Contents lists available at Universitas Muhammadiyah Lampung

Hipotenusa Journal of Research Mathematics Education

Journal homepage: https://journal.uml.ac.id/index.php/HT/index

Shortest route analysis from Candimas to universitas muhammadiyah kotabumi using graph theory

Aghnia Nasywa Nur Rendra [*,1,a], Cintia Marantika[a], Rosiyana[a], Gigih Aditiya[a], Darwanto[a]

[a] *Department of mathematics Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Kotabumi, Jl. Hasan Kepala Ratu No. 1052, Sindang Sari, Kotabumi District, North Lampung Regency, Lampung 34517, Indonesia*

ARTICLE INFO

Keywords:
Dijkstra's algorithm;
Shortest path;
Graph theory;
Route navigation.

ABSTRACT

Suboptimal route selection within the road network leading to Universitas Muhammadiyah Kotabumi (UMKO) can result in longer and less efficient journeys; therefore, a systematic analysis method is required to determine the shortest path. This study aims to identify the shortest route from Candimas Medical Center (CMC) Kotabumi to UMKO using Dijkstra's algorithm. A quantitative approach was employed, utilizing inter-node distance data obtained through field observations and digital measurements via Google Maps on June 7, 2026. The transportation network was modeled as a weighted graph comprising nine nodes (vertices) and eleven edges, with weights representing the travel distance between nodes in meters. Dijkstra's algorithm was applied to determine the path with the minimum accumulated weight (distance) from the starting node to the destination node. The results indicate that the shortest path is A → B → C → E → H → I, covering a total distance of 7,750 meters. These findings demonstrate that Dijkstra's algorithm can be systematically applied to determine the shortest path within the CMC–UMKO transportation network.

1. Introduction

Transportation is a crucial component that supports various community activities by connecting different locations. A well-functioning transportation system enhances accessibility and facilitates the smooth conduct of social, economic, and educational activities [1]. Furthermore, an adequate transportation network influences the efficiency of human movement during travel [2]. Consequently, travel efficiency particularly regarding route selection must be considered to ensure journeys are undertaken effectively and optimally. Therefore, a method capable of effectively determining the shortest path based on the distance between locations is required. This study addresses the modeling of the road network between Candimas Medical Center and Universitas Muhammadiyah Kotabumi as a weighted graph and the application of Dijkstra's algorithm to determine the shortest path within that network. Accordingly, the study aims to identify the shortest route from Candimas Medical Center to Universitas Muhammadiyah Kotabumi by utilizing Dijkstra's algorithm within a graph-based model.

* Corresponding author.
E-mail address: aghnianasywanurrendra@gmail.com (Aghnia Nasywa Nur Rendra).
[1] These authors contributed equally to this work.

https://doi.org/10.36269/hjrme.vxix.xxx
Received 10 June 2026; Received in revised form 20 July 2026; Accepted 28 July 2026
Available online 01 August 2026
2723-486X/Published by Universitas Muhammadiyah Lampung.

In transportation networks, users are often presented with multiple alternative routes to reach the same destination. Differences in distance between paths result in varying levels of efficiency for each route in reaching the destination. The shortest path problem in graph theory concerns finding a path between a starting node and a destination node with the minimum total weight [3]. Consequently, selecting the route with the minimum total weight is crucial for achieving a more efficient journey. Finding the shortest route is a common optimization problem encountered in daily life; it can be represented using a weighted graph, where the weight of each edge signifies a value or measure relevant to the problem at hand [4]. In transportation networks, the distance between nodes can serve as the edge weight to determine the path with the minimum total distance [5].

The Kotabumi area contains several road segments and intersections that form alternative routes from Candimas Medical Center (CMC) to Universitas Muhammadiyah Kotabumi (UMKO). The existence of these alternative routes results in varying travel distances to reach the destination. Therefore, a method is required to objectively determine the route with the minimum travel distance. Based on this context, the research questions are: (1) how the CMC - UMKO road network can be modeled as a weighted graph, and (2) how Dijkstra's algorithm can be applied to determine the route with the minimum travel distance within that network.

Dijkstra's algorithm has previously been applied to determine the shortest route from STIKOM Tunas Bangsa to Suzuya Merdeka Mall in Pematangsiantar City [6]. That study utilized weighted graph modeling with distance serving as the edge weight and Dijkstra's algorithm to identify the route with the minimum distance. The present study shares similarities regarding the use of Dijkstra's algorithm and weighted graph modeling but differs in the specific locations and network analyzed: the route from Candimas Medical Center (CMC) to Universitas Muhammadiyah Kotabumi.

