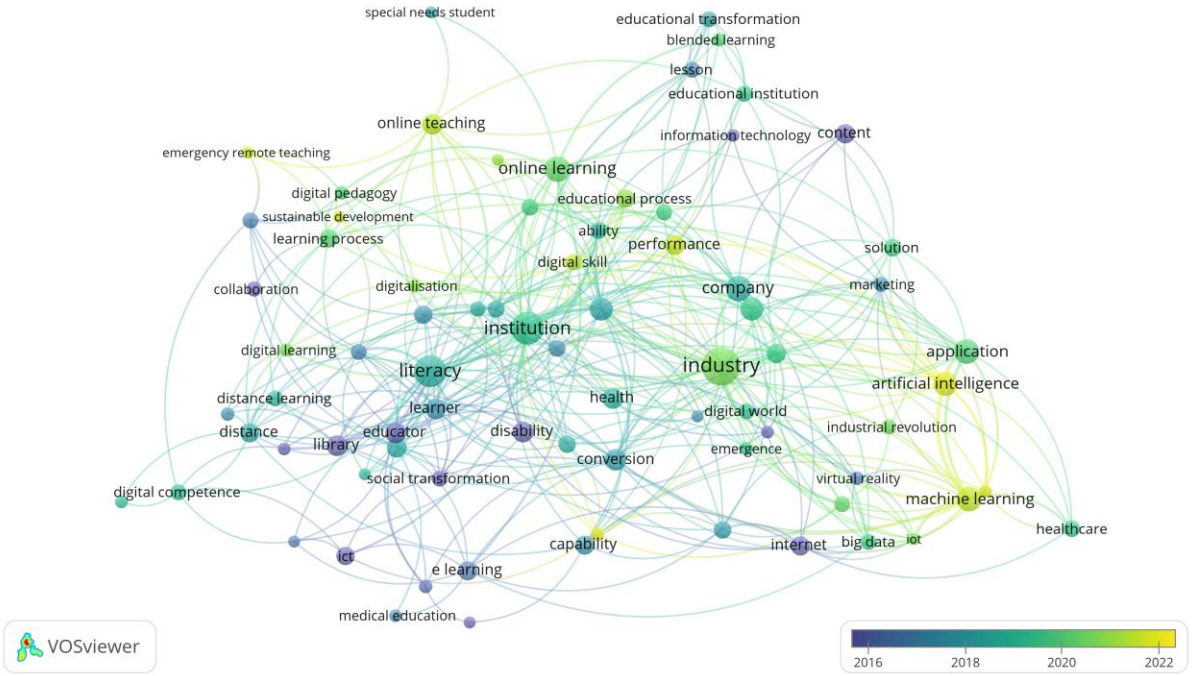

Figure 3. Density visualization.

3.3. Development of Digital Transformation in Education

In the early days of education, teachers acted as the only source of education. As time progressed, new learning sources emerged called books. Johan Amos Comenius is considered to be the first person to write picture books for school children. The book called Orbis Sensualium Pictus or The World Illustrated was first published in 1657. It started from here that educators began to realize the need for learning tools that could provide stimulation and a comprehensive learning experience for students through all the senses, especially the sense of sight and hearing. At the beginning of its development, learning media was only considered as a tool to help teachers in their work. After that, teaching aids are designed to enhance students' learning experience, increase their absorption or retention of information, and improve their memory.

Visual teaching aids, such as pictures, models, graphics, or other real objects, are the first teaching aids used. However, too much focus on visual aids leads to a lack of attention to design elements, production learning development, and evaluation. Therefore, when audio technology began to develop in the 20th century, visual tools equipped with audio tools were developed and became known as audio-visual aids (AVA). Teachers can use various tools to convey educational messages to students through hearing and sight. Audio-visual aids allow them to avoid the verbalism that might occur with visual aids alone.

DOI:
p- ISSN 2828-3236 e- ISSN 2828-3309

Audio-visual learning equipment emerged when efforts to use visual tools were added to audio equipment around the mid-1900s (Mayer *et al*., 2020). After that, communication theory began to influence the use of audio-visual tools in the late 1950s (Saettler, 1954). Audio visual tools are seen as tools to help teachers and also transmit learning messages in communication theory. Student factors as an important element in learning have not received sufficient attention in communication theory.

