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ANALYSIS OF HIGH SCHOOL SUBJECT SELECTION PATTERNS AT "A" TUTORING INSTITUTIONS USING THE APRIORI ASSOCIATION METHOD

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ABSTRACT

In the face of fierce competition to enter college, students often seek support from tutoring institutions to strengthen their learning abilities. However, LBB has limitations in providing learning programs. To understand students' preferences in choosing subjects, data mining methods can be used, which is the process of gathering information from large databases with statistical, mathematical, and artificial intelligence techniques. This research uses data from 40 students as samples that will be analyzed using the Apriori Association method. The search for support values is limited to three sets of elements because no combination meets the minimum support value requirement, so the procedure is stopped. The search for confidence values is carried out using a combination of two sets of potential items (L2). There are three association rules that can be useful for understanding students' preferences in choosing subjects. The first rule is "If you choose Math, you will choose English" with a confidence of 0.6, the second rule is "If you choose English, you will choose Math" with a confidence of 0.6, and the third rule is "If you choose Biology, you will choose Mathematics" with a confidence of 0.70. The results of the analysis in this study can be applied by Tutoring Institution "A" in the future to develop programs that are suitable for deepening the understanding of certain subjects.

Keywords: Apriori, Association, Data Mining, Subjects

INTRODUCTION

Education at the Senior High School (SMA) level is an important foundation for academic development and preparation for higher levels of education. High school provides opportunities for students to explore various subjects, broadening their interests and talents through diverse studies. The two main majors that are common in high school are Natural Sciences (IPA) and Social Sciences (IPS). Science majors concentrate on understanding scientific concepts in subjects such as mathematics, physics, chemistry, and biology. Meanwhile, social science majors study economics, geography, history and sociology. However, there are mandatory subjects that must be studied by both majors, namely mathematics and English, and it is recommended that students take one subject across majors to complete their knowledge. Currently, high school students experience intense competition to enter tertiary institutions because the number of candidates continues to increase and capacity is limited. Tutoring institutions (LBB) are a solution for students in facing this challenge, providing the needed academic support and strengthening learning abilities. However, LBB has limitations in that not all subjects can be included in the program. In addition , in facing the large amount of material that must be studied in high school, students often have difficulty prioritizing which subjects require in-depth study of the material [1], [2], [3], [4], [5].

Based on these limitations, it is necessary to find a solution to understand students' preferences in choosing subjects. This preference can be understood through data on the subjects chosen by students at an LBB. This data is useful for LBB to develop appropriate programs to deepen understanding of certain subjects. To make this happen, it can be done using data mining methods. Data mining is the process of collecting meaningful information or patterns from large or complex databases using statistical, mathematical and artificial intelligence techniques. The main goal of data mining is to discover important information, trends, hidden patterns, and knowledge that can be used to make better decisions. Data mining techniques can help organizations optimize their operations, increase efficiency, discover new possibilities, and predict future problems.[6], [7].

There are 5 groups provided by data mining, namely Association, Prediction, Clustering, Classification and Estimation. One important type of data mining is the Apriori association method. This method is used to identify meaningful relationships between items in very large data sets, especially in the context of transactions or item selection. The aim is to identify associations between specific items, such as items frequently purchased together in a transaction or subject selection patterns in an educational context. The Apriori method works by exploring a data set to find itemsets that often appear together (frequently occurring itemsets) and generating association rules that show the relationship between these items. Thus, the Apriori method provides valuable insights into emerging patterns in datasets, which can be used for smarter decision making in a variety of fields, including business, education, science, and others. Therefore, research into subject selection patterns using the Apriori method is important for LBB to develop effective tutoring programs, provide better and more focused services, and help students achieve their academic potential optimally [8], [9].

There has been various research conducted regarding the Apriori approach, some of the works that researchers used as references in this research are as follows. In 2019, Anas and Darma conducted research which was triggered by the large collection of data on STIE-GK Muara Bulian students' course choices from year to year. Researchers used an association algorithm to determine trends in student course selection at STIE-GK Muara Bulian. Data will be processed using an a priori algorithm. The results of this research show the value of *support* and *confidence* , with the 2-itemset reference that has the greatest value being the combination of Marketing and Business Feasibility Studies (SKB) courses, with a *support value* of 14% and *confidence* of 18%. Regarding the 3-itemset reference, four association rules met the minimum standards *of support* (5%) and *confidence* (10%). It was found that all combinations of Marketing, SKB, and Human Resource Management (HRM) elective courses had the highest scores, namely 12% *support* and 85% *confidence* [10].