Based on the issues described, this study focuses on determining the shortest path from Candimas Medical Center (CMC) to Universitas Muhammadiyah Kotabumi by considering the distances between nodes in the transportation network. The transportation network was modeled as a weighted graph and analyzed using Dijkstra's algorithm to obtain a path with the minimum total distance. Unlike previous studies, this research focuses on the CMC - UMKO transportation network comprising nine nodes and eleven edges analyzed based on inter-node distances. The specific object and network analyzed constitute the novelty of this study regarding the application of Dijkstra's algorithm to determine the shortest path within the transportation network of the Kotabumi area.

2. Method

Mathematical concepts can be applied to real-world problems through a quantitative approach involving measurement, calculation, and mathematical modeling such as determining the shortest path within a transportation network [7]. In this study, a quantitative approach is employed by measuring and calculating the distances between travel points on the CMC - UMKO road network. These distance data are then modeled as a weighted graph, where each point serves as a node and the distance represents the edge weight, in order to identify the path with the minimum distance.

This research was carried out to determine the shortest route from Candimas Medical Center (CMC) to Universitas Muhammadiyah Kotabumi. Data collection was conducted through field observations using Google Maps to identify alternative routes and obtain data between points. Each location or intersection that is part of the network is designated as a node (vertex), while the road segment connecting two nodes is designated as an edge with the distance traveled as the weight [8]. The representation of the network in the form of a weighted graph allows the network structure to be analyzed systematically to support more efficient route determination.

The data collection process involved identifying the locations and intersections within the road network connecting Candimas Medical Center to Universitas Muhammadiyah Kotabumi. Each point within the network was recorded as part of the research data, and the distances between points were determined using information from Google Maps combined with observations of the analyzed road network [9]. Data were collected for each alternative road segment connecting the starting point to the destination, thereby establishing distance information for every connection between points. The collected distance data was then cross-verified to ensure consistency among the locations, road segments, and distances used in the study. Subsequently, the data were organized based on the connections between points and used to assign weights to each edge of the graph [10]. Observational findings served as the basis for determining these edge weights. Once all data was verified, the established road network served as the foundation for applying Dijkstra's algorithm to determine the shortest path.

The transportation network is modeled as a weighted graph, where locations serve as nodes and the connections between them as edges weighted by travel distance. When traveling from a starting point to a destination, selecting an appropriate route is essential for achieving greater distance efficiency. Applying mathematical algorithms according to established

procedures is part of the mathematical problem-solving process [11]. Dijkstra's algorithm is one such algorithm that can be applied to determine this route. It is used to find the shortest path because it can identify the route with the minimum accumulated weight in a graph with positive edge weights [12].

Table 1
Description of Vertices in a Transportation Network Graph

No	Nodes	Locations
1.	A	CMC Kotabumi
2.	B	Tugu Letjen. Alamsyah
3.	C	Tugu Payan Mas
4.	D	Pertigaan SMK 03 Kotabumi
5.	E	Pertigaan Ahmad Akuan
6.	F	Klinik Handayani
7.	G	Pertigaan Bass Studio
8.	H	Rumah Nuwo Balak
9.	I	Universitas Muhammadiyah Kotabumi

Based on Table 1, each node in the transportation network has been determined based on its location and intersections that are part of the route from Candimas Medical Center (CMC) to Universitas Muhammadiyah Kotabumi. Furthermore, the relationships between nodes are used to form the edges of the graph, with the distance between locations serving as the edge weight. Details regarding the connections between nodes and their corresponding distance weights are presented in Table 2.

Table 2
Details of Graph Edge Weights

No	Side	Distance
1.	A→B	650 m
2.	B→C	2.200 m
3.	B→D	2.100 m
4.	C→E	600 m
5.	C→F	1.400 m
6.	C→G	3.300 m
7.	D→E	2.300 m
8.	E→H	2.600 m
9.	F→G	3.500 m
10.	G→H	280 m
11.	H→I	1.700 m

The data analysis process was conducted by applying Dijkstra's algorithm to determine the shortest path within the transportation network [13]. Dijkstra's algorithm is a method used to find the path with the minimum total weight in a weighted graph [14]. The analysis involved calculating the accumulated weight from the starting node to each subsequent node until the destination was reached. The results of this analysis were used to identify the travel route with the shortest distance.

