Submission Information

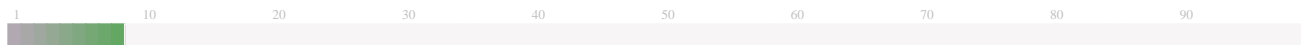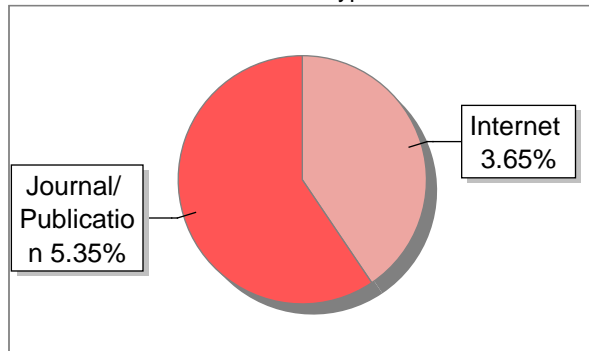|	
Author Name	Arif Rahman
Title	Educational Transformation in the Digital Era: Big Data Analysis to Increase Teacher Management Efficiency in Vocational High Schools
Paper/Submission ID	2021474
Submitted by	zulfa.erlin@staff.uad.ac.id
Submission Date	2024-06-20 13:07:02
Total Pages, Total Words	8, 4499
Document type	Article

Result Information

Similarity **9 %**

Sources Type

Journal/Publication 5.35%
Internet 3.65%

Report Content

Words < 14, 4.36%
Quotes 0.62%
Ref/Bib 9.49%
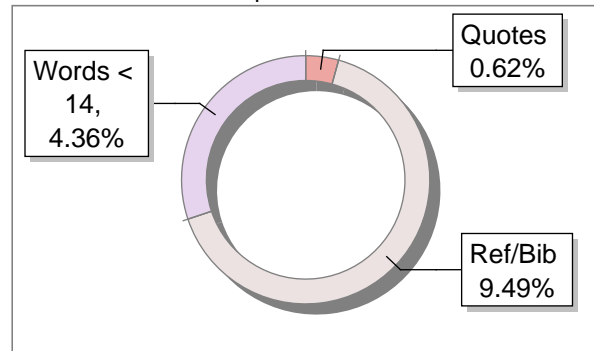
Exclude Information

Quotes	Excluded
References/Bibliography	Excluded
Source: Excluded < 14 Words	Not Excluded
Excluded Source	**3 %**
Excluded Phrases	Not Excluded

Database Selection

Language	English
Student Papers	Yes
Journals & publishers	Yes
Internet or Web	Yes
Institution Repository	Yes

A Unique QR Code use to View/Download/Share Pdf File

LOCATION	MATCHED DOMAIN	%	SOURCE TYPE
2	baou.edu.in	2	Publication
3	adoc.pub	1	Internet Data
4	Half a Century of Studying Genotype Environment Interactions in Pla by Elias-2016	1	Publication
5	journal.unair.ac.id	1	Internet Data
6	Computer Tomography 3D Edge Detection Comparative for Metrology Applications by Ontiveros-2013	<1	Publication
7	Academic social networks Modeling, analysis, mining and applications, by Kong, Xiangjie Shi- 2019	<1	Publication
8	ashpublications.org	<1	Internet Data
9	Practicing What We Preach Authentic Assessment in Mathematics by Hopkins-1999	<1	Publication
10	jurnal.ugm.ac.id	<1	Publication
11	morth.nic.in	<1	Publication
12	Thesis Submitted to Shodhganga, shodhganga.inflibnet.ac.in	<1	Publication
13	e-journal.umc.ac.id	<1	Internet Data

14	eprints.untirta.ac.id	<1	Internet Data
15	repository.unair.ac.id	<1	Internet Data
17	www.researchgate.net	<1	Internet Data
18	zenodo.org	<1	Publication
19	docplayer.info	<1	Internet Data
20	docplayer.info	<1	Internet Data
21	www.epa.gov	<1	Publication
22	www.readbag.com	<1	Internet Data
30	morth.nic.in	<1	Publication
40	asbmr.onlinelibrary.wiley.com	<1	Internet Data