Winyo, Trisno, and Kurra in 2024 researched the use of association algorithms to select thesis titles. This research was conducted because the large number of thesis titles submitted each year resulted in the creation of a large archive. However, the advantages of the thesis title were not managed well. If managed well, this data can be used to help students who often have difficulty identifying topics that suit their interests and field of study. This research uses an association algorithm to identify student thesis title selection patterns at STIMIKOM Stella Maris Sumba. In this research, *data mining* is used to build all association rules. Based on the discussion in this research, the highest *support* and *confidence values* with the 2-itemset reference are a combination of fuzzy logic and expert systems, with *support of* 14% and *confidence of* 18%. For the 3-itemset reference, four association rules were obtained that met the minimum requirements *of support* (5%) and *confidence* (10%). All combinations of Expert Systems, Software Applications, and Fuzzy Logic have the highest scores, with 12% *support* and 85% [11]*confidence* .

Indriyawati, Khoirudin, and Widodo in 2021 used association rules and a priori algorithms to anticipate course scheduling. This research focuses on the topic of students who have difficulty choosing elective courses because assessments are made based on the number of people interested rather than talent. This makes it difficult for administrators to plan classes for the next semester because quotas are often met. Therefore, student data trends are needed to help management predict which classes will be opened. The data was analyzed using the Apriori approach to obtain a set of frequently occurring items. This collection of items will be used to build rules, which will then be assessed as models. Research findings show that 72 students completed the KRS in the 2019-2020 Odd semester. The KRS data criteria are based on seven courses: A (Object Oriented Programming), B (Decision Support Systems), C (Professional Ethics), D (Information Systems Project Management), E (Research Methodology), F (Graphic Design), and G (Multimedia). It is known that the rule with the highest value is "If you choose B and C, then choose D then F". This rule shows that if a student chooses courses B (Decision Support Systems), C (Professional Ethics), and D (Information Systems Project Management), then he will most likely choose course F (Graphic Design) with a *support value* of 32 % and *confidence* of 83%. Apart from that, the literacy results show combinations of courses with more than 30 participants, such as (A, B, C, D) and (B, E, F, G). This shows that there is a fairly large pattern or correlation between the courses taken by students [12].

Sasonoputri and Wahyusari in 2022 conducted research on the use of a priori algorithms to identify book borrowing trends in libraries and make recommendations for more efficient book placement. Data analysis reveals association rules, such as the fact that if someone borrows a book with code 300-499, they are more likely to borrow a book with code 500-599, with *support of* 47.0588% and *confidence* of 60.3774%. Apart from that, another rule found was that if someone borrowed a book with code 500-599, they were more likely to borrow a book with code 300-499, with *support of* 47.0588% and *confidence* of 78.0488%. Furthermore, the findings of this data mining research reveal other association rules, such as if someone borrows a book with code 300-499, they are more likely to borrow a book with code 500-599 with 55.84% *confidence* . Another association rule states that if you borrow a book with code 500-599, you will borrow a book with code 300-499 with 78.18% *confidence* . These association rules can provide recommendations for better placement of books in libraries based on known borrowing trends [13].

RESEARCH METHOD

Research Stages

Research stages are designed to structure and direct the research process, making it easier to complete. These stages are as follows [14]:

1. Problem analysis is a research stage that involves identifying, understanding, and analyzing the sources of existing problems. This procedure is very important in various scenarios because it requires an effective and acceptable answer to the problem at hand.
2. A literature review is a research technique that involves obtaining and assessing various relevant references or literature related to the subject or area under study. The main goal is to fully understand existing research or knowledge. Commonly reviewed literature includes scientific articles, books, reports, papers, journals, and various other sources.
3. Data collection involves gathering facts or information that are relevant and important to answer a research question, solve a problem, or better understand a phenomenon. The data collected can be presented in the form of factual details, figures, opinions or observations related to the current research topic or objectives.
4. One of the steps in using the Apriori algorithm for data analysis in *Association Rule Mining* is to apply it. The main goal of the Apriori algorithm is to identify appropriate association patterns in large data sets.