3. Results and Discussion

3.1. Research Object

The Dijkstra algorithm is used to determine the shortest path between the starting and ending vertices in a positively weighted graph. The results of this study are consistent with those of Waruwu et al. [14] Who applied the Dijkstra algorithm to determine the shortest route in an inter-university network. Both studies show that the Dijkstra algorithm can be used to determine the path with the minimum total weight in a network represented in graph form. However, this study has differences in the objects and characteristics of the network analyzed, namely, the focus on the road network from Candimas Medical Center (CMC) to Universitas Muhammadiyah Kotabumi (UMKO) with nodes representing locations and intersections on the local road network in Kotabumi. Thus, the distinguishing aspect of this study is its application of the Dijkstra algorithm to the CMC - UMKO route network and the use of distance data between nodes in the network to determine the path with the minimum distance. [15] Points A through I are represented as vertices, while the connections between the vertices are represented as edges.

According to [16], the shortest path search process is carried out by evaluating each route based on the minimum weight from the starting point to the destination. This study examines the road network connecting the two locations. The road network is represented as a graph, where nodes indicate locations or intersections, while edges represent the roads connecting these locations. Each edge is assigned a weight representing distance or travel time. Mapping the travel route from CMC Kotabumi to Universitas Muhammadiyah Kotabumi is performed at this stage to serve as the basis for analysis. Determining the starting and ending points is the first step in this study. CMC Kotabumi is designated as the starting point, while Universitas Muhammadiyah Kotabumi is designated as the ending point. Each road connecting two points is represented as an edge in the graph and assigned a weight based on the travel distance or the length of each road segment. Furthermore, these roads are represented on a map of the Kotabumi area by marking key points located at intersections and junctions of major roads.

In the graph modeling process, the determination of vertices and edges is carried out systematically to ensure that the road network representation reflects actual field conditions. The selected points encompass not only key locations but also strategic intersections that can influence travel direction and route efficiency. The selection of these points is crucial due to the level of connectivity between nodes influences the shortest path results generated by the algorithm. The weight of each

edge is determined based on road segment lengths obtained from distance measurements using Google Maps and verified through field observations. The use of these weights aims to produce a more objective and quantifiable route analysis. Consequently, the resulting graph serves not only as a visual representation of the road network but also as a mathematical model that can be used to analyze path optimization [17-26].

Furthermore, graph visualization of the Kotabumi area map provides a clearer representation of connectivity patterns between road segments. This visualization enables the identification of alternative routes, intersections with high connectivity, and potential bottlenecks that could impact travel efficiency. Consequently, mapping the road network as a graph is a crucial step in supporting a scientific and systematic analysis of shortest routes. The subsequent stage involves applying a shortest-path search method to the constructed graph. This method is used to determine the optimal path from the starting point to the destination based on the lowest accumulated weight. The analysis results are expected to provide recommendations for efficient routes and serve as a foundation for developing navigation systems and conducting graph-based transportation studies in the Kotabumi area.

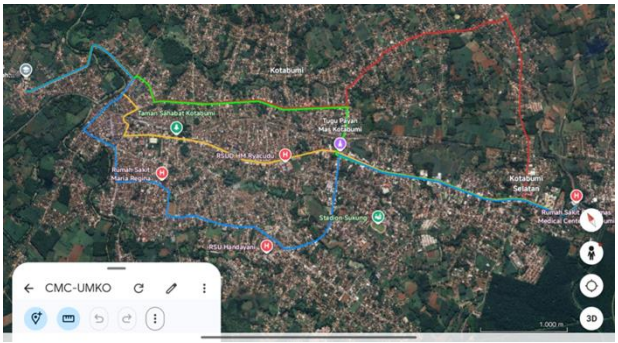


Fig. 1. Route map from CMC Kotabumi to Universitas Muhammadiyah Kotabumi

Subsequently, the acquired transportation route map is converted into a weighted graph to serve as a mathematical representation of the road network under study. This transformation is performed to facilitate the route analysis process and to identify relationships between locations more systematically. In the graph representation, each node corresponds to a specific point or intersection, while the connections or edges between them indicate the traversable connectivity between locations. Through this approach, the structure of the transportation network can be analyzed using concepts from graph theory [27-30].

Each edge in the graph is assigned a weight representing the travel distance between two connected points. Distance data was obtained through Google Maps on the route from Candimas Medical Center (CMC) to Universitas Muhammadiyah Kotabumi. In addition, direct observation was conducted using a motorcycle on June 7, 2026, at around 3:00 PM WIB to observe the condition and connectivity of road sections on the analyzed route. Data verification was carried out by comparing the suitability of the route and road section conditions shown on Google Maps with the results of direct observations in the field. The matched data were then used as the edge weight in the graph in the shortest path analysis process. Assigning weights to each edge based on distance (kilometers) ensures that the graph represents the actual road network so that it can determine the path with the minimum total distance between CMC Kotabumi and UMKO.