Experts began to pay attention to students as an important part of learning in 1960-1965. BF Skinner's behaviorist theory is starting to have an impact on the use of media in learning. According to behaviorist theory, educating means changing student behavior (Mayer, 2001). Behaviorism theory supports and encourages the creation of media that can change student behavior as a result of the learning process. Programmed teaching and learning machines are a product of behaviorism theory.

In 1965-1970, the systems approach began to show its influence in the world of education and teaching. The systems approach encourages the use of media as an integral part of the learning process. Media, which is no longer only seen as a teacher's tool, but has been given the authority to carry learning messages, should be an integral part of the learning process. Media, which is no longer only seen as a teacher's tool, but has been given the authority to carry learning messages, should be an integral part of teaching and learning activities. This systems approach encourages the use of media as an integral part of the learning process. Every learning program must be planned systematically by focusing on students. There are two characteristics of the teaching system approach, namely (Rofiah, 2016):

(i) The teaching systems approach leads to the teaching and learning process. The teaching and learning process is an arrangement that allows teachers and students to interact with each other.
(ii) The use of special methods to design a teaching system that consists of systemic procedures for planning, designing, implementing, and assessing the entire teaching and learning process.

From 1950 to 1995, there were major changes in learning technology, one of which was the emergence of computers in learning. Computers were first used in education in 1980. Everyone tries to use computers well and systematically to achieve educational goals. As early as 1983, forty percent of elementary schools and seventy-five percent of secondary schools used computers for instruction. In the 1990s, the situation was very different. Computers greatly influence learning in all schools. One of the impacts that often occurs in society is a lack of social interaction with fellow individuals, which can lead to social addiction. Nowadays, there are many new learning technologies, such as laptops, TVs, and projectors. Laptops are practical learning tools that can not only be kept indoors but can also be taken anywhere. Additionally, laptops are much cheaper than computers. However, projectors are used in every delivery of material and to help teachers.

3.4. The Influence of Digital Transformation in Education

Digitalization in the education sector demands a response from education. Digital transformation helps in improving the overall quality of education (Hang, 2021). Digital transformation provides learning that is more suited to the needs of each student. Digital transformation shows the use of digital technology applications in the world of education. The application of digital technology in the world of education is something that must be utilized in conducting educational organizations and teaching and learning processes. Digital transformation must start by enabling educators to create new learning environments that allow failure as part of the learning process.

DOI:
p- ISSN 2828-3236 e- ISSN 2828-3309

Digital transformation in education is a real form of the rapid use of information and communication technology in the world of education. Digital transformation in education is characterized by the development of distance learning models, the ease of providing open education, and sharing resources between educational institutions, libraries, and other educational instruments starting from teachers, lecturers, or laboratories which change their function to become sources of information. In the world of education, digital transformation which utilizes digital technology in learning runs on four different pillars, namely involving students, optimizing operations, empowering educators, and transforming learning which is supported by the fundamental commitment of educational institutions/institutions (Rahmi, 2023).

The digitalization of education has created new ways of teaching and learning. The digital transformation process has an impact on changes in education's view of books. Books are no longer the only learning source to support the achievement of learning success in the world of education. Books and digital technology applications are a single unit that acts as a learning reference. Initially, textbooks were learning (instructional) media whose dominant role was in the classroom, media for delivering curriculum material, and a central part of an education system (Efendi, 2009). With digital technology, textbooks are displayed in the form of digital books or electronic books. This further clarifies the shift in student learning styles through electronic media. With digital technology as an electronic medium that presents learning material, teachers are no longer the only source of knowledge.

3.5. Learning Model as A Form of Implementing Digitalization in Education

Before the digitalization of education, conventional learning models (lectures, discussions, etc.) were still widely used. In conventional learning, the teacher provides information or speech to many students. Students listen and take notes as needed. Conventional learning is a learning model that only focuses on lectures. In this learning model, students are only asked to remember what the teacher taught and must not relate it to the current situation (contextual). Conventional learning considers students more as objects. According to the conventional learning model, students are only required to memorize the information provided by the teacher and are not required to relate it to real-world situations (Primayana *et al*., 2019). So, it can be said that before the digital transformation in education, most learning processes were carried out conventionally, where learning was teacher-centered (Agrahari, 2016). Meanwhile, due to digital transformation, many learning models have changed and are combined with the use of technology. According to Hadio Wijoyo in his book entitled “Tranformasi Digital dan Gaya Belajar”, there are two learning models which are one of the impacts of the digitalization of education, namely Blended Learning and Distance Education.