5. The next step is to run tests using the RapidMiner application. Testing the Apriori algorithm using the RapidMiner application means implementing and running it within the RapidMiner data analysis platform.
6. Creating a report is the final step, involving a series of actions necessary to present and organize information in a systematic and organized way.

Data Mining

Although technological advances have enabled organizations to collect large amounts of data and analyze it manually, this is still not enough. Therefore, new techniques such as *data mining are needed* to process data into useful business data. The collection of methods used to explore and analyze large amounts of data is called *data mining* . *Data mining* has various functions such as description, classification, grouping, association, sorting, prediction, and forecasting. Data mining helps define research conditions, verify hypotheses, and explore new relationships in data. Prediction models, cluster analysis, association analysis, and anomaly detection are the subjects of *data mining science* . *Data mining* is a general technology that can be used for various types of data as long as the data is relevant to a particular application. Data from data bases, data from data warehouses, and transactional data are the most common types of data used for *data mining applications* . *Data mining* can also be used for other types of data, such as stream data, ordered data, graphic or network data, spatial data, text data and multimedia data [14], [15].

Data mining has become a very popular technology in various fields. Data mining has made many advances in understanding and using data, from finance to health care and from commerce to information technology. Data mining is used by financial institutions to identify fraud patterns, predict market trends, and optimize investment portfolios. Data mining is used in the health sector to predict disease, develop more efficient treatment models, and analyze patient medical records. In commerce, data mining helps in finding potential customers, market segmentation, and developing better marketing strategies. In addition, data mining is used in information technology to analyze log data, predict network damage, and detect cybersecurity threats. Data mining continues to play an important role in the advancement of various fields in this digital era, as it can explore large and complex data and extract insights from it [14], [16].

Association

In *data mining* , association rules are used to find frequently occurring patterns in multi-item transactions. This is a subset of *frequent pattern* mining that looks for correlations, associations, and relationships in data. The main task in association *data mining* is to find features that appear together. The most important association rule is the availability of a database that records purchase transactions or item selection automatically, which allows identification of product or item associations. Association rules have many advantages. Association rules can be used to inform strategies for promoting products, segmenting buyers, creating catalogs, and understanding customer shopping patterns. In addition, association rules are also implemented in the form of a recommendation system. Examples are recommendation systems for selecting subjects in educational institutions, recommendation systems for online purchases, search engine recommendation systems, and book lending recommendation systems in libraries. Lastly, these rules also provide information about transactions in a format known as "if-then", which is calculated based on the probabilistic nature of the data [7], [9], [17].

There are some general terms to understand when it comes to association rules. A single attribute or object in a data set is called an "item." An item in a subject selection dataset could be, for example, mathematics, English, or biology. "K-item" is a combination of several items. A combination of two items, for example, is a combination of "math" and "English" or "mathematics" and "biology". An "itemset" is a collection of several items integrated into one data set. For example, if a transaction contains "math", "English" and "biology", then the itemset of the transaction is {"math", "English" and "biology"}. The number of times a set of items appears in a dataset is supported. *Support* is the frequency of appearance of a set of items in a data set. *Support* is generally used to determine how frequent or popular an itemset is in a dataset. How often an association rule is true can be measured by *confidence* . *Confidence* is used in Apriori to determine how often the association rules generated by the algorithm are correct based on the data [7], [9], [18].

A priori

The Apriori algorithm is a part of data mining science that focuses on association categories. It is used to identify high-frequency patterns in a database, which are items that appear frequently with support above a certain threshold. These patterns form the basis for associative rules and other *data mining techniques* . The Apriori algorithm includes [8], [14]:

1. 1-item itemset search:
   The algorithm recognizes and calculates the frequency of each item in the data, as well as the frequency of occurrence that exceeds a predetermined minimum value.
2. Formation of candidate itemsets:
   The results from the previous stage (iteration 1) are used to create candidate itemsets consisting of two or more items. If the minimum value does not match, the procedure is terminated.

3. *Support* calculation :

   This method determines which sets of items meet the minimum support threshold by calculating their frequency of occurrence.