The weighted graph used in this study represents not only the transportation network but also serves to analyze the relationships between points along the observed routes. Each node and edge in the graph represents the connection between locations and the corresponding travel distance. Through this modeling approach, the route identification process can be carried out more systematically, as the weights of the alternative routes can be compared. Thus, the analysis results can identify the route with the minimum total distance, which can serve as a reference for determining a more effective and efficient travel route to the destination.



Fig. 2. Weighted graph representation of the route

Based on Fig. 2, node A represents the starting point, while point I represents the destination. Point C serves as the primary branching point, whereas point H acts as a convergence point for several alternative routes before reaching the final destination.

3.2. Weighted Graph

The mapping of points in Figure 3 above represents the key nodes used in the transportation network analysis. The positions of points A through I were determined based on significant locations such as major intersections, potential congestion points, and alternative routes connecting Candimas Medical Center (CMC) to Universitas Muhammadiyah Kotabumi. Details for each node are presented in Fig. 3.

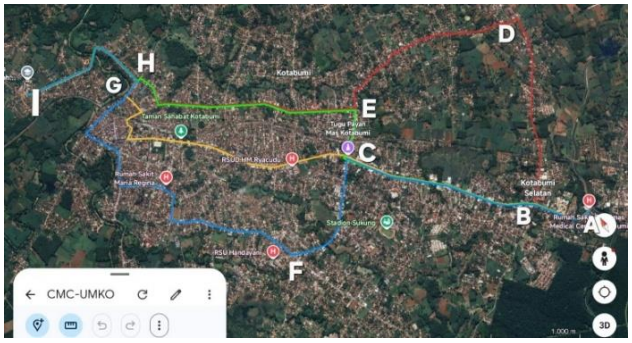


Fig. 3. Point mapping on the map from CMC Kotabumi to Universitas Muhammadiyah Kotabumi.

Thus, node A is designated as the starting point, while point I is set as the endpoint in the shortest-path search process using Dijkstra's algorithm. To simplify the calculation process, the actual geographical conditions shown on the map were abstracted into a graph model. The topological network model resulting from this route is presented in Fig. 4 below.

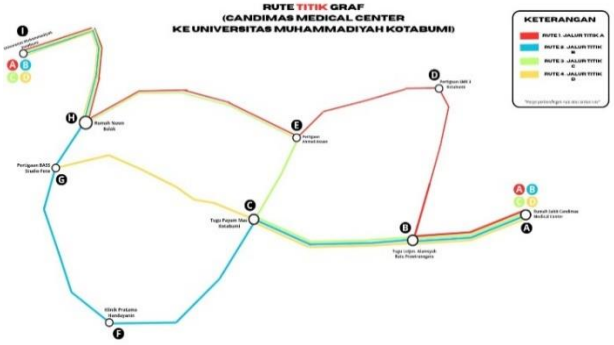


Fig. 4. Graph Network Scheme of the CMC Kotabumi Universitas Muhammadiyah Kotabumi Route with Designated Points.

Based on the prior mapping of geographic points, Fig. 4 illustrates the simplification of the route into an abstract graph network scheme. This model was specifically developed to provide a clearer representation of the connectivity between nodes and all available alternative paths. Using the network topology structure shown in Figure 4, the actual distance values or edge weights for each path connecting the nodes can be calculated and presented in detail in Table 2.

Each edge in the graph has a weight representing the distance between the connected nodes. These data describes the structure of a transportation network structure represented as a weighted graph. Node A is connected to point B with a distance of 650 meters. Node B is then connected to point C (a distance of 2,200 meters) and to point D (2,100 meters). Additionally, node C connects to points E and F, with distances of 600 meters and 1,400 meters, respectively.

Additionally, node C is connected to point G over a distance of 3,300 meters. Elsewhere in the network, node D connects to node E (2,300 meters), while node E connects to node H (2,600 meters). The connection between points F and G has the greatest weight 3,500 meters whereas the link between points G and H covers the shortest distance, with a weight of 280 meters. Meanwhile, node H connects to point I over a distance of 1,700 meters. This edge weight data serves as the basis for a shortest-path analysis to determine the most efficient route within the transportation network under investigation [31-35].

