



Naïve Bayes and Bidirectional Algorithm Analysis: Encoder Representations From Transformers (BERT) to Teachers' Learning Services to Students Based on the Website of SMK Multi Karya School

Ismail Sianturi*, Muhammad Iqbal, Zulham Sitorus

Postgraduate, Master of Information Technology, Panca Budi University of Development, Medan, Indonesia

Email: ^{1*}ismailsianturi18@gmail.com ²muhammadiqbal@dosen.pancabudi.ac.id, ³zulhamsitorus@dosen.pancabudi.ac.id

(* : ismailsianturi18@gmail.com)

Submitted: 23/07/2025; Accepted: 30/07/2025; Published: 31/07/2025

Abstract– This study analyzes the comparison of two algorithms, namely Naive Bayes and Bidirectional Encoder Representations From Transformers (BERT), for the evaluation of the performance of education personnel at SMK MULTI KARYA. This study uses manual calculation methods and the Python application. The results showed that the Naive Bayes algorithm gave very consistent results with accuracy, precision, and recall values of 76.67% both in manual calculations and with Python. This indicates that the Naive Bayes algorithm is effective in grouping data on the performance of education personnel. Meanwhile, the Bidirectional Encoder Representations From Transformers (BERT) algorithm shows mixed results, while with Python it reaches 12.00%. There are significant differences in recall values and precision between these two calculation methods. Nevertheless, the performance category "Good Performance Staff" remains the most dominant. The difference in results between manual and python calculations is that Naive Bayes is a more stable and consistent method across different platforms, whereas Bidirectional Encoder Representations From Transformers (BERT) shows flexibility but with smaller variation in results. Therefore, in the context of education performance evaluation, Naive Bayes are more reliable to produce consistent performance categories, while Bidirectional Encoder Representations From Transformers (BERT) can be an alternative with a fairly high level of accuracy but require further consideration in the interpretation of the results..

Keywords: Performance Evaluation; Naive Bayes; BERT; Education Personnel

1. INTRODUCTION

In an educational institution, the commitment to provide the best educational services to students is a top priority. A deep understanding that good service will create a conducive learning environment, which will ultimately increase student satisfaction and also attract the interest of new prospective students. To continue to improve the quality of learning services and facilities in schools, the agency routinely takes the initiative at the end of every semester by collecting input from students to teachers. One of the methods adopted is to distribute questionnaires to students to evaluate various aspects of teacher services and existing facilities. The purpose of this education can be achieved through the teaching and learning process at school. In this learning process, there will be interactions or reciprocal relationships between teachers and students that affect each other, so it is hoped that there will be a change in behavior in students in a more positive direction. [1]. Succinctly, it can be stated that the goal of national education is to educate the life of the nation and shape the Indonesian people as a whole, with the following characteristics: 1) Faith and devotion to God Almighty, 2) Have noble behavior, 3) Have knowledge and skills, 4) Be physically and mentally healthy, 5) Have a strong and independent personality, 6) Be responsible to the community and the nation. "Pedagogic competence is a capacity related to student understanding and the management of an educational and dialogical learning process". Indicators of pedagogic competence include: (1) understanding of student characteristics, (2) mastery of learning theories and principles of effective learning, (3) curriculum development, (4) constructive learning activities, (5) development of students' potential, (6) communication with students, and (7) assessment and evaluation [2] [3]. A good understanding of student services and expectations is the first step. Schools need to actively collect student feedback through surveys, interviews, or group discussions to identify areas that need improvement or development from the research results of Chairunisa et al. The school curriculum also has a very close relationship in building and striving to achieve the educational goals of the school [4] [5]. The Naïve Bayes algorithm is a simple probabilist classification method, used to calculate probabilities based on a combination of values and frequencies from existing data. This algorithm is based on Bayes' Theorem, which assumes that all features (indicators) are independent of each other, given the values of the class variables. The Naive Bayes algorithm is a very simple method for categorizing probabilities, having a very high degree of accuracy when applied to databases with a lot of Thomas Bayes data, which is to predict future opportunities based on past experience so it is known as Bayes' theorem. The theorem is combined with "naïve" where it is assumed that the conditions between attributes are mutually free. Therefore, the researcher concluded that the Naive Bayes Algorithm is a classification method that can be used to assess teachers' services to students. By using observation data or questionnaires where the data can reflect the actions and interactions of teachers, such as discipline, clarity of material delivery, and attitudes towards students, [6] [7]. BERT can process a word in a sentence based on whether or not there is a connection between the word and the sentence as a whole. The BERT consists of six layers of Transformers arranged on top of the encoder and decoder, each adding to the complexity of the training process, high configuration, long time to train, and high cost [8] [9].



