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APPLICATION OF GRAPH COLORING USING WILCH-POWELL IN SCHEDULING LECTURES AT DHARMAS UNIVERSITY INDONESIA

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ABSTRACT
Node coloring in graph theory can be used in course scheduling. The urgent problem in this research is the frequent scheduling conflicts between one lecturer and different courses simultaneously, especially at Faculty of Teacher training and Education, Dharmas Indonesia University. This research aims to determine the appropriate course scheduling to avoid conflicts between lecturers and various courses. In determining the course schedule, the researcher applies the Wilch-Powell algorithm. The method used is deductive axiomatic, derived from existing theorems, and then node coloring is applied to the graph representation of Faculty of Teacher training and Education, Dharmas University Indonesia's course scheduling. Based on the research, a teaching matrix for Faculty of Teacher training and Education, Dharmas University Indonesia lecturers for the even semester of the 2024/2025 academic year was obtained with five different colors. The five colors represent the scheduling of 19 courses for the mathematics program, 17 courses for the early childhood education program and English education program, each with five different colors without any conflicts, requiring four classrooms.

Keywords : Graf, Algoritma Welch-Powel, Course Scheduling, Faculty of Teacher training and Education, Dharmas Indonesia University.

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PRELIMINARY

Dharmas Indonesia University (UNDHARI) is a private educational institution located in Dharmasraya Regency, West Sumatra Province. One of the four faculties at UNDHARI is the Faculty of Teacher Training and Education (FKIP). Based on observations and interviews with the management of POP, there is a common issue where lecturers frequently experience scheduling conflicts with other courses in the same class. After determining the issue, it was discovered that certain professors taught in other faculties, class availability was restricted, and course scheduling was still done by hand. The researcher recognized the importance of the study based on the problem identification, which was that the manual scheduling system resulted in conflicts between lecturers and courses on the same day and time. The primary issue is that manual scheduling is still used, leading to frequent

conflicts between lecturers, courses, and classes. The manual scheduling process requires a high level of accuracy to ensure that there are no overlapping elements in the schedule (Bustan & Salim 2019). The researcher offers a concrete solution to this problem by applying node coloring on graphs with the help of the Welch-Powell algorithm. Since there is no set timetable for each FKIP lecturer delivering the same course in multiple sessions at the same time, this study aims to address this issue. The researcher uses graph language to link the lecturers and the courses in order to maintain the focus of the study.

Graph is a subject studied in graph theory (Wicaksono,P.S & Kartono 2020). One branch of mathematics is graph theory. A graph is a diagram that contains certain information if interpreted correctly (Supiyandi and Eka 2018). The discussion of this branch of knowledge receives considerable attention due to its wide applications and its relevance to everyday life (Andrari, Maimunah, & Qadarsih, 2023). One technique in graph theory is graph coloring, which involves coloring a map, whether with minimum or maximum colors (Qomaruddin, Bismi, & Hariyanto 2022). There are three types of cases in coloring, namely node coloring, edge coloring, and region coloring (Cipta, Widyasari, and Batubara 2023). Node coloring is the assignment of colors to the nodes in a graph so that each pair of neighboring nodes has a different color (Aryanto and Siahaan 2022). The benefit of giving color is to help someone recognize several directly adjacent nodes (Surbakti and Ramadhani 2022). The definition of a graph is a pair of sets $G\ (u,v,\Psi)$ with $V(G)$ being a non-empty set of points, $E(G)$ being the set of edges connecting points in G, and an incidence function $\Psi(G)$ that associates each edge in G with a pair of points in G (Darmajid 2011). One mathematician named Leonhard Euler solved the problem of the bridges of Konigsberg located in the city of Kaliningrad, Germany. The problem of the bridges of Konigsberg is whether it is possible for someone to cross each bridge exactly once and return to the starting point (Sulistiani, Ais, and Fanani 2022). Euler modeled the land as points and the bridges as edges (Asmara, ., and . 2018).