Based on Table 3, the shortest path is A → B → C → E → H → I, with a total distance of 7,750 meters. The A-B-C-E-H-I path was selected because its total distance of 7,750 meters is shorter than that of the A-B-D-E-H-I route, making it the path with the minimum total distance within the analyzed network [36].

3.3. Research Data

Based on the weight data presented in Table 2, the shortest path search was conducted using Dijkstra's algorithm by calculating the cumulative distance from the starting node A to the destination point.

Table 3
Results of Dijkstra's Algorithm Iterations for Determining the Shortest Path

Iteration	Selected Node	Distance and Predecessor Updates
0	A	B = 650 m (A)
1	B	C = 2850 m (B), D = 2750 m (B)
2	D	E = 5.050 m (D)
3	C	E = 3450 m (C), F = 4250 m (C), G = 6150 m (C)
4	E	H = 6050 m (E)
5	F	G = 6150 m (C), H = 6050 m (E)
6	H	I = 7750 m (H)
7	G	There are no updates.
8	I	Goal achievement milestone

Based on Table 3, the Dijkstra algorithm selects the node with the smallest cumulative distance at each iteration, so that the path A→B→C→E→H→I is selected because at each stage, it has the lowest accumulated weight among the available alternatives via node D (the A-B-D-E-H-I path has a cumulative distance of 650 + 2,100 + 2,300 + 2,600 + 1,700 = 9,350 m, which is greater than that of the main path). Other alternative paths also do not yield a shorter total distance. Thus, the A-B-C-E-H-I path represents the route with the minimum total distance 7,750 meters among all the route alternatives modeled in the graph. Consequently, this route can be recommended as the shortest path from CMC Kotabumi to UMKO based on the analyzed road network

data, although determining the most efficient route in practice would still require considering other factors such as traffic density and road conditions that were not primary weights in this modeling [37-38].

4. Conclusion

This study aimed to determine the shortest path from Candimas Medical Center (CMC) Kotabumi to Universitas Muhammadiyah Kotabumi (UMKO) using weighted graph modeling and Dijkstra's algorithm. The analysis reveals that the path with the shortest path is A-B-C-E-H-I, covering a total distance of 7,750 meters; this result was obtained by calculating the accumulated minimum weights at each connected node until the destination node was reached. These findings demonstrate that Dijkstra's algorithm can systematically determine the path with the minimum travel distance within a transportation network modeled as a weighted graph. The study contributes by applying graph theory and shortest-path algorithms to the local road network in Kotabumi, serving as a preliminary reference for the development of navigation systems and graph-based transportation studies in the area. A limitation of this study is that the distance data used as graph weights were collected during a single measurement period and did not account for variations in traffic conditions or travel times as alternative weights. As this study is limited to using distance as the sole weight for determining the shortest path, future research should consider developing multi-attribute weights incorporating distance, travel time, and traffic density based on field-observed traffic conditions and road safety factors to ensure a more comprehensive analysis. Furthermore, since this study employed only one method (Dijkstra's algorithm), subsequent research should compare the results with other algorithms, such as A* or Bellman-Ford, to test for consistency across the same road network.

CRediT authorship contribution statement

Aghnia Nasywa Nur Rendra: Conceptualization, Methodology, Data curation, Formal analysis, Investigation, Writing – original draft. Cintia Marantika: Investigation, Data curation, Writing – review & editing. Rosiyana: Investigation, Data curation, Writing – review & editing. Gigih Aditya: Investigation, Data curation, Writing – review & editing. Darwanto: Supervision, Methodology, Validation, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Acknowledgment

The authors would like to express their gratitude to Universitas Muhammadiyah Kotabumi for providing academic support during the completion of this study. The authors also thank the parties who assisted in the field observation and data collection process.