EXCLUDED SOURCES

1	www.dx.doi.org	3	Publication
16	uad.ac.id	<1	Internet Data

Educational Transformation in the Digital Era: Big Data Analysis to Increase Teacher Management Efficiency in Vocational High Schools

Maya Novita Sari[1], Arif Rahman[2]*, Mohd Izzuddin Mohd Pisol[3], Endang Sri BH[1], Sela Rachmawati[4], Triana Aprilia[1], Destri Fitriana[5]

[1] Fakultas Ilmu Pendidikan dan Psikologi, Universitas Negeri Yogyakarta.
Jl. Colombo No.1, Karang Malang, Caturtunggal, Depok, Sleman, Yogyakarta 55281, Indonesia.
[2] Fakultas Agama Islam, Universitas Ahmad Dahlan
Jl. Ringroad Selatan, Tamanan Banguntapan, Yogyakarta, Indonesia
[3] Faculty of Education, Universitas Islam Selangor
BanbutSeri Putra, 43000 Kajang, Selangor, Malaysia
[4] Universitas Negeri Jember
Jl. Kalimantan Tegalboto No.37, Krajan Timur, Sumbersari, Kabupaten Jember, Jawa Timur
[5] Fakultas Ilmu Tarbiyah dan Keguruan, Universitas Islam Negeri Sunan Kalijaga
Jl. Marsda Adisucipto Yogyakarta, Yogyakarta, Indonesia

* Corresponding Author. Email: arif.rahman@pai.uad.ac.id

ARTICLE INFO

ABSTRACT

Analisis Big Data berperan dalam mengoptimalkan efisiensi pengelolaan guru di SMK pada masa transformasi pendidikan di era digital. Penelitian ini menggunakan metode tinjauan pustaka untuk menganalisis konsep, teori, dan temuan penelitian sebelumnya yang relevan. Penelitian ini menekankan tantangan sekolah kejuruan, seperti pesatnya evolusi kebutuhan keterampilan yang didorong oleh pasar dan kurangnya guru kejuruan yang berkualitas. Artikel ini mengusulkan pendekatan pengumpulan dan analisis data sistematis untuk mengatasi tantangan ini, dengan fokus pada volume, kecepatan, dan variabilitas dalam *big data* pendidikan. Melalui "pendekatan drivetrain," penelitian ini menguraikan kerangka kerja untuk menentukan tujuan, pengaruh, data, dan pengembangan model, menyoroti bagaimana hal ini dapat menghasilkan pengelolaan guru yang lebih fokus dan efektif. Temuan menunjukkan bahwa analisis Big Data dapat mengoptimalkan penempatan guru berdasarkan kualifikasi, keahlian, dan kebutuhan sekolah, meningkatkan efektivitas pengajaran dan efisiensi pengelolaan sumber daya manusia secara keseluruhan. Artikel ini diakhiri dengan menggarisbawahi pentingnya pengambilan keputusan berbasis data di era digital pendidikan.

Big Data analysis has a role in optimizing the efficiency of teacher management in Vocational High Schools during the educational transformation in the digital era. This research uses a literature review method to analyze relevant concepts, theories, and previous research findings. This research emphasizes vocational schools' challenges, such as the rapid evolution of market-driven skills needs and the lack of qualified vocational teachers. This article proposes a systematic data collection and analysis approach to address these challenges, focusing on volume, velocity, and variability in educational big data. Through a "drivetrain approach," this research outlines a framework for determining purpose, influence, data, and model development, highlighting how this can result in more focused and effective teacher management. The findings show that Big Data analysis can optimize teacher placement based on qualifications, expertise, and school needs, improving teaching effectiveness and overall human resource management efficiency. This article concludes by underscoring the importance of data-based decision-making in the digital era of education.

INTRODUCTION

Education in the current era of society 5.0 has changed us from traditional systems to digital systems that utilize advanced technologies. One of the big data is still a hot topic for discussion because of its usefulness in collecting, managing, and analyzing large amounts of data to help in considering decision-making, innovation, and increasing efficiency in various sectors.