The research question in this study is how the Wilch-Powell algorithm can assist in creating a class schedule where each lecturer does not have the same schedule with different classes. The Welch-Powell algorithm is an algorithm used to color a graph G effectively, and it does not always provide the minimum number of colors for a graph. However, the advantage of this algorithm is its simpler and easier use (Lestari and Mulyono 2020). The update of this research compared to previous studies is that this research schedules classes for several study programs, whereas previous research only focused on one study program (Rohmawati and Fathoni 2022). The purpose of this research is to determine the scheduling

of classes in the Faculty of Teacher Training and Education at Dharmas University Indonesia study program using the Wilch-Powell algorithm to achieve a minimal number of classes.

METHODS

This research uses the deductive axiom method. The working method of this approach is by deriving existing theorems, which are then applied in coloring nodes and represented in the form of graphs (Mahmudah, Qomariah, and Al'ayyubi 2024). The shape of the graph determines the lecturer's class schedule. The literature study of this research involves examining books, journals, or papers related to the research topic (Sugiyono 2014). By organizing courses in the form of a matrix, where the courses are represented as nodes, and neighboring nodes represent classes taught by the same lecturer (Utami, DS, and Intan 2020). Once the graph is formed, the Wilch-Powell algorithm will be used to color the graph with a minimum number of colors, and then the results of this implementation will be used as a reference in scheduling (Anggraini, Resti, and Ilmiyah 2024).

The variables involved were identified: courses, students, roles, lecturers, and the time that will be used for scheduling (Rohmawati and Fathoni 2022). The stages include:

1) Literature Study

   This literature study is conducted to identify problems by searching national literature, books, and articles on timetable arrangements, Wilch-Powell Algorithm, and graph coloring.

2) Data Collection

   The data collection stage includes the distribution of data on courses taught by lecturers of the Faculty of Teacher Training and Education for the even semester of the 2024/2025 academic year at Dharmas Indonesia University. The list of course lecturers and their teaching availability is the source of this research data, which includes information about the lecturers, courses, and the number of credits.

3) Data Processing

   After the data is collected, the data processing stage occurs. In this stage, the data is transformed into a matrix and then represented in graph form. A course matrix is required to apply the Wilch-Powell algorithm.

4) Implementation of the Result

   At this stage, the researchers create an implementation that is easy for readers to understand. The implementation in this research is the Wilch-Powell algorithm used to simulate the course scheduling program. The results of using this algorithm are used

as a basis for determining the combination of lecturers and courses to be taught. Based on the combinations of lecturers and courses obtained, the schedule for assigning classes to lecturers and the courses they teach will be created.

5) Test

After the implementation is completed, the scheduling system will be tested to ensure that the implementation results are correct. If there are errors, analysis and corrections will be made.

6) Conclusion and Suggestions

At this stage, analysis and recommendations are made based on the results of this research. At this stage, analysis and recommendations are made regarding the results of this research. The Wilch-Powell algorithm is one of the algorithms that can be used to color graphs through vertex coloring (Budi 2024). The steps of the Wilch-Powell algorithm are:

1) Arrange all nodes in order of degree, from largest to smallest.
2) Use the first color, for example, red, to color the first node, which has the highest degree. Then, any node adjacent to the first node will be given the same color, also red.
3) Continue with the second color and so on until all nodes are colored.