References

1. D. K. Rahayu and S. Martini, “Peran moda transportasi darat dalam mobilitas tenaga kerja,” *J. Transport.*, vol. 22, no. 2, pp. 109–116, 2022, doi: 10.26593/jtrans.v22i2.6061.109-116.
2. A. B. Simbolon, D. A. Artika, Y. C. Sitanggang, and P. Harliana, “Implementasi algoritma Dijkstra dalam menganalisis rute terpendek dan efisiensi jarak tempuh dari stasiun kereta api Medan menuju 6 kampus di area Medan Estate,” *JATI: J. Mhs. Tek. Inform.*, vol. 9, no. 1, pp. 162–168, 2025, doi: 10.36040/jati.v9i1.12155.
3. I. A. Wulandari and P. Sukmasetya, “Implementasi algoritma Dijkstra untuk menentukan rute terpendek menuju pelayanan kesehatan,” *J. Ilm. Sist. Inf. (JISI)*, vol. 1, no. 1, pp. 30–37, 2022, doi: 10.24127/jisi.v1i1.1953.
4. N. D. Rahmawati, B. Waluya, and I. Kharisudin, “Analyzing mathematical creative thinking processes in higher education: A learning style perspective in graph problem solving,” *Hipotenusa: J. Math. Soc.*, vol. 7, no. 1, pp. 146–160, 2025, doi: 10.18326/hipotenusa.v7i1.4186.
5. H. D. Ariyani, K. Nafillah, K. Nindita, N. Ngatmin, and S. T. Rahayu, “Pemodelan graf berarah berbobot untuk optimasi penentuan rute terpendek antar kampus Polimarin berbasis algoritma Dijkstra,” *Euler: J. Ilm. Mat. Sains Teknol.*, vol. 14, no. 1, pp. 151–162, 2026.
6. W. Pasaribu, C. Purba, Y. S., dan I. Gunawan, “Implementasi algoritma dijkstraa berbasis teori graf untuk penentuan rute terpendek dari STIKOM Tunas Bangsa ke Suzuya Merdeka Mall Kota Pematangsiantar,” *J. Tek. Inform. dan Teknol. Inf.*, vol. 6, no. 1, hal. 214–227, Mar 2026, doi: 10.55606/jutiti.v6i1.7008.
7. T. A. L. Sari, B. A. Sulistyono, and S. Samijo, “Implementation of the RME model using the CTL approach on mathematics learning outcomes,” *Hipotenusa J. Res. Math. Educ. (HJRME)*, vol. 9, no. 2, pp. 157–163, 2026, doi: 10.36269/hjrme.v9i2.4587.
8. V. Antia, I. D. Cahyaningtyas, G. J. Perkasa, J. N. Izzah, and B. Latif, “Penentuan rute terpendek Stasiun Lempuyangan ke UIN Sunan Kalijaga dengan algoritma Dijkstra,” *Polynom: J. Math. Educ.*, vol. 3, no. 2, pp. 56–62, 2023, doi: 10.14421/polynom.2023.32.56-62.
9. J. Purba, S. Manurung, J. Girsang, J. A. Gulo, and S. P. Sipayung, “Implementasi algoritma Dijkstra untuk menentukan rute terpendek dari SMA 17 Medan ke Unika St. Thomas,” *J. Minfo Polgan*, vol. 14, no. 1, pp. 1045–1052, 2025, doi: 10.33395/jmp.v14i1.14963.
10. A. J. Tampubolon, E. Ricardo, D. S. Simbolon, A.

Pasaribu, J. Panggabean, and S. P. Sipayung, "Implementasi algoritma Dijkstra menentukan rute terpendek dari Unika St. Thomas menuju kantor dinas kependudukan Kota Medan," *J. Minfo Polgan*, vol. 14, no. 1, pp. 1274–1286, 2025, doi: 10.33395/jmp.v14i1.14997.