According to Bai (2021), big data in the educational context can be recognized through five main aspects, namely volume, velocity, variety, value, and verity. Schools worldwide generate hundreds of millions of educational data daily, reflecting the volume characteristics. Fast growth reflects the characteristics of velocity. The characteristics of variety in educational big data are obtained from facts that include many entities (such as students, teachers, and managers) and relationships (such as teacher-student relationships and relationships between classmates and others). Meanwhile, value and verity relate to the data's quality and decision-making value. In this regard, there are several aspects obtained in the data produced by educational institutions, such as teacher qualifications and work experience, teacher performance evaluations, and training that teachers have participated in, as well as data regarding student progress so that it can be used as evaluation material for teachers in improving teaching professionalism. Educational institutions can make accurate, detailed, evidence-based decisions with effective data management.

Education in the digital era raises the need for transformation at various levels of education, like Vocational High Schools, which equip students with theory and practical skills that suit the needs of the business/industry world. Vocational schools face complex challenges, such as market-driven skills requirements that continue to change rapidly. Therefore, the need for efficiency in teacher management is crucial to ensure that students receive learning that meets market needs. Through big data analysis on teacher management, data can be found regarding teacher performance analysis, professional development, utilizing data to place teachers in subjects that suit each teacher's area of expertise and experience, and increasing teacher retention.

The Director General of PSMK (2019) wrote that education at the vocational school level has entered a vocational teacher emergency, and all skills programs in K require a relatively high number of vocational teachers. Teacher Employment & Deployment, World Bank 2008 One of the problems faced by education in Indonesia is the striking inequality in teacher placement. Almost all regions lack teachers, both in urban and rural areas. It was recorded that 66% of remote schools experienced a shortage of teachers, while 68% of urban areas and 52% of rural areas had excess teachers. Apart from that, it was recorded that there were 52,639 non-PNS teachers in public vocational schools and 126,510 non-PNS teachers in private vocational schools. The high number of non-PNS teachers is an indication that there are still many schools that lack teachers. In another research from Suwandi (2016) regarding teacher management policies in vocational schools, three main issues arise: a mismatch between teacher qualifications and applicant qualifications, teacher formation that does not suit needs, and transfers of vocational school teachers that are not based on teacher qualifications. Apart from that, obstacles in scientific activities, unsatisfactory career path systems, the significant influence of professional competency improvement forums, competency assessment practices dominated by school principals, and supervisors' success are problems that also influence the quality of education in vocational schools.

The explanation described above has many factors that influence it, but it focuses on one solution that can be implemented to overcome this problem, namely systematic data collection. With this approach, information regarding teacher qualifications and competencies can be collected carefully and structured, enabling more informed decision-making. Likewise, discrepancies between teacher and applicant qualifications can be resolved by collecting educational history, certification, and work experience data. By compiling a comprehensive database, schools can more easily match specific needs with prospective teachers' abilities. Then, the problem of inappropriate teacher formation can be analyzed by collecting data on trends in teacher needs in various regions, projected industry needs, and curriculum developments. This data allows schools to design more adaptive teacher formation that aligns with actual needs.

The structured data collection mentioned above can be done through a data analysis. Data analysis involves using technology and methods to interpret, transform, and present data to support

decision-making and identify patterns or trends that can provide an in-depth understanding of a situation or problem. With a systematic data collection approach, schools can face teacher procurement problems in vocational schools more effectively. The data collected can be the basis for designing more targeted teacher development policies and programs, ensuring that human resources in the education sector can be optimally optimized. In this way, vocational schools can become superior educational institutions, producing a generation of students ready to compete globally. There are various instruments for analyzing data that can be used, such as dapodik, promoted by the Ministry of Education and Culture, cloud, Mixture Modeling as a method for grouping data, and other data analysis applications.

The description presented above motivates researchers to explore the potential of big data analysis, and it is hoped that educational institutions can utilize and apply big data in teacher management so that education in the digital era will not only focus on transferring knowledge but also on developing relevant skills and can be applied in a modern work environment so that managing teacher resources in vocational schools becomes a critical element in ensuring the quality of education is responsive and relevant. Advances in information technology, especially in the context of big data, provide excellent opportunities for optimizing teacher management in vocational schools.