2. RESEARCH METHODOLOGY

The following is the research methodology for analyzing Naïve Bayes and Bidirectional Encoder Representations from Transformers (BERT) in the context of teacher-to-student learning services based on the website of SMK Multi Karya Vocational School.

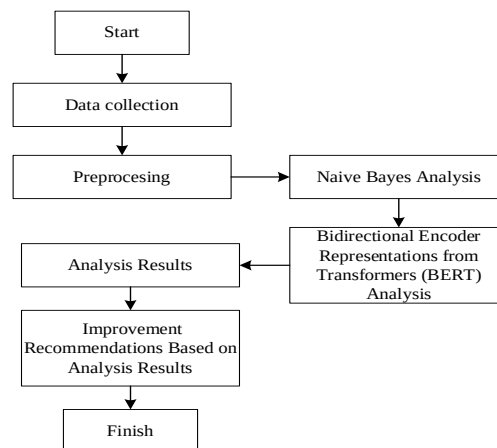


Figure 1. Research Stages

1. The research begins with the starting process, which includes planning the research steps to be carried out.
2. Data collection: The data collection process is carried out to gather the information that will be needed. This may include student satisfaction surveys or the collection of internal School data related to teaching services and curriculum.
3. Data Preprocessing: After the data is collected, data preprocessing is carried out to clean the data from potential errors or missing values. This process also includes the conversion of data to a format suitable for analysis.
4. Naïve Bayes Analysis: The process of analyzing the Naïve Bayes algorithm is done to group students based on their against the service. This algorithm helps identify patterns or groups that may exist in the dataset.
5. Analysis of Idirectional Encoder Representations From Transformers The next step is to perform an analysis using the Idirectional Encoder Representations From Transformers (BERT) algorithm. BERT provides a deeper understanding of the variability distribution of satisfaction variables and can identify groups with different levels of variability.
6. Evaluation of Results: After the analysis of Naive bayaes, the results are evaluated. This process involves assessing whether the identified groups are meaningful and relevant to the research. If needed, the research can undergo improvement or iteration.
7. Rekomendasi Peningkatan : Berdasarkan hasil analisis, dilakukan proses rekomendasi peningkatan. Rekomendasi ini dapat mencakup saran untuk meningkatkan layanan tertentu atau perubahan kebijakan yang dapat meningkatkan kepuasan siswa.
8. Improvement Recommendations: Based on the results of the analysis, an improvement recommendation process is carried out. These recommendations may include suggestions to improve certain services or policy changes that could improve student satisfaction.
9. Re-Evaluation: After implementation, the results are re-evaluated. This evaluation process helps to measure the effectiveness of any improvements or changes that have been made and ensure that the research objectives are achieved.
10. Completed: The research was concluded after the evaluation of the research and ensured that the research steps had been carried out properly. Conclusions and findings from research can be presented or published.

2.2 Research Data

Table 1. Query Data

No	Name	K1	K2	K3	K4	K5	K6	K7	K8	K9
1	P1	75	77	65	80	80	85	80	65	81
2	P2	80	85	81	84	82	79	83	90	82
3	P3	89	86	85	90	90	90	89	90	88
4	P4	80	85	70	80	85	65	75	65	70
5	P5	91	90	89	90	87	91	90	91	80
6	P6	55	89	75	85	90	90	86	90	80
7	P7	85	88	87	85	86	85	83	89	80
8	P8	85	75	80	85	80	80	82	80	91



60	P60	92	91	90	90	90	91	92	90	90
----	-----	----	----	----	----	----	----	----	----	----

Table 2. Comment Data

Suitability of teaching materials to the needs of the industry or world of work	Positive	Positif
Curriculum flexibility in accommodating student needs		Positif
Teachers give students the freedom to ask questions and opinions		Positif
Suitability of the exam/assignment with the material being taught		Positif
Creativity in formulating innovative ideas and solutions		Positif
Is the flexibility of the curriculum in accommodating the needs of students		Netral
Is the Suitability of the exam/assignment with the material being taught		Netral
.....		
Not quick to respond		Negatif
No freedom to ask questions		Negatif

2.3 Satisfaction with Teacher Services

In an educational process, we always want to produce graduates who are good, qualified, have good and reliable learning achievements. To achieve the success of education, it must go through several good processes and systems, including various things, namely the teaching and learning process, learning resources, tools and evaluation. [10] Education is the development and maintenance of a child's personal, social, moral, and religious potential. Children are in the process of growing up and need help from adults. Children should be able to develop freely but with purpose. There are 5 aspects that can be measured to determine student satisfaction with the teacher's services, namely (Reliability), (Responsiveness), (Assurance), (Empathy), (Tangible) [11] [12] [13]. Data mining is a data analysis activity to look for a specific pattern, with large amounts of data and BERT to produce information that can be used and developed further [14]. Data mining is a series of processes to unearth added value in the form of information that has not been known manually from a database [15].