11. N. Nurshifa, D. Desmayanasari, N. Noprisa, and F. Lestari, "Peningkatan kemampuan pemahaman matematis peserta didik menggunakan media video pembelajaran pasca COVID-19," *Hipotenusa J. Res. Math. Educ. (HJRME)*, vol. 5, no. 1, pp. 46–55, 2022, doi: 10.36269/hjrme.v5i1.771.
12. A. P. Wibowo, K. Azmi, Y. Azzahra, Y. Y. Purba, and D. Kartika, "Penerapan algoritma Dijkstra untuk menentukan rute terpendek dari RS Bina Kasih menuju RS Adam Malik," *J. Ilm. Mat.*, vol. 13, no. 1, pp. 157–167, 2025, doi: 10.26740/mathunesa.v13n1.p157-167.
13. S. Nurazizah, M. Azira, M. Z. Rezky, A. Asyifa, dan N. A. Fajriah, "Analysis of students' errors in answering mathematical literacy questions," *Hipotenusa J. Res. Math. Educ.*, vol. 8, no. 2, hal. 120–141, Agu 2025, doi: 10.36269/hjrme.v8i2.3682.
14. S. A. Waruwu, A. H. Rizky, M. Y. Noor, dan P. Harliana, "Optimasi rute terpendek antar Universitas Negeri Medan dan Universitas Muhammadiyah Sumatera Utara menggunakan algoritma dijkstra dan implementasi python," *J. Nas. Komputasi dan Teknol. Inf.*, vol. 7, no. 6, hal. 1606–1612, Des 2024, doi: 10.32672/jnkti.v7i6.8160.
15. R. Aryana and N. S. Sangkala, "Implementation of set theory in developing the definition of graph theory," *Integral: J. Math. Educ. Learn.*, vol. 2, no. 1, pp. 12–16, 2023.
16. J. Irawan, A. M. Yusuf, M. E. Iswanto, and V. Wati, "Penerapan algoritma Dijkstra dalam sistem pencarian lokasi indekos di Indramayu," *Teknokom*, vol. 7, no. 2, pp. 259–265, 2024, doi: 10.31943/teknokom.v7i2.228.
17. N. A. Sari dan I. Fitri, "The influence of project based learning (PJBL) on mathematical communication skills in relation to cognitive styles," *Hipotenusa J. Res. Math. Educ.*, vol. 8, no. 2, hal. 68–83, Agu 2025, doi: 10.36269/hjrme.v8i2.3375.
18. M. Usman, H. Pramudawardani, R. Umam, and H. Takahashi, "Synthesizing a Framework and Establishing Content Validity of an Energy Literacy Instrument for Indonesian Students," Islamic J. Integr. Sci. Educ. (IJISE), vol. 4, no. 3, pp. 175–185, 2025, doi: 10.30762/ijise.v4i3.6993.
19. M. Yasin, S. Huda, F. G. Putra, M. Syazali, R. Umam, and S. Widyawati, "IMPROVE Learning Model and Learning Independence: Influence and Interaction on Mathematics Problem-Solving Abilities in Islamic Boarding School," J. Phys.: Conf. Ser., vol. 1467, no. 1, Art. no. 012003, 2020, doi: 10.1088/1742-6596/1467/1/012003.
20. A. Saregar, F. G. Putra, R. Diani, A. Anugrah, M. Misbah, and R. Umam, "Innovative Integrated Disaster Education in Physics Learning: An Effort to Enhance Students' Disaster Literacy Skills," J. Pendidik. IPA Indones., vol. 14, no. 2, Art. no. 23959, 2025, doi: 10.15294/jpii.v14i2.23959.
21. F. G. Putra, D. Lengkana, S. Sutiarso, Nurhanurawati, A. Saregar, R. Diani, S. Widyawati, S. Suparman, K. Imama, and R. Umam, "Mathematical Representation: A Bibliometric Mapping of the Research Literature (2013–2022)," Infinity J., vol. 13, no. 1, pp. 1–26, 2024, doi: 10.22460/infinity.v13i1.p1-26.
22. M. Munifah, I. Tsani, M. Yasin, H. S. Tortop, E. K. Palupi, and R. Umam, "Management System of Education: Conceptual Similarity (Integration) Between Japanese Learning System and Islamic Learning System in Indonesia," Tadris: J. Keguruan dan Ilmu Tarbiyah, vol. 4, no. 2, pp. 159–170, 2019, doi: 10.24042/tadris.v4i2.4893.
23. N. Nurulsari, Abdurrahman, H. Maulina, I. Sukamto, and R. Umam, "Exploring the Prospective of Pre-Service Physics Teacher's Pedagogical Content Knowledge: A Case Study," J. Phys.: Conf. Ser., vol. 1467, no. 1, Art. no. 012023, 2020, doi: 10.1088/1742-6596/1467/1/012023.
24. F. Lestari, Dalman, Noprisa, D. Efendi, I. Ariyanti, B. Anggara, and R. Umam, "The Effectiveness of Math Learning Based on Multiple Intelligence: Implications at MTs Darul Ma'wa," AIP Conf. Proc., vol. 2438, no. 1, Art. no. 020001, 2021, doi: 10.1063/5.0071296.
25. I. P. Hardini, A. Saregar, Subandi, A. Anugrah, M. R. Fitri, V. R. Panse, R. Umam, and S. Huda, "Development of Electronic Student Worksheet on Disaster-Based Waves for Eleventh-Grade Senior High School Students," AIP Conf. Proc., vol. 3226, no. 1, Art. no. 020023, 2026, doi: 10.1063/5.0329108.
26. S. Huda, L. Anggraini, R. D. Saputri, M. Syazali, and R. Umam, "Learning Model to Improve the Ability to Understand Mathematical Concepts," PRISMA, vol. 8, no. 2, pp. 173–181, 2019.
27. S. Huda, M. Munifah, and R. Umam, "Think Talk Write (TTW) Learning Model on Thinking Skills, Creativity, and Problem Solving," J. Gifted Educ. Creativity, vol. 7, no. 1, pp. 25–32, 2020.
28. S. Huda, M. Munifah, M. Syazali, S. S. Rahayu, and R. Umam, "The Effectiveness of Two Stay Two Stray, Somatic, Auditory, Visualization, Intellectually, and Auditory Learning to Improving Numerical Ability," Humanit. Soc. Sci. Rev., vol. 8, no. 4, pp. 431–441, 2020, doi: 10.18510/hssr.2020.8442.
29. S. Huda, M. U. Ridwanulloh, U. Karomah, R. E. Febrian, E. Kurniasari, U. F. Laili, and R. Umam, "Effectiveness of Physics Exams Using Smartphone-Based Test System in Senior High School of MAN 1 Kediri City, Indonesia," AIP Conf. Proc., vol. 3226, no. 1, Art. no. 020059, 2026, doi: 10.1063/5.0333689.
30. P. S. Bumi, R. Umam, and A. Saregar, "Optimization of Physics Learning on Uniform Linear Motion (GLB) and Uniformly Accelerated Linear Motion (GLBB) Through Interactive Virtual Practicum Simulation Based on PhET," Islamic J. Integr. Sci. Educ. (IJISE), vol. 4, no. 2, pp. 107–117, 2025, doi:

10.30762/ijise.v4i2.5850.

31. S. Huda, Suherman, Komarudin, M. Syazali, and R. Umam, “The Effectiveness of Al-Qurun Teaching Model (ATM) Viewed from Gender Differences: The Impact on Mathematical Problem-Solving Ability,” J. Phys.: Conf. Ser., vol. 1467, no. 1, Art. no. 012001, 2020, doi: 10.1088/1742-6596/1467/1/012001.
32. N. A. Jafaruddin, N. Andini, I. Lestari, M. Pratidina, R. Sahrani, Ramlawati, and R. Umam, “Narrative Review: Teaching Preservatives Using Problem-Based Learning (PBL) in Chemistry Education,” Islamic J. Integr. Sci. Educ. (IJISE), vol. 5, no. 2, pp. 111–128, 2026, doi: 10.30762/ijise.v5i2.8586.
33. A. Abdurrahman, N. Nurulsari, H. Maulina, B. Rahman, R. Umam, and K. Jermsittiparsert, “Multi-level Scaffolding: A Novel Approach of Physics Teacher Development Program for Promoting Content Knowledge Mastery,” Int. J. Innov. Creat. Change, vol. 7, no. 8, pp. 71–89, 2019.
34. R. Prastowo, S. Huda, R. Umam, K. Jermsittiparsert, A. E. Prasetiyo, H. S. Tortop, and M. Syazali, “Academic Achievement and Conceptual Understanding of Electrodynamics: Applications Geoelectric Using Cooperative Learning Model,” J. Ilm. Pendidik. Fis. Al-Biruni, vol. 8, no. 2, pp. 165–175, 2019, doi: 10.24042/jipfalbiruni.v0i0.4614.
35. A. Saregar, Sunyono, E. Y. Haenilah, H. Hariri, F. G. Putra, R. Diani, Misbah, and R. Umam, “Natural Disaster Education in School: A Bibliometric Analysis with a Detailed Future Insight Overview,” Int. J. Educ. Methodol., vol. 8, no. 4, pp. 743–757, 2022, doi: 10.12973/ijem.8.4.743.
36. M. U. Ridwanulloh, S. Huda, and R. Umam, “Innovative Leadership Management: The Pattern of School Quality Development at SMP Muhammadiyah 2 Inovasi Malang,” Progresiva: J. Pemikiran dan Pendidikan Islam, vol. 11, no. 1, pp. 25–42, 2022, doi: 10.22219/progresiva.v11i01.20742.
37. R. Diani, “Search, Solve, Create, and Share (SSCS) Learning Model: The Impact on the Students’ Creative Problem-Solving Ability on the Concept of Substance Pressure,” J. Penelit. Fis. Apl. (JPFA), vol. 9, no. 1, pp. 65–77, 2019, doi: 10.26740/jpfa.v9n1.p65-77.
38. Munifah, A. N. Romadhona, I. Ridhona, R. Ramadhani, R. Umam, and H. S. Tortop, “How to Manage Numerical Abilities in Algebra Material?,” Al-Jabar: J. Pendidik. Mat., vol. 10, no. 2, pp. 223–232, 2019, doi: 10.24042/ajpm.v10i2.5325.