METHOD

The research method used in the research "Educational Transformation in the Digital Era: Big Data Analysis to Increase the Efficiency of Teacher Management in Vocational High Schools" is a literature review method. The literature study method involves collecting and analyzing relevant literature to the research topic. Researchers carry out systematic searches in various sources of information, such as scientific journals, books, articles, and other related documents. The selected literature is then analyzed critically to gain an in-depth understanding of the concepts, theories, previous research findings, and conceptual frameworks relevant to this research.

This research utilizes knowledge developed by previous researchers in educational transformation, Big Data analysis, and teacher human resource management. By detailing previous findings, this research can build a solid conceptual foundation for designing and directing further research on applying Big Data in the context of vocational school education in the digital era.

FINDING AND DISCUSSION

Aspects of Big Data in Teacher Management

Big data is data that exceeds the processing capacity of conventional database systems. The data is too big, moves too fast, or does not fit the strictures of your database architectures. People must choose an alternative way to process this data to gain value. The hot IT buzzword of 2012, big data, has become viable as cost-effective approaches have emerged to increase massive data volume, velocity, and variability (Dumbil: 2012).

Big data analytics is closely related to the concepts of volume, velocity, and variability in the context of managing large and complex data. To explore the three aspects of "V" in big data analysis for teacher management, people can see the explanation below.

1. Volume

   Volume refers to the enormous amount of data generated or collected by a system. In big data analytics, the main focus is the capacity to manage and analyze large volumes of data. Big data analysis tools and techniques are designed to handle data on a much larger scale than conventional systems can handle. Data volumes in the context of teacher management include large amounts of information generated or collected around teacher activities, such as performance evaluations, training data, and student data. Big data analytics needs to manage these large volumes to provide meaningful insights.

2. Velocity

Velocity refers to how quickly data is generated, exchanged, or changes occur. In big data analysis, velocity is essential because much data is generated in real-time or near real-time. Big data analytics systems must be able to process and provide insights from this fast-moving data without significant delays. Velocity relates to how quickly data flows or is updated. In teacher management, data can be generated quickly, for example, by evaluating teacher performance. Big data analytics needs to operate at a velocity that enables rapid response to changes in this data.

3. Variability

Variability relates to a data set's diversity of formats, structures, or data types. In big data analysis, variability includes dealing with varied data, including structured and unstructured data, text, image, video formats, and data originating from different sources. Variability includes the variety of formats and types of data that exist. Teacher management data can vary from attendance transaction records to national standard test results. Big data analytics must handle these various types of data effectively.

In education management, this connection creates opportunities to utilize big data analytics to increase efficiency and speed of response to educational changes and more profound analysis of various and varied educational data. For example, big data analytics can be used to understand changes in teacher training needs in real time, manage large volumes of student evaluation data, and integrate data from various educational sources. The concepts of volume, velocity, and variability in big data analysis for teacher management require the application of big data processing technology. Distributed processing techniques and machine learning algorithms can help manage data at scale, respond quickly to changes, and handle variability in data types (L'heureux: 2017)

Continuing the explanation above, the data obtained will produce predictions and something more concrete, which can then be followed up. In the data era, this context is referred to as the drivetrain, which is analogous to a system consisting of mechanical components that work together to transfer power or energy from the engine to the driving wheels of a vehicle, which means that in big data analysis, the drivetrain approach can be interpreted as a framework. Work that leads to using data to achieve results that can be implemented or responded to actively (Kruse: 2017). There is a picture below that relates to the four critical steps in the drivetrain approach, namely:

Figure 1. The four steps in the Drivetrain Approach (Howard, 2012)

In the Drivetrain approach, the first step is 'Defined Objectives,' the main focus is setting clear and concrete goals to be achieved through data. In teacher management, goals can range from increasing management efficiency and improving teaching quality to teacher professional development. The next step is 'Levers,' identifying factors or variables that can be controlled or regulated to achieve the goals set. In teacher management, this may include variables such as teacher qualifications, participation in training, or resource allocation that may influence teaching effectiveness. The third stage is Data. This stage involves determining the data type needed to understand and measure the influence of controlled factors (levers) on the objectives set. Teacher management data analysis may include information about teacher performance, training history,

attendance, and other relevant characteristics. The final step involves developing a model or framework to understand better how the controlled factors (levers) can achieve the stated objectives. Analyzing teacher management data may involve developing statistical models or machine learning algorithms to determine how variables influencing teacher management contribute to achieving educational goals.