   One Item:

   $$Support = \frac{\text{number of choose } A}{\text{total voters}} * 100\%$$

   Two Items

   $$\text{Support} = \frac{\text{number of choose } A \text{ } and \text{ } B}{\text{total voters}} * 100\%$$

4. Establishment of association rules:

   The results of the item set support in the previous stage are used to determine association rules that meet the minimum confidence limits.

   $$\text{Confidence} = \frac{\sum \text{who chooses } A \text{ } dan \text{ } B}{\sum \text{voters } A} * 100\%$$

   Association rules are recalculated using lift values to determine how strong they are. The following formula is used to find the lift value:

   $$\text{Lift} = \frac{Support\ (A+B)}{Support\ A * Support\ B}$$

Subject Selection Patterns

Students' choice of subjects at tutoring centers is often influenced by a number of different factors. Academic requirements and special demands of students are one of the main factors influencing subject choice patterns. Each student's learning needs are unique. For example, some students need extra help with math, while others need more help with English or science. The way tutoring centers choose subjects is also influenced by the environment. For example, if there is a tendency at school or in the surrounding environment that certain subjects are very important, such as preparation for national exams or university entrance exams, students tend to take additional tutoring for those subjects [19], [20], [21].

Students' personal interests and inclinations towards certain subjects are also influencing factors. Students who like mathematics tend to participate more actively in tutoring, even if there is no external pressure. To improve their understanding, students who are less interested or have difficulty in a subject can take additional lessons. Apart from these factors, the programs and regulations of tutoring institutions can also influence the choice of subjects. Students can register to take lessons in a particular subject because there is an interesting program or comprehensive package for that subject. Academic needs, environmental influences, individual student interests, and institutional policies and programs all influence how students choose courses at tutoring institutions [19], [20], [21].

RESULTS AND DISCUSSION

Several subjects chosen by students can be used to determine subject selection patterns. It is hoped that with this pattern, the Learning Guidance Institute (LBB) "A" can find out the preferences of the subjects chosen by students. In this research, the subject data chosen by students is processed using data mining methods to obtain the desired patterns. A sample of 40 students was used for research.

Table 1. Subject Choice Data

No.	Subject Choices		
1.	Mathematics	English	Biology
2.	English	Physics	Economy
3.	Mathematics	Biology	Economy
4.	Mathematics	English	Economy
5.	Mathematics	English	Economy
6.	English	Biology	Economy
7.	Mathematics	Physics	Economy
8.	Mathematics	Chemistry	Biology
9.	English	Economy	Geography
10.	English	Physics	Biology
11.	Biology	Economy	Geography
12.	English	Biology	Economy
13.	Mathematics	Physics	Biology
14.	Economy	Geography	History
15.	Mathematics	Biology	Economy
16.	Mathematics	Physics	Biology
17.	English	Physics	Economy
18.	Mathematics	English	Economy
19.	Mathematics	English	Biology
20.	English	Physics	Economy
21.	Mathematics	Chemistry	Biology
22.	Mathematics	English	Physics
23.	Mathematics	English	Biology
24.	English	Chemistry	Biology
25.	Mathematics	Physics	Economy
26.	Mathematics	Chemistry	Biology
27.	Mathematics	English	Physics
28.	Mathematics	English	Economy
29.	Mathematics	English	Physics
30.	English	Physics	Chemistry
31.	Mathematics	Physics	Economy
32.	Mathematics	English	Economy
33.	Mathematics	English	Biology
34.	English	Geography	History
35.	Economy	Geography	History
36.	Mathematics	English	Economy

37.	Mathematics	English	Biology
38.	Geography	History	Sociology
39.	Mathematics	English	History
40.	Economy	Geography	Sociology

To find the frequency of each item in the subject selection data, first determine how often each item appears in all the data. The following table shows the calculation results.