2.3 Algorithm Naives Bayes

Naïve Bayes can be explained as an equation that calculates the probabilities of a class by combining the probabilities of each feature separately (assuming that the features are independent of each other). Naïve Bayes is a simple Bayes classification algorithm using Bayes' theorem by calculating a set of probabilities [16] [17].

$$P(H/Y) = \frac{P\left(\frac{Y}{H}\right) \times P(H)}{P(Y)} \quad (1)$$

2.4 Idirectional Encoder Representations From Transformers (BERT)

BERT generates a combined representation of tokens that can be used for sentiment classification and analysis. Once the vector representation is created, the model can be customized for a specific task. Tokenization steps in BERT Tokenization, Token Embeddings, Token Conversion to ID, Segment Embeddings, Position Embeddings[18][19].

3. RESULT AND DISCUSSION

3.1 Data Selection

The calculation steps in this process are carried out systematically, starting from data cleaning, category coding, to posterior probability calculation for the final classification. The results of this analysis are the basis for assessing the effectiveness of learning interactions and in developing a data-based education service recommendation system.

3.2 Analysis results Naive Bayes

3.2.1 So with the existence of this formula, the following are the steps for calculating the confusion matrix, namely to find calculations of accuracy, accuracy, and recall in the evaluation of the performance of education personnel

1. Accuracy Calculation

$$\text{Accuracy} = \frac{9+26+17+4}{60} = 93,33\%.$$

2. Precision Calculation

$$\text{Educator Precision Is Excellent} = \frac{9}{9+2} = 81,82\%$$

$$\text{Precision of Good Educators} = \frac{26}{26+0} = 1$$





$$\text{Educator Precision Is Good Enough} = \frac{17}{17+0} = 1$$

$$\text{Educators' Precision Is Not Good} = \frac{0}{0+0} = 0$$

3. Recall Calculation

$$\text{Recall Educators Are Excellent} = \frac{9}{9+0} = 1$$

$$\text{Recall Good Educators} = \frac{26}{26+2} = 92,86\%$$

$$\text{Recall Educators Are Good Enough} = \frac{17}{17+0} = 1$$

$$\text{Poor Educator Recall} = \frac{0}{0+0}$$

Tabel 3 Calculations of accuracy, precision, and recall.

Akurasi: 93 %						
AKTUAL	Excellent Performance Educators	Good Performance Educator	Performance Educators Are Pretty Good	Poor Performance Educators	Poor Performance Educators	Precision Class
Excellent Performance Educators	11	0	0	0	0	81 %
Good Performance Educator	2	26	0	0	0	1
Performance Educators Are Pretty Good	0	0	17	0	0	1
Poor Performance Educators	0	0	0	4	0	1
Poor Performance Educators	0	0	0	0	0	0
Recall Class	1	0,9286	1	1	0	0

3.3 Results of Bidirectional Encoder Representation from Transformers (BERT)

Each word is converted into a token, and then each token is counted separately. For each token, BERT sums up three vector types: Token Embedding, Positional Embedding, and Segment Embedding. The results of this summation are inputs to the model to understand the meaning in the context of the sentence as a whole.

1. 'kes', '##esu', '##aian', 'mater', '##i', 'aja', '##r', 'dengan', 'ke', '##but', '##uhan', 'industri', 'atau', 'dunia', 'kerja'

a. Token: "kes" → Position: 0

Dimensionon 0 (i=0), Complete):

$$PE(0,0) = \sin\left(\frac{0}{10000^{0/768}}\right) = \sin(0/1) = \sin(0) = 0.000$$

Dimensionon 0 (i=0),odd)

$$PE(0,1) = \sin\left(\frac{0}{10000^{0/768}}\right) = \cos(0/1) = \sin(0) = 1.0000$$

Dimensionon 2 (i=1,even):

$$PE(0,2) = \sin\left(\frac{0}{10000^{2/768}}\right) = \sin(0/1.0965) = \sin(0) = 0.0000$$