Through this approach, teacher management can become more focused and effective. For example, it can be used to forecast teacher training needs, improve resource allocation, or understand the factors that influence teacher satisfaction and retention. By utilizing data effectively, educational institutions can make more accurate, detailed, and evidence-based decisions, respond more actively to change, and maximize teacher potential in achieving optimal learning quality.

Optimizing Teacher Placement through Big Data Analysis in Vocational Schools

Teachers with direct contact with students must have special skills or qualifications in the academic field. Based on Law No. 14 of 2005 concerning Teachers and Lecturers, it is stated that teachers are required to have academic qualifications, competencies, and educational certificates, be physically and spiritually healthy, and have the ability to realize national education goals. Academic qualification and teacher competency standards are further regulated in the Minister of National Education Regulation No. 16 of 2007 article 1 paragraph (1), which states that every teacher must meet the academic qualification and competency standards that apply nationally. For the vocational school level, teachers must have a minimum academic qualification of Diploma 4 (D4) or undergraduate (S1) study program appropriate to the subject taught and obtained from an accredited study program. With the competencies they have, teachers are expected to be able to carry out their duties well to educate students.

Further, in the emergency book for vocational teachers at vocational schools, education at the vocational school level in Indonesia has entered a vocational teacher emergency, which is indicated by the continued shortage of civil servant teachers, primarily vocational teachers. Even though we have been assisted by honorary teachers consisting of non-permanent teachers (GTT) and permanent foundation teachers (GTY), the number still needs to be increased. Not to mention, in the future, many teachers will retire at the end of their term of office. Even though there is an excess of civil servant teachers in certain subjects due to the unequal distribution and need for teachers in each school, in general, all vocational programs in vocational schools still require a relatively high number of vocational civil servant teachers. As time passes, the number of teachers retiring in vocational schools, especially vocational teachers, is increasing. The areas of expertise that will lose vocational teachers due to the end of the term of office mainly occur in the fields of Technology and Engineering as well as Business and Management. On the other hand, the skills programs with the most significant number of retired vocational teachers are the construction and property technology skills programs, automotive engineering, and office management.

The Need for Vocational Teachers based on the Field of Expertise The detailed distribution of the need for vocational teachers is shown in Table 7. Table 7 shows that the most needed teachers are vocational teachers who teach subjects in technology and engineering, namely 15,063 people, followed by information and communication technology expertise, as many as 11,658 people. Meanwhile, the shortage of vocational teachers in other areas of expertise ranges from 239 to 4,150 teachers. The need for more vocational teachers is only in the energy and mining expertise field, namely, only 239 teachers. On the other hand, there is also an excess of vocational teachers due to the unequal distribution of vocational teachers in each school. One thousand five hundred ninety vocational teachers could not teach according to their expertise, with the most significant excess in technology and engineering expertise, namely 799 teachers. The excess of teachers in the fields of agribusiness and agrotechnology is also quite large, reaching 207 vocational teachers. Meanwhile, the surplus of teachers in energy and mining expertise is less than ten vocational teachers.