3.6. Implementation of Digital Transformation Applications in Education

Currently, there are several forms of implementing digital transformation in the education sector, one of which is:

(i) Using the Google Classroom application in the learning process (Salamah, 2020). The Google Classroom application allows teaching staff to still be able to deliver learning well and easily understood by students, namely by providing materials, and assignments, and even filling in student attendance lists online every day.

(ii) Using the Ruang Guru application as an alternative online tutoring that can be easily accessed and has several superior features such as RuangUji, RuangLatihan, RuangVideo,

DOI:
p- ISSN 2828-3236 e- ISSN 2828-3309

RuangLes, RuangLesOnline, DigitalBootCamp, and Edumail allows students to upgrade their learning abilities so that they can achieve the desired results.

(iii) Use of Cell Phones as M-Learning in Islamic Education (Nawi & Hamzah, 2013).

(iv) Using Web Multimedia Loopers as an e-learning media that presents material regarding looping in Algorithms and Programming subjects (Al Husaeni *et al*. 2022).

Figure 4 shows several applications that are a concrete manifestation of digital transformation in the world of education. **Figure 5** shows several Learning Management Systems (LMS) used at the Indonesian Education University such as SPADA, SPOT, SIAK, and E-Book. Meanwhile, **Figure 6** shows several learning media for children with special needs such as MITA (Language Therapy for Children with Autism), Spokle, Be My Eyes, AutiSpark, and Birdhouse for Special Needs.

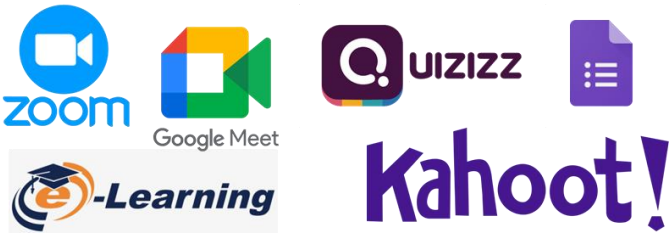

Figure 4. Application of digital transformation.

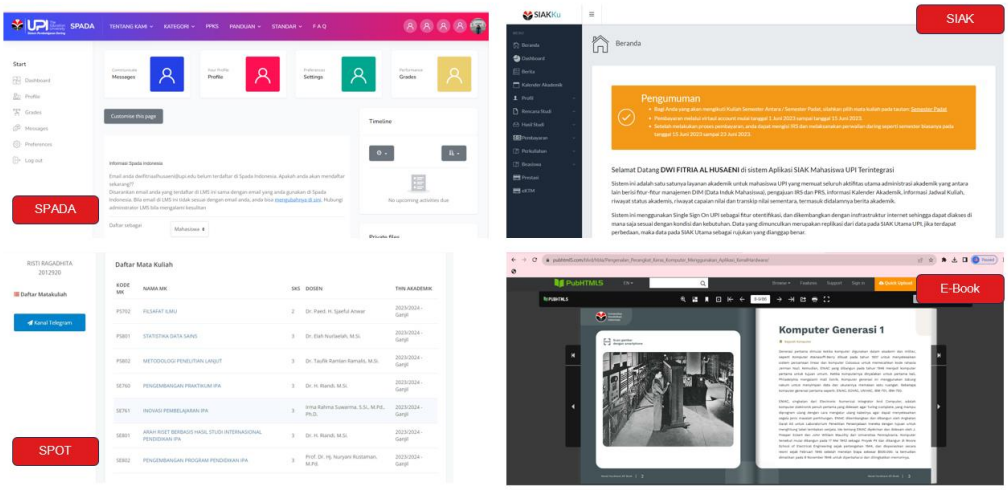

Figure 5. One form of digital transformation in the university environment.

Figure 6. Learning application for children with special needs as a form of digital transformation in a special needs education environment.

DOI:
p- ISSN 2828-3236 e- ISSN 2828-3309

3.7. Benefits of Digital Transformation in Education

The benefit of digital transformation in the education sector is greater accessibility. If in the past education was only limited to physical classrooms and printed books, now education can be accessed via digital devices such as computers, tabloids, and even smartphones. The ease of accessing various knowledge digitally allows many people, especially the younger generation, to learn anywhere and at any time without being limited by geographic and time constraints.