Dimensionon 3 (i=1,odd):

$$PE(0,3) = \cos\left(\frac{0}{10000^{2/768}}\right) = \cos(0/1.0965) = \cos(0) = 1.0000$$

b. Token: "##esu" → Position: 1

Dimensionon 0 (i=0):

$$PE(1,0) = \sin\left(\frac{1}{1}\right) = \sin(1) = 0.8415$$

Dimensionon 1 (i=0):

$$PE(1,1) = \cos\left(\frac{1}{1}\right) = \cos(1) = 0.5403$$



Dimensionon 2 (i=0):

$$PE(1,2) = \sin\left(\frac{1}{1.0965}\right) = \sin(0.912) = 0.7902$$

Dimensionon 3 (i=1):

$$PE(1,3) = \cos\left(\frac{1}{1.0965}\right) = \sin(0.912) = 0.6129$$

c. Token: "##aian" → Position: 2

Dimensionon 0 (i=0):

$$PE(2,0) = \sin\left(\frac{2}{1}\right) = \sin(2) = 0.9093$$

Dimensionon 1 (i=0):

$$PE(2,1) = \cos\left(\frac{2}{1}\right) = \cos(2) = 0.4161$$

Dimensionon 2 (i=1):

$$PE(2,2) = \sin\left(\frac{2}{1.0965}\right) = \sin(1.824) = 0.9680$$

Dimensionon 3 (i=1):

$$PE(2,3) = \sin\left(\frac{2}{1.0965}\right) = \cos(1.824) = 0.2508$$

d. Token: "mater" (pos = 3)

Dimensionon 0 (i=0):

$$PE(3,0) = \sin\left(\frac{3}{1}\right) = \sin(3) = 0.1411$$

Dimensionon 1 (i=0):

$$PE(3,1) = \cos(3) = 0.9899$$

Dimensionon 2 (i=1):

$$PE(3,2) = \sin\left(\frac{3}{1.0965}\right) = \sin(2.736) = 0.3980$$

Dimensionon 0 (3=0):

$$PE(3,3) = \cos(2.736) = 0.9174$$

processed up to token 14 so that the results can be seen in Table 4

Tabel 4. perennial Positional Encoding

Token/Position	Dimension 1	Dimension 2	Dimension 3
"kes"	0.5403	0.7902	0.6129
"##esu"	0.5403	0.7902	0.6129
"##aian"	0.4161	0.9680	0.2508
"mater"	0.9899	0.3980	0.9174
"##i"	0.6536	-0.1698	-0.9855
"aja"	0.2837	0.9231	0.3864
"dengan"	0.7539	0.6123	0.27906
"ke"	0.1455	0.9985	-0.0547
"##but"	-0.9111	0.3260	-0.9453
"##uhan"	-0.8391	-0.6833	-0.7301
"industri"	0.0044	-0.9996	0.0277
"atau"	0.8438	-0.6483	0.7614
"dunia"	0.9074	0.2958	0.9552
"kerja"	-0.1367	0.9999	-0.0166

3.4 Below is presented the confusion matrix of the Naïve Bayes method as part of the model performance analysis.

Here's the Confusion Matrix - Naïve Bayes:

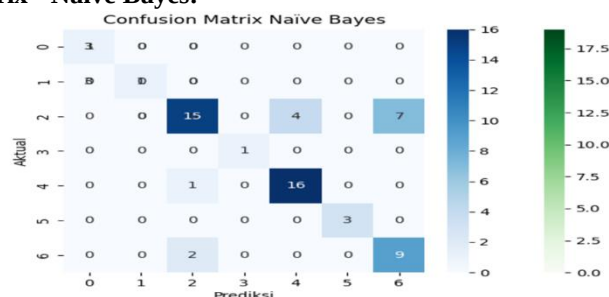


Figure 2. confusion matrix dari metode Naïve Bayes



Akurasi: 76.67%

Precision: 0.89, Recall: 0.91, F1-Score: 0.89

Classification Report:

	precision	recall	f1-score	support
Good	1.00	1.00	1.00	1
Not Good	1.00	1.00	1.00	1
Good	0.83	0.58	0.68	26
Bad	1.00	1.00	1.00	1
Cukup Baik	0.80	0.94	0.86	17
Not Good	1.00	1.00	1.00	3
Very Good	0.56	0.82	0.67	11