Table 1. The need for vocational teachers based on expertise

No.	Areas of Expertise	Needs of the Teaching Profession	Excess Number of Teachers	Needs of the Teaching Profession After Distribution
1.	Technology and Engineering	-15.063	799	-14.264
2.	Agribusiness and agro-technology	-4.150	207	-3.943
3.	Tourist	-3.306	171	-4.135
4.	Maritime	-1.588	139	-1.449
5.	Business and management	-8.347	105	-8.242
6.	Arts and creative industries	-1.269	97	-1.272
7.	Information and communication technology	-11.658	60	-11.598
8.	Energy and mining	-239	8	-231
9.	Health and social workers	-962	4	-958
	Total	-47.582	1.590	-45.992

Education in the digital era significantly changes the human resource management paradigm in Vocational High Schools. One of the latest innovations that stands out is using big data analysis to optimize teacher placement based on teachers' qualifications and expertise. Big Data analysis provides the ability to explore teacher potential holistically. By collecting data on teacher qualifications, experience, and competencies, educational institutions can build a more accurate picture of the strengths and weaknesses of each teaching staff. For example, data can highlight teachers with expertise in a particular subject or teaching method.

In this context, teacher placement becomes more strategic. Big Data analysis allows for identifying the match between teacher qualifications and school needs. Teachers can be assigned to areas that suit their expertise, improving teaching effectiveness and classroom management. For example, a teacher with expertise in information technology can be placed in a related department at a vocational school, providing maximum benefits for students and the school. Individual teachers feel the positive impact of optimizing teacher placement and extends to the overall efficiency of human resource management. By developing the right placement strategy, schools can maximize their teaching staff's potential, which involves managing a balanced workload, equal distribution of teachers, and increasing overall productivity.

This efficiency is related to teacher performance in the classroom and impacts school administration. Big Data analytics enables better management of teacher data, including monitoring career development, training needs, and performance evaluation. Thus, opportunities for better decision-making increase, allowing schools to dynamically adapt human resource management strategies according to changes in the educational environment and student needs (Williamson: 2017).

The application of Big Data analysis in the placement of teachers in vocational schools is the leading step toward an adaptive and responsive educational transformation. Optimizing teacher placement increases efficiency and creates a learning environment that supports maximum student development. By combining technology and human resource management wisdom, Vocational Schools can form a solid foundation to produce future generations ready to compete in the digital era. Referring to Sari's (2022) statement, using data analysis in education will provide a new meaning in preparing more prepared and mature education. At least this will influence more effective and meaningful classroom learning management.

Decision-making through Big Data analysis

Big data analysis aims to facilitate decision-making. In the context of teacher management in Vocational High Schools or the education sector in general, Big Data analysis provides rich and in-depth information. By leveraging Big Data, the ultimate goal is to provide a solid basis for better decision-making, ensure effective teacher deployment, and improve the overall quality of education.

In the current era of education, data, and analysis have a central role in the decision-making process (Drigas: 2014). A profound transformation is taking place among educators, where decisions are based on carefully collected and analyzed information. According to research conducted by the Best Boarding Schools in Dehradun, this approach is not only limited to the scope of the faculty but also involves various aspects, including student admissions and the recruitment process (ecologlobal: 2023). Education is no longer just about understanding facts but also about implementing knowledge in the context of more effective decision-making.

Following are several points on the benefits of making decisions through data analysis:

Figure 2. Benefit of Data-Driven Decision Making (ecologlobal, 2023)

Using data and analytics in education adopts an approach that has proven successful in a corporate environment. This approach involves making decisions based on evidence obtained from previous events, trends, and patterns. When this information can be accessed quickly and efficiently, it will play an essential role in guiding steps in the world of education, especially in facing new challenges. School principals, as policymakers, especially, need to be careful about the results of educational data analysis (Sari et al., 2022); good decisions result from wisdom in treating study data as a guide in viewing a policy.

CONCLUSION

Educational Transformation in the Digital Era: Big Data Analysis to Increase the Efficiency of Teacher Management in Vocational High Schools is a crucial role of Big Data in optimizing teacher management in Vocational Schools. Applying big data in education is a progressive step toward overcoming challenges and increasing the education system's effectiveness.

The complexities faced by Vocational High Schools are primarily related to the need for educational transformation to align with the demands of the ever-changing job market. The focus is on the need for practical skills that complicate teacher management. Big Data is considered a solution to overcome these challenges, such as structured data collection, teacher qualifications, and work experience, and explored as a solution to overcome the issue of mismatching teacher qualifications with school needs.