Digital transformation provides opportunities for educators and students to access more diverse and up-to-date educational resources. For example, students can explore scientific journals, digital books, learning videos, and much more. Not only does it have an impact on students, but the digital transformation of education also allows teaching staff to access various innovative teaching methods and tools that can help them deliver material more interestingly and effectively.

Digital transformation opens up opportunities for collaboration between educators and students from various regions or countries, thereby broadening horizons and increasing cross-cultural understanding. The digital transformation of education also makes learning more interesting and interactive. With the online learning platform, students can participate in discussions, share ideas, and collaborate with classmates virtually.

3.8. Challenges in Implementing Digital Transformation in Education

One of the challenges in implementing digital transformation is the digital divide, where not all students have adequate access to devices and a stable internet connection. According to data released by the Indonesian Ministry of Education and Culture's Pusdatin, there are still around 42,159 schools that do not have internet access. Apart from that, quoting from medcom.id, the National Coordinator of the Education and Teachers' Association (P2G), Satriwan Salim, on 6 May 2022, stated that based on data from the Ministry of Education and Culture, 40% of Indonesian schools do not have internet access. Meanwhile, currently, the Badan Pusat Statistik (BPS) has issued the 2023 Indonesian Statistical Report, there are 399,376 school units in Indonesia in the 2022/2023 academic year. This means that approximately 159,750 school units in Indonesia do not have internet access. This can certainly widen the educational gap between those who can access technology and those who are not able to access technology. Therefore, the government and educational institutions need to work together in creating policies and programs that ensure equal access to technology for all students, especially those from low economic backgrounds.

Apart from the digital divide, another challenge that needs to be overcome in digital transformation in the education sector is increasing the skills and competence of educators. Educators must master technology and be able to integrate it into learning effectively. Adequate training and support are needed so that educators can make good use of technology and develop innovative learning strategies. Apart from that, it is also necessary to pay attention to security and privacy aspects in the use of technology in the educational sector. Students data must be properly protected and cyber security measures must be implemented seriously. Educational institutions need to have clear policies and procedures regarding the use of technology and data protection efforts.

DOI:
p- ISSN 2828-3236 e- ISSN 2828-3309

3.9. Opportunities with Digital Transformation in Education

Digital transformation can open a wide new window in obtaining an education that is more inclusive, creative, and relevant to the demands of the times. Future generations can develop the digital, critical, creative, and collaborative skills essential for success in a technology-driven society. In addition, digital transformation provides opportunities to overcome educational gaps between regions and between countries. By having access to the same educational resources, students from remote areas or developing countries can receive education that is equivalent to students in urban areas or developed countries. This can of course help create a society that is more just and equitable in educational opportunities.

3.10. Developing the Potential of Digital Transformation in Education

To realize the full potential of digital transformation in the education sector, close collaboration between the government, educational institutions, and all relevant stakeholders is needed. Adequate investment is needed in technological infrastructure, educator training, and curriculum development that meets the needs of the times. Apart from that, there is also a need to be aware of the importance of overcoming the digital divide and providing equal access to technology for all students.

4. CONCLUSION

Digital transformation opens vast new windows for future generations, eliminating geographical barriers, providing access to more inclusive education, and preparing them to face an increasingly connected and technology-dependent world. With digital transformation in the education sector, future generations will be better prepared and competitive in facing global challenges. Apart from that, digital transformation also encourages creativity and innovation in education. With wider access to technology, students can create their digital content, such as learning videos, presentations, or other creative projects. Learners and teachers can explore various digital tools to convey their ideas and concepts engagingly and interactively. Digital transformation not only increases learning motivation but also develops creative skills that are important in this digital era. Digital platforms facilitate collaboration and communication between students, teachers, and parents. This has the effect of increasing parental involvement in their children's education, including children with special needs as well as supporting the learning and activities of students with special needs, such as voice writing applications for students with writing difficulties or translation software for students with hearing impairments.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

6. REFERENCES

Agrahari, R. (2016). The nature of educational reform and change: From teacher-centered to student-centered learning. *Educational Quest-An International Journal of Education and Applied Social Sciences*, *7*(2), 133-139.

Al Husaeni, D. F., and Nandiyanto, A. B. D. (2022). Bibliometric using Vosviewer with Publish or Perish (using google scholar data): From step-by-step processing for users to the

practical examples in the analysis of digital learning articles in pre and post Covid-19 pandemic. *ASEAN Journal of Science and Engineering*, *2*(1), 19-46.