Confusion Matrix:

```
[[ 1 0 0 0 0 0 0]
 [ 0 1 0 0 0 0 0]
 [ 0 0 15 0 4 0 7]
 [ 0 0 0 1 0 0 0]
 [ 0 0 1 0 16 0 0]
 [ 0 0 0 0 0 3 0]
 [ 0 0 2 0 0 0 9]]
```

3.5 Below is presented the confusion matrix of the Naïve Bayes method as part of the model performance analysis. Here's the Confusion Matrix - BERT:

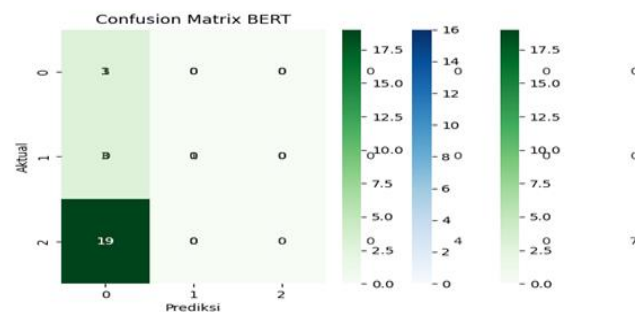


Figure 3. confusion matrix from the Naïve Bayes method

=== RESULTS BERT===

accuracy: 12.00%

Precision: 0.04, Recall: 0.33, F1-Score: 0.07

Classification Report:

	precision	recall	f1-score	support
Negative	0.12	1.00	0.21	3
Neutral	0.00	0.00	0.00	3
Positive	0.00	0.00	0.00	19
Accuracy	0.12	0.25		
macro avg	0.04	0.33	0.07	25
weighted avg	0.01	0.12	0.03	25

Confusion Matrix:

```
[[ 3 0 0]
 [ 3 0 0]
 [19 0 0]]
```

4 CONCLUSION

Based on the model performance evaluation table, Naïve Bayes showed far superior results to BERT on all measured metrics, namely accuracy, precision, recall, and F1-Score. The Naïve Bayes model achieved an accuracy of 76.67%, with a precision value of 0.89, recall of 0.91, and an F1-Score of 0.89. These numbers show that Naïve Bayes has a consistent and reliable ability to classify data, with a relatively low error rate and a good balance between the ability to detect positive classes (recall) and prediction accuracy (precision). On the other hand, the BERT model shows very low performance, with an accuracy of only 12.00%, precision of 0.04, recall of 0.33, and an F1-Score of 0.07. This poor performance indicates that the BERT model fails to capture patterns in the data properly, most likely due to problems in the training



process, such as lack of fine-tuning, inadequate training data, or a mismatch of the model architecture with the characteristics of the dataset used. The significant performance differences between these two models suggest that Naïve Bayes is better suited for classification tasks in the context of this dataset, while BERT requires substantial improvements to be able to compete.