Table 2. Frequency of Each Itemset

Items	Frequency
Mathematics	25
English	25
Physics	13
Chemistry	5
Biology	17
Economy	21
Geography	7
History	5
Sociology	2

From table 2, it is known that there are 9 subjects chosen by students, with the greatest frequency being mathematics and English. Next, an a priori application will be carried out. The a priori association applied is a minimum *support* of 0.3 and a minimum *confidence* of 0.6. The following is the *support calculation* per 1 itemset

$$\text{Support} = \frac{\text{number of choose } A}{\text{total transactions}} * 100\%$$

Calculating support per itemset

$\text{Support (Matematika)} = \frac{25}{40} * 100\% \ = 0{,}625$

$\text{Support (Bahasa Inggris)} = \frac{25}{40} * 100\% = 0{,}625$

$\text{Support } (Fisika) = \frac{13}{40} * 100\% = 0{,}325$

$\text{Support } (Kimia) = \frac{5}{40} * 100\% = 0{,}125$

$\text{Support } (Biologi) = \frac{17}{40} * 100\% = 0{,}425$

$\text{Support } (Ekonomi) = \frac{21}{40} * 100\% = 0{,}525$

$\text{Support } (Geografi) = \frac{7}{40} * 100\% = 0{,}175$

$\text{Support } (Sejarah) = \frac{5}{40} * 100\% = 0{,}125$

$\text{Support } (Sosiologi) = \frac{2}{40} * 100\% = 0{,}05$

The following table shows the amount of support obtained from the previous itemset support search calculations.

Table 3. Support 1 Itemset

Items	Frequency	Support
Mathematics	25	0.625
English	25	0.625
Physics	13	0.325
Chemistry	5	0.125
Biology	17	0.425
Economy	21	0.525
Geography	7	0.175
History	5	0.125
Sociology	2	0.05

The next stage is to identify itemsets that match the minimum *support* of 0.3 . Each feasible itemset 1 that meets the minimum support criteria is called a large itemset (L1), as shown in the table below.

Table 4. Large Itemset (1 Itemset)

Items	Frequency	Support
Mathematics	25	0.625
English	25	0.625
Physics	13	0.325
Biology	17	0.425
Economy	21	0.525

Table 4 shows the size of the itemsets that come from itemsets that meet the minimum *support value* . The next step is to calculate the number (frequency) of occurrence of two itemsets from items that meet the previous minimum *support value* (1 itemset). The frequency table for the 2 data itemsets can be seen in the table below.

Table 5. Frequency 2 Itemset

Items		Frequency
Mathematics	English	15
Mathematics	Physics	8
Mathematics	Biology	12
Mathematics	Economy	11
English	Physics	8
English	Biology	10
English	Economy	12
Physics	Biology	3
Physics	Economy	0
Biology	Economy	5

Calculating support per 2 itemsets

$$\text{Support} = \frac{\text{transaction amount } A,B}{\text{total transactions}} * 100\%$$

$$\text{Support(Matematika, Bahasa Inggris)} = \frac{15}{40} * 100\% = 0{,}375$$
$$\text{Support(Matematika, Fisika)} = \frac{8}{40} * 100\% = 0{,}2$$
$$\text{Support(Matematika, Biologi)} = \frac{12}{40} * 100\% = 0{,}3$$
$$\text{Support(Matematika, Ekonomi)} = \frac{11}{40} * 100\% = 0{,}275$$
$$\text{Support(Bahasa Inggris, Fisika)} = \frac{8}{40} * 100\% = 0{,}2$$
$$\text{Support(Bahasa Inggris, Biologi)} = \frac{10}{40} * 100\% = 0{,}25$$
$$\text{Support(Bahasa Inggris, Ekonomi)} = \frac{12}{40} * 100\% = 0{,}3$$
$$\text{Support(Fisika, Biologi)} = \frac{3}{40} * 100\% = 0{,}075$$
$$\text{Support(Fisika, Ekonomi)} = \frac{0}{40} * 100\% = 0$$
$$\text{Support(Biologi, Ekonomi)} = \frac{5}{40} * 100\% = 0{,}125$$

The following are the findings of *the support values* obtained for the two itemsets

Table 6. Supports 2 Itemsets

Items		Frequency	Support
Mathematics	English	15	0.375
Mathematics	Physics	8	0.2
Mathematics	Biology	12	0.3
Mathematics	Economy	11	0.275
English	Physics	8	0.2
English	Biology	10	0.25
English	Economy	12	0.3
Physics	Biology	3	0.075
Physics	Economy	0	0
Biology	Economy	5	0.125

In table 6, the results of the findings of *the support values* obtained for two itemsets are displayed. The next step is to select candidate itemsets that do not meet the minimum limit set, namely 0.3. Every 2 candidate itemsets that pass the minimum *support requirements* will be declared as the second *large* itemset (L2), as shown in the table below.