Al Husaeni, D. F., and Nandiyanto, A. B. D. (2022). Bibliometric computational mapping analysis of publications on mechanical engineering education using vosviewer. *Journal of Engineering Science and Technology*, *17*(2), 1135-1149.

Al Husaeni, D. F., Budisantoso, E. N. Q., Urwah, M. A., Azizah, N. N., Dinata, P. Z., Apriliany, S., and Siregar, H. (2022). The effect of using web-based interactive learning media for vocational high school students to understanding of looping: Qualitative approach. *Journal of Science Learning*, *5*(1), 115-126.

Al Husaeni, D. F., Nandiyanto, A. B. D., and Maryanti, R. (2023). Bibliometric analysis of educational research in 2017 to 2021 using VOSviewer: Google scholar indexed research. *Indonesian Journal of Teaching in Science*, *3*(1), 1-8.

Anshori, S. (2017). Pemanfaatan TIK sebagai sumber dan media pembelajaran di sekolah. *Civic-Culture: Jurnal Ilmu Pendidikan PKn dan Sosial Budaya*, *1*(1), 10-20.

Ari, R., Altinay, Z., Altinay, F., Dagli, G., and Ari, E. (2022). Sustainable management and policies: the roles of stakeholders in the practice of inclusive education in digital transformation. *Electronics*, *11*(4), 585.

Balyer, A., and Öz, Ö. (2018). Academicians' views on digital transformation in education. *International Online Journal of Education and Teaching*, *5*(4), 809-830.

Demartini, C. G., Benussi, L., Gatteschi, V., and Renga, F. (2020). Education and digital transformation: The “riconnessioni” project. *IEEE Access*, *8*, 186233-186256.

Efendi, A. (2009). Beberapa catatan tentang buku teks pelajaran di sekolah. *INSANIA: Jurnal Pemikiran Alternatif Kependidikan*, *14*(2), 320-333.

Hang, N. T. (2021). Digital education to improve the quality of human resources implementing digital transformation in the context of industrial revolution 4.0. *Revista Geintec-Gestao Inovacao E Tecnologias*, *11*(3), 311-323.

Hess, T., Matt, C., Benlian, A., and Wiesböck, F. (2016). Options for formulating a digital transformation strategy. *MIS Quarterly Executive*, *15*(2), 123-139.

Hutchison, K., Paatsch, L., and Cloonan, A. (2020). Reshaping home–school connections in the digital age: Challenges for teachers and parents. *E-learning and Digital Media*, *17*(2), 167-182.

Kumar, K. (2021). Mapping of nanotechnology research in animal science: Scientometric anlaysis. *ASEAN Journal of Science and Engineering*, *1*(2), 111-126.

Maya, Y. (2020). Penggunaan blended learning pada pembelajaran era industri 4.0. *Bahastra: Jurnal Pendidikan Bahasa dan Sastra Indonesia*, *4*(2), 31-38.

Mayer, R. E. (2001). Chapter II: Changing conceptions of learning: A century of progress in the scientific study of education. *Teachers College Record*, *103*(7), 34-75.

Mayer, R. E., Fiorella, L., and Stull, A. (2020). Five ways to increase the effectiveness of instructional video. *Educational Technology Research and Development*, *68*(3), 837-852.

DOI:
p- ISSN 2828-3236 e- ISSN 2828-3309

Muktiarni, M., Rahayu, N. I., Ismail, A., and Wardani, A. K. (2023). Bibliometric computational mapping analysis of trend metaverse in education using vosviewer. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *32*(2), 95-106.

Muskania, R., and Zulela, M. S. (2021). Realita transformasi digital pendidikan di sekolah dasar selama pandemi covid-19. *Jurnal Pendidikan Dasar Nusantara*, *6*(2), 155-165.

Nandiyanto, A. B. D., Al Husaeni, D. N., and Al Husaeni, D. F. (2023). Introducing ASEAN journal of science and engineering: A bibliometric analysis study. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *31*(3), 173-190.

Nandiyanto, A. B. D., Al Husaeni, D. N., and Al Husaeni, D. F. (2021). A bibliometric analysis of chemical engineering research using vosviewer and its correlation with covid-19 pandemic condition. *Journal of Engineering Science and Technology*, *16*(6), 4414-4422.