The Wilch-Powell algorithm is very suitable for application in course scheduling (Amanda Iza Sofiani et al. 2025). Its application is very easy to implement by all circles, both educational institutions and other government institutions (Rachmawati, Amijaya, and A'yun 2024). The diagram of node coloring using the Wilch-Powell algorithm can be seen in Figure 1:

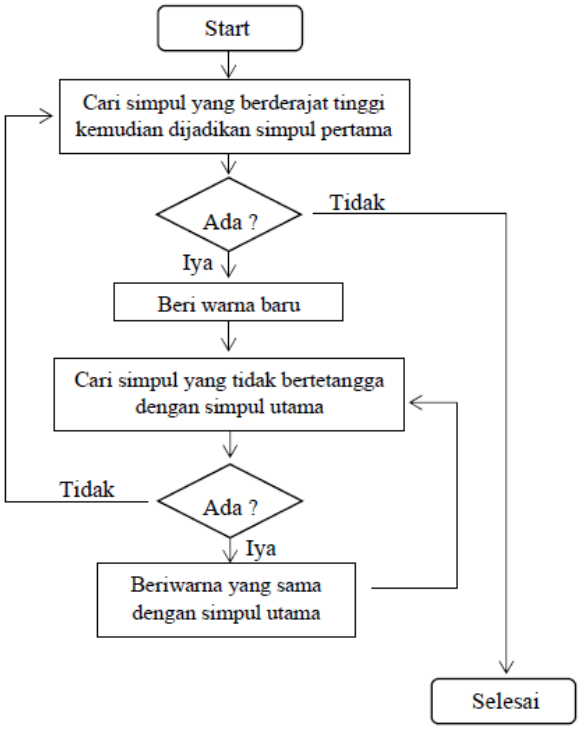

Figure 1. Flowchart of the *Wilch-Powell* Algorithm

RESULT AND DISCUSSION

Scheduling of lectures for the Faculty of Teacher Training and Education (FKIP) of Dharmas Indonesia University (UNDHARI) for the even semester of the 2024/2025 academic year is arranged based on meetings with the program heads and lecturers. Only three study programs mathematics education, early childhood education, and English language education were included in this investigation. Each lecturer is assigned a teaching load of 12 credits (SKS) for each semester, and if it exceeds the SKS load, it will be considered excess work. A maximum of two courses per day or six credit hours are allotted to each lecturer. In this study, the Welsh-Powell technique is used to apply vertex coloring to graphs.

Due to the limited usage of color coding, the Wilch-Powell method has the advantage of minimizing schedule conflicts for study programs with one class per cohort. A scheduling conflict is guaranteed to arise if one node is connected to an adjacent node of the same color. Neighboring nodes must be given distinct colors if you don't want the schedules to clash. The Wilch Powell algorithm's disadvantage is that it will not work well for study programs with a lot of classes each cohort because of the intensive use of color, which necessitates a lot of classes.

Each study program had multiple classrooms available for use in lectures outside of the lab classrooms, according to the report. Unfortunately, there was only one classroom available for the study programs. In order to accommodate three study programs that might be used alternately for a week, the researcher erected a classroom. In clarifying the relationship between courses and the lecturers in charge, the researchers illustrate it in the form of a matrix graph. Where a value of 1 indicates that the lecturer is teaching the intended course. Conversely, a value of 0 indicates that the lecturer is not teaching the intended course (Rohmawati and Fathoni 2022). To clarify further, the researchers divided the scheduling in each program.

1. Mathematics Education Program

The mathematics education program has 19 courses spread across the second, fourth, and sixth semesters. The distribution and the instructors of the courses are presented in Table 1.