REFERENCES

- [1] Amillina, I., & Qoiriah, A. (2021). Penerapan Algoritma Naïve Bayes dalam Klasifikasi Tingkat Kepuasan Siswa terhadap Pembelajaran Daring. *Jurnal Ilmiah Teknologi Informasi Dan Robotika*, 3(2), 16–23. <https://doi.org/10.33005/jifti.v3i2.59>
- [2] “Bănărescu, A. (2015). Detecting and Preventing Fraud with Data Analytics. *Procedia Economics and Finance*, 32(15), 1827–1836. [https://doi.org/10.1016/s2212-5671\(15\)01485-9](https://doi.org/10.1016/s2212-5671(15)01485-9)
- [3] Basri, I. (2017). Evaluasi Pembelajaran Sekolah Dasar (SD) Berbasis Pendidikan Karakter dan Multikultural. *Jurnal Ilmiah Sekolah Dasar*, 1(4), 247. <https://doi.org/10.23887/jisd.v1i4.12593>
- [4] Candra Susanto, P., Ulfah Arini, D., Yuntina, L., Panatap Soehaditama, J., & Nuraeni, N. (2024). Konsep Penelitian Kuantitatif: Populasi, Sampel, dan Analisis Data (Sebuah Tinjauan Pustaka). *Jurnal Ilmu Multidisplin*, 3(1), 1–12. <https://doi.org/10.38035/jim.v3i1.504>
- [5] Chairunnisa, I. C., Rusdinal, R., Ermita, E., & Kadri, H. Al. (2021). Pelayanan Tenaga Administrasi Sekolah Urusan Kurikulum Berbasis Teknologi Informasi di SMK se-Kota Padang Panjang. *Journal of Educational Administration and Leadership*, 2(2), 116–119. <https://doi.org/10.24036/jeal.v2i2.135>
- [6] Firmansyah, F., & Wongso, F. (2023). Pengaruh Komunikasi Interpersonal Dan Kualitas Pelayanan Terhadap Kepuasan Dan Loyalitas Pelanggan Pada Toko Putra Harapan Pekanbaru. *Jotika Journal In Management and Entrepreneurship*, 2(2), 100–109. <https://doi.org/10.56445/jme.v2i2.72>
- [7] Hafizha, D., Ananda, R., & Aprinawati, I. (2022). Analisis Pemahaman Guru Terhadap Gaya Belajar Siswa Di Sdn 020 Ridan Permai. *Jurnal Review Pendidikan Dasar: Jurnal Kajian Pendidikan Dan Hasil Penelitian*, 8(1), 25–33. <https://doi.org/10.26740/jrpd.v8n1.p25-33> [8] A. P. Natasuwarna, “Tantangan Menghadapi Era Revolusi 4.0 - Big Data dan Data Mining,” *SINDIMAS*, vol. 1, no. 1, pp. 23–27, Jul. 2019, doi: 10.30700/SM.V1I1.530.G336.
- [9] HASTONO, S. P. (2006). *Anallisis Data*. 1–212.
- [10] “View of Data-Driven Approach for Credit Risk Analysis Using C4.5 Algorithm.” Accessed: Jul. 03, 2025. [Online]. Available: <https://journal.binus.ac.id/index.php/comtech/article/view/8243/4748>
- [11] Ii, B. A. B. (2021). 3_185410089_Bab_Ii - Siska Rahmawati. 6–19.
- [12] Kartiwi, A. P., & Sa’ud, U. S. (2017). *Kualitas Layanan Akademik Sekolah*.
- [13] Mahrani, S., Pasi, I. D., Mutmainnah, A. K., Samosir, S. W. P., & Gunawan, I. (2021). Proses Pembangunan Smart City Di Indonesia Menggunakan Metode Big Data Analytis Dalam Penerapan E-Commerce. *Media Jurnal Informatika*, 13(2), 57. <https://doi.org/10.35194/mji.v13i2.1866>
- [14] Mudding, A. A. (2024). Mengungkap Opini Publik: Pendekatan BERT-based-caused untuk Analisis Sentimen pada Komentar Film. *Journal of System and Computer Engineering (JSCE)*, 5(1), 36–43. <https://doi.org/10.61628/jsce.v5i1.1060>
- [15] Nurwahyuni siti. (2020). Pengaruh Islamic Financial Disclosure Dan Digitalisasi Zakat Terhadap Keputusan Muzaki Dalam Menyalurkan Zakat Universitas Pendidikan Indonesia. *Repository.Upi.Edu | Perpustakaan.Upi.Edu*, 28–31. <http://repository.umsu.ac.id/handle/123456789/15809>.
- [16] C. Jovanica, D. D. Rahmintaningrum, H. A. Nuradni, and A. Salsabila, “ANALISIS PENGARUH AKTOR PADA TAGAR #ROKETCHINA DI MEDIA SOSIAL TWITTER MENGGUNAKAN SOCIAL NETWORK ANALYSIS (SNA),” *Jurnal Ilmiah Komunikasi Makna*, vol. 10, no. 1, pp. 43–56, Mar. 2022, Accessed: Dec. 03, 2024. [Online]. Available: <https://jurnal.unissula.ac.id/index.php/makna/article/view/15644>
- [17] Prasetyo, I. (2014). *Teknik Analisis Data Dalam Research and Development*, UNY 2014. UNY: Fakultas Ilmu Pendidikan, 6, 11. <http://staffnew.uny.ac.id/upload/132310875/pengabdian/teknik-analisis-data-dalam-research-and-development.pdf>
- [18] Rahman, A., Munandar, S. A., Fitriani, A., Karlina, Y., & Yumriani. (2022). Pengertian Pendidikan, Ilmu Pendidikan dan Unsur-Unsur Pendidikan. *Al Urwatul Wutsqa: Kajian Pendidikan Islam*, 2(1), 1–8. [19] “View of Analysis of machine learning approaches to determine online shopping ratings using naïvebayes and svm.” Accessed: Jul. 03, 2025. [Online]. Available: <https://ijecom.org/index.php/IJECOM/article/view/60/62>
- [19] Safak, M. (2021). *Tingkat Kepuasan Peserta Didik pada Pembelajaran Matematika di Masa Pandemi*