Nandiyanto, A. B. D., and Al Husaeni, D. F. (2021). A bibliometric analysis of materials research in Indonesian journal using VOSviewer. *Journal of Engineering Research*, *9,* 1-16.

Nandiyanto, A. B. D., and Al Husaeni, D. F. (2022). Bibliometric analysis of engineering research using vosviewer indexed by google scholar. *Journal of Engineering Science and Technology*, *17*(2), 883-894.

Nandiyanto, A. B. D., Ragadhita, R., Al Husaeni, D. N., and Nugraha, W. C. (2023). Research trend on the use of mercury in gold mining: Literature review and bibliometric analysis. *Moroccan Journal of Chemistry*, *11*(1), 11-1.

Nandiyanto, A. B. D., Ragadhita, R., and Aziz, M. (2023). Involving particle technology in computational fluid dynamics research: A Bibliometric analysis. *CFD Letters*, *15*(11), 92-109.

Nandiyanto, A. B. D., Ragadhita, R., Fiandini, M., Al Husaeni, D. F., Al Husaeni, D. N., and Fadhillah, F. (2022). Domestic waste (eggshells and banana peels particles) as sustainable and renewable resources for improving resin-based brakepad performance: Bibliometric literature review, techno-economic analysis, dual-sized reinforcing experiments, to comparison... *Communications in Science and Technology*, *7*(1), 50-61.

Nawi, A., and Hamzah, M. I. (2013). Tahap penerimaan penggunaan telefon bimbit sebagai M-Pembelajaran dalam Pendidikan Islam. *Journal of Islamic and Arabic Education*, *5*(1), 1-10.

Nurrahma, A. H. I., Putri, H. H., and Syahadat, R. M. (2023). Scientific research trends of flooding stress in plant science and agriculture subject areas (1962-2021). *ASEAN Journal of Science and Engineering*, *3*(2), 163-178.

Oliveira, K. K. D. S., and de SOUZA, R. A. (2022). Digital transformation towards education 4.0. *Informatics in Education*, *21*(2), 283-309.

Primayana, K. H., Lasmawan, I. W., and Adnyana, P. B. (2019). Pengaruh model pembelajaran kontekstual berbasis lingkungan terhadap hasil belajar IPA ditinjau dari minat outdoor pada siswa kelas IV. *Jurnal Pendidikan dan Pembelajaran IPA Indonesia*, *9*(2), 72-79.

Rahayu, N. I., Suherman, A., and Muktiarni, M. (2023). The use of information technology and lifestyle: An evaluation of digital technology intervention for improving physical activity

and eating behavior. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, *32*(1), 303-314.

Rahayu, R., Iskandar, S., and Abidin, Y. (2022). Inovasi pembelajaran abad 21 dan penerapannya di Indonesia. *Jurnal Basicedu*, *6*(2), 2099-2104.

Rahmi, R. (2023). Urgensi kompetensi guru dalam pelaksanaan pembelajaran berbasis digital pendidikan. *AL-KAINAH: Journal of Islamic Studies*, *2*(1), 69-78.

Rofiah, N. H. (2016). Desain pengembangan pembelajaran akidah akhlak di perguruan tinggi. *Fenomena*, *8*(1), 55-70.

Saettler, P. (1954). Historical overview of audio-visual communication. *Audio Visual Communication Review*, 109-117.

Salamah, W. (2020). Deskripsi penggunaan aplikasi google classroom dalam proses pembelajaran. *Jurnal Penelitian Dan Pengembangan Pendidikan*, *4*(3), 533-538.

Salsabila, U. H., Lestari, W. M., Habibah, R., Andaresta, O., and Yulianingsih, D. (2020). Pemanfaatan teknologi media pembelajaran di masa pandemi covid-19. *Trapsila: Jurnal Pendidikan Dasar*, *2*(2), 1-13.

Syahrijar, I., Supriadi, U., and Fakhruddin, A. (2023). Upaya meningkatkan mutu pembelajaran pai melalui pembelajaran berbasis digital (studi eksploratif di SMA negeri 15 dan SMA Alfa Centauri kota Bandung). *Journal on Education*, *5*(4), 13766-13782.

Sych, T., Khrykov, Y., and Ptakhina, O. (2021). Digital transformation as the main condition for the development of modern higher education. *Educational Technology Quarterly*, *2021*(2), 293-309.

DOI:
p- ISSN 2828-3236 e- ISSN 2828-3309