Table 7. Large Itemset (2 Itemsets)

Items		Frequency	Support
Mathematics	English	15	0.375
Mathematics	Biology	12	0.3
English	Economy	12	0.3

Table 7 shows the large itemset (L2) which comes from itemsets that meet the minimum *support value* . The next stage is to calculate the number (frequency) of occurrence of three itemsets from items that meet the previous minimum *support value.* The transaction data frequency table for the three itemsets after modifying their frequency of appearance is shown in the table below.

Table 8. Frequency 3 Itemset

Items			Frequency
Mathematics	English	Biology	5
Mathematics	English	Economy	6

After successfully obtaining a large itemset and determining its frequency of appearance in table 8, the second iteration involves computing a combination of three items to produce candidate itemset 3. *Support* for each itemset is calculated using the same algorithm as itemsets 1 and 2. The steps for calculating itemset 3 are as follows:

Calculating support per 3 itemsets

$$\text{Support} = \frac{\text{transaction amount } A,B,C}{\text{total transactions}} * 100\%$$

$$\text{Support(Matematika, Bahasa Inggris, Biologi)} = \frac{5}{40} * 100\% = 0{,}125$$

$$\text{Support(Matematika, Bahasa Inggris, Ekonomi)} = \frac{6}{40} * 100\% = 0{,}15$$

Table 9. Supports 3 itemsets

Items			Frequency	Support
Mathematics	English	Biology	5	0.125
Mathematics	English	Economy	6	0.15

Table 9 shows that there is no combination of the three sets of items that meets the minimum *support criterion* of 0.3, so the operation is terminated. To continue searching for *confidence values* , a combination of two sets of items (L2) that match the association criteria is used.

Establishment of association rules

$$\text{Confidence} = \frac{\sum \text{transaction } A \text{ dan } B}{\sum \text{transaction } A} * 100\%$$

If you choose Mathematics, you will choose English

$$\text{Confidence} = \frac{15}{25} * 100\% = 0{,}6$$

If you choose English , you will choose Mathematics

$$\text{Confidence} = \frac{15}{25} * 100\% = 0{,}6$$

If you choose Mathematics, you will choose Biology

$$\text{Confidence} = \frac{12}{25} * 100\% = 0{,}48$$

If you choose Biology you will choose Mathematics

$\text{Confidence} = \frac{12}{17} * 100\% = 0{,}705882$

If you choose English you will choose Economics

$\text{Confidence} = \frac{12}{25} * 100\% = 0{,}48$

If you choose Economics you will choose English

$\text{Confidence} = \frac{12}{21} * 100\% = 0{,}571429$

Table 10. Association Rules

Rule	Confidence
If you choose Mathematics, you will choose English	0.6
If you choose English you will choose Mathematics	0.6
If you choose Mathematics, you will choose Biology	0.48
If you choose Biology you will choose Mathematics	0.705882
If you choose English , you will choose Economics	0.48
If you choose Economics you will choose English	0.571429

Table 10 shows the results of calculating the total confidence of two itemsets with *confidence values* that meet the minimum *confidence* for three rules, namely the first rule "If you choose Mathematics, you will choose English" with *a confidence* of 0.6, the second rule "If you choose English, then will choose Mathematics" with *a confidence* of 0.6, and the third rule "If you choose Biology, you will choose Mathematics" with *a confidence* of 0.70.

CONCLUSION

Based on a priori association analysis of existing data at Tutoring Institution "A", it is known that there are three association rules that can be useful for understanding student preferences in choosing subjects. The first rule is "If you choose Mathematics, you will choose English" with *a confidence* of 0.6, the second rule is "If you choose English, you will choose Mathematics" with *a confidence* of 0.6, and the third rule is "If you choose Biology then will choose Mathematics" with *a confidence* of 0.70. The results of the analysis in this research in the future can be applied by Tutoring Institution "A" to develop appropriate programs to deepen understanding of certain subjects.

REFERENCE

[1] NT Romadhona *et al.* , "Improving the Quality of Education through Tutoring," *Journal of Community Service and Engagement (JOCOSAE)* , vol. 2, no. 6, pp. 18–23, 2022.