This research emphasizes data-based decision-making as the key to increasing teacher management efficiency. The "drivetrain approach" concept is explained as an approach that can help formulate goals, identify leverage factors that determine the type of data needed, and develop models to support better decision-making. This research illustrates how Big Data can be optimized to increase the efficiency and effectiveness of teacher management in vocational schools. The article encourages transformation towards an adaptive and responsive education system in the digital era by combining information technology and human resource management policies.

REFERENCES

Hasanah, D. S., Fattah, N., & Prihatin, E. (2010). Pengaruh Pendidikan Latihan (Diklat) kepemimpinan guru dan iklim kerja terhadap kinerja guru sekolah dasar se Kecamatan Babakancikao Kabupaten Purwakarta. *Jurnal Penelitian Pendidikan*, *11*(2), 90–105. Retrieved from http://jurnal.upi.edu/file/8-Dedeh_Sofia_Hasanah.pdf

An'ars, M. G. (2022). Sistem Informasi Manajemen Berbasis Key Performance Indicator (KPI) dalam Mengukur Kinerja Guru. *Jurnal Data Mining Dan Sistem Informasi*, *3*(1), 8-18.

Bai, M., Wang, X., Xin, J., & Wang, G. (2016). An efficient algorithm for distributed density-based outlier detection on big data. *Neurocomputing*, *181*, 19-28.

Creighton, T. B. (2006). *Schools and Data: The Educator' s Guide for Using Data to Improve Decision Making*. Corwin Press.

Drigas, A. S., & Leliopoulos, P. (2014). The use of big data in education. *International Journal of Computer Science Issues (IJCSI)*, *11*(5), 58.

Dumbill, E. (2013). Big data and thought crime: an interview with Jim Adler. *Big Data*, *1*(1), 10–13.

Howard, J., Zwemer, M., & Loukides, M. (2012). *Designing great data products*. " O'Reilly Media, Inc.".

Khurniawan, A. W., & Erda, G. (2019). 18 darurat guru kejuruan di SMK. *Vocational Educational Policy, White Paper Volume 1 No. 18 Tahun 2019*, *1*(24), 3-24.

Kurniawan, A., Sari, M. N., Sianipar, D., Hutapea, B., Supriyadi, A., Rahman, A., ... & Purba, S. (2023). *Manajemen Kelas*. Global Eksekutif Teknologi.

Kruse, F., Dmitriyev, V., & Gómez, J. M. (2017). Building a connection between decision maker and data-driven decision process. In *Eur Conf Data Anal* (Vol. 4, No. 1, pp. 77-78).

L'heureux, A., Grolinger, K., Elyamany, H. F., & Capretz, M. A. (2017). Machine learning with big data: Challenges and approaches. *Ieee Access*, *5*, 7776-7797.

NS, M., Rahman, A., & Habiburrahman, S. (2022). Madrasah Leadership in the Post COVID-19 Era: Lesson Learn From Crisis in Indonesia. *EduLine: Journal of Education and Learning Innovation*, 2 (2), 193–198.

Sholihah, J. A. (2020). *Menumbuhkan Pengetahuan Operator Sekolah Dalam Mengembangkan Data Pokok Pendidikan (Dapodik) di SMK Al-Imron Kecamatan Pragaan Kabupaten Sumenep* (Doctoral dissertation, Institut Agama Islam Negeri Madura).

Sin, K., & Muthu, L. (2015). Application of big data in education data mining and learning analytics–a literature review. *ICTACT journal on soft computing*, *5*(4), 1035-1049.

Suwandi, S. (2016). Analisis studi kebijakan pengelolaan guru SMK dalam rangka peningkatan mutu pendidikan. *Jurnal Pendidikan Teknologi dan Kejuruan*, *23*(1), 90-100.

The Use of Data and Analytics in Education Decision-Making. https://www.ecoleglobale.com/blog/data-and-analytics-in-education/

Williamson, B. (2017). Big data in education: The digital future of learning, policy and practice. *Big Data in Education*, pp. 1–256.

West, D. M. (2012). Big data for education: Data mining, data analytics, and web dashboards. *Governance studies at Brookings*, *4*(1), 1–10.