Table 1. Implementation of Mathematics Education Course with Lecturer

No	Course Code	Course Name	Credits	Lecturer				
				AEH	SRP	DNA	R	EF
1	MAT401	Algebraic Structure	3	1	0	0	0	0
2	MAT402	Multivariable Calculus	3	0	0	1	0	0
3	MAT403	Ordinary Differential Equations	3	0	1	0	0	0
4	MAT404	Real Analysis	3	0	0	1	0	0
5	MAT405	Psychology of Mathematical Learning	2	0	0	0	0	1
6	MAT406	Mathematics Learning Media	2	0	1	0	0	0
7	MAT407	Mathematical Statistics	3	1	0	0	0	0
8	MAT409	Selected Topics in Basic Mathematics	2	0	0	0	0	1
9	MAT601	Discrete Mathematics	3	0	0	1	0	0
10	MAT602	Curriculum Review and Lesson Plan Design	3	0	0	0	1	0
11	MAT603	Selected Topics in Secondary Education	3	0	0	0	0	1
12	MAT604	Data Processing*	3	0	1	0	0	0
13	MAT607	Geometry System*	3	0	1	0	0	0
14	MAT608	Mathematical Modeling*	3	1	0	0	0	0
15	MAT608	Graph Theory	3	0	0	1	0	0
16	MAT613	Financial Mathematics*	3	0	0	0	0	1
17	PMAT1201	Elementary Linear Algebra	3	0	1	0	0	0
18	PMAT1202	Mathematics Learning Strategy	3	0	0	0	1	0
19	PMAT1203	Integral Calculus	3	0	0	0	0	1

Based on Table 1, each lecturer teaches courses that have been determined by the program head based on program meetings. The available rooms for the mathematics education program are two rooms, namely room *B2.5* and room *A1.7.* According to the classes and courses available, class distribution is applied to each combination of lecturers and subjects as shown in Table 2.

Tabel 2. Matrik mata kuliah prodi pendidikan matematika

Simpul x	***V 1***	***V 2***	***V 3***	***V 4***	***V 5***	***V 6***	***V 7***	***V 8***	***V 9***	***V 10***	***V 11***	***V 12***	***V 13***	***V 14***	***V 15***	***V 16***	***V 17***	***V 18***	***V 19***
V_1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0
V_2	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
V_3	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0
V_4	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
V_5	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1
V_6	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0
V_7	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
V_8	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	1
V_9	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
V_{10}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
V_{11}	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0
V_{12}	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0
V_{13}	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0
$V1_4$	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V_{15}	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
V_{16}	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	1
V_{17}	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0
V_{18}	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
V_{19}	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0

Based on Table 2, the highest degree obtained is four and the lowest degree is one. For those with the highest degree of four, it is connected with the node. $(V_3,V_5,V_6,V_8,V_{12},V_{13},V_{16},V_{17},V_{19})$, degree three connected with nodes $(V_2,V_4,V_9,V_{11},V_{15})$, degree 2 connected to the node (V_1,V_7,V_{14}), degree 1 connected to the node (V_{10},V_{18}). After performing node coloring using the Welch-Powell algorithm, five different colors were obtained. The colors for node coloring are red, yellow, green, purple, and blue. From these five colors, it can be interpreted that the lecture schedule for the Mathematics Education Study Program for the academic year 2024/2025 has 5 days in a week, which are Tuesday to Saturday, starting from semesters 2, 4, and 6. The graph coloring can be seen in Figure 2.

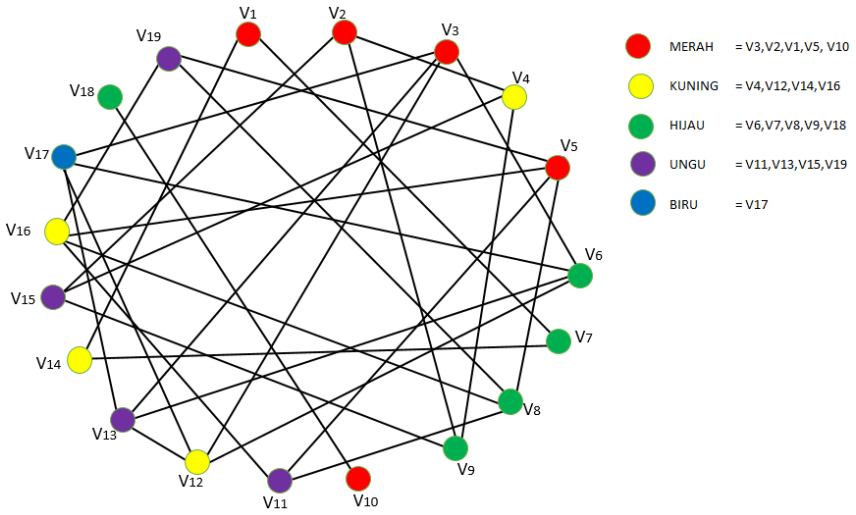

Figure 2. Graph of mathematics education courses

Based on the results of the graph of mathematics education courses, the grouping of courses, the teaching lecturers, and the classrooms created by the researcher are presented in Table 3.