[2] R. Priyasmika, A. Alfan, and RS Rohmah, "SBMPTN Study Tutoring for Class XII Students of Sukodadi State High School," *Ta'awun: Journal of Community Service* , vol. 2, no. 2, pp. 142–150, 2022.
[3] P. Rahmadi, KPS Dirgantoro, T. Listiani, and EB Nababan, "Improving Student Mathematics Learning Outcomes Through Online Tutoring in Tenjo," *Jurnal Abdimas PHB* , vol. 6, no. 2, pp. 522–528, 2023.
[4] I. Paramika, IW Dharmayana, and I. Sulian, "Comparison of Student Learning Motivation Between Learning Through Face-to-Face Tutoring and Learning Through Online Tutoring with the Bengkulu City State High School Teacher Room Application," *CONSILIA BK Scientific Journal* , vol. 5, no. 1, pp. 89–98, 2022.
[5] E. Susilowati, "SNBT Online Tutoring for High School Students at Latis Education Tutoring," *Community Development Journal* , vol. 4, no. 4, pp. 9090–9094, 2023.
[6] P. Wibawa Rahayu *et al.* , *Data Mining Textbook* . Jambi: PT. Sonpedia Publishing Indonesia, 2024.
[7] A. Wanto *et al.* , *Data Mining: Algorithms and Implementation* . Medan: Kita Write Foundation, 2020.
[8] Y. Mustika *et al.* , *Data Mining and its Applications* . Bandung: Widina Bhakti Persada Bandung, 2021.
[9] D. Sitanggang, *Apriori Algorithm* . Medan: Unpri Press, 2023.
[10] A. Anas and B. Darma, "Association Algorithm to Get Patterns of Selected Courses at STIE-GK Muara Bulian," *Journal of Edik Informatics* , vol. 6, no. 1, pp. 1–12, 2019.
[11] A. Winyo, Trisno, and T. Kurra, "Analysis of the Association's Algorithm for Choosing the Title of Stella Maris Sumba Stimkom Thesis Students," *Multidisciplinary Indonesian Center Journal (MICJO)* , vol. 1, no. 1, pp. 404–411, 2024.
[12] H. Indriyawati, Khoirudin, and E. Widodo, "Application of Association Rules with the Apriori Algorithm for Predicting Course Scheduling," *Scientific Journal of Information and Communication Technology (JTIK)* , vol. 12, no. 2, pp. 42–47, 2021.
[13] FS Sasonoputri and R. Wahyusari, "Application of the Apriori Algorithm to Find Book Borrowing Patterns in Libraries," *SIMETRIS* , vol. 16, no. 1, pp. 17–23, 2022.
[14] J. Han, Hanghang Tong, and J. Pei, *Data Mining: Concepts and Techniques* , 4th ed. Waltham: Elsevier, 2022.
[15] NLWSR Ginantra *et al.* , *Data Mining and Application of Algorithms* . Denpasar: Kita Write Foundation, 2021.
[16] F. Sulianta, *Basic Data Mining from A to* Z. Bandung, 2024.
[17] RP Karina, S. Lestanti, and F. Febrinita, "Application of the Apriori Algorithm in the Selection of Majors for Prospective New Students at SMAK Diponegoro Blitar," *JATI (Informatics Engineering Student Journal)* , vol. 6, no. 2, pp. 716–724, 2022.
[18] F. Andriani, V. Sihombing, and AP Juledi, "Development of a Web-Based Application for Mining Association Patterns Using Apriori Methods," *Journal of Computer Science and Information Systems (JIKOMSI)* , vol. 7, no. 1, pp. 70–74, 2024.

[19] I. Wahyuni, Maison, and H. Pathoni, "Analysis of Students' Interest in Learning in Physics Subjects at SMA Negeri 2 Jambi City," *Physics and Science Education Journal (PSEJ)* , vol. 1, no. 1, pp. 22–28, 2021.
[20] RR Dalimunthe, RD Harahap, and DA Harahap, "Analysis of Elementary School Students' Learning Interest in Science Subjects During the Covid-19 Pandemic," *BASICEDU Journal* , vol. 5, no. 3, pp. 1341–1348, 2021.
[21] C. Sarah, IN Karma, and ANK Rosyidah, "Factors that Influence Students' Interest in Learning in Mathematics Subjects in Cluster III Cakranegara," *Education Progress* , vol. 2, no. 1, pp. 13–19, 2021.