Table 3. Course Schedule for the Mathematics Education Study Program

No	Course Code	Course Name	Credits	Lecturer Name	Day	B2.5	A1.7
1	MAT401	Algebraic Structure	3	Antik Estika Hader, M.Si	Tuesday	08.00 - 10.30	
2	MAT402	Multivariable Calculus	3	Dwi Novri Asmara, M.Si	Tuesday		10.30 - 12.10
3	MAT403	Ordinary Differential Equations	3	Suci Rahma Putri, M.Pd	Tuesday	10.30 - 12.10	
4	MAT404	Real Analysis	3	Dwi Novri Asmara, M.Si	Wednesday	08.00 - 10.30	
5	MAT405	Psychology of Mathematical Learning	2	Eka Filahanasari, M.Pd	Tuesday		13.00 - 15.00
6	MAT406	Mathematics Learning Media	2	Suci Rahma Putri, M.Pd	Thursday	08.00 - 09.40	
7	MAT407	Mathematical Statistics	3	Antik Estika Hader, M.Si	Thursday		13.00 - 15.00
8	MAT409	Selected Topics in Basic Mathematics	2	Eka Filahanasari, M.Pd	Thursday	10.30 - 11.30	
9	MAT601	Discrete Mathematics	3	Dwi Novri Asmara, M.Si	Thursday		10.30 - 12.10

10	MAT602	Curriculum Review and Lesson Plan Design	3	Ratnawati, M.Pd	Tuesday	13.00 - 15.00	
11	MAT603	Selected Topics in Secondary Education	3	Eka Filahanasari, M.Pd	Friday	10.30 - 12.10	
12	MAT604	Data Processing*	3	Suci Rahma Putri, M.Pd	Wednesday		10.30 - 12.10
13	MAT607	Geometry System*	3	Suci Rahma Putri, M.Pd	Friday		13.30 - 15.30
14	MAT608	Mathematical Modeling*	3	Antik Estika Hader, M.Si	Wednesday	08.00 - 10.30	
15	MAT608	Graph Theory	3	Dwi Novri Asmara, M.Si	Friday	08.00 - 10.31	
16	MAT613	Financial Mathematics*	3	Eka Filahanasari, M.Pd	Wednesday		13.00 - 15.00
17	MAT201	Elementary Linear Algebra	3	Suci Rahma Putri, M.Pd	Saturday	08.00 - 10.31	
18	MAT202	Mathematics Learning Strategy	3	Ratnawati, M.Pd	Thursday	13.00 - 15.00	
19	MAT203	Integral Calculus	3	Eka Filahanasari, M.Pd	Friday		13.30 - 15.30

2. Early Childhood Education Study Program

The Early Childhood Education Study Program has 17 courses in the second, fourth, and sixth semesters. The distribution and instructors of the research courses are presented in Table 4.

Table 4. Teaching Presentation of Early Childhood Education Study Lecturers

No	Course Code	Course	Credit	Lecturer						
				NS	DK	SYN	AS	DNA	AN	FS
1	AUD201	AUD Religious Morality	3	1	0	0	0	0	0	0
2	AUD202	Learning Planning	3	1	0	0	0	0	0	0
3	AUD203	AUD Science	3	0	1	0	0	0	0	0
4	AUD204	AUD Mathematics	3	0	1	0	0	0	0	0
5	AUD401	Development of AUD Creativity	3	0	1	0	0	0	0	0
6	AUD402	Social Development AUD	3	1	0	0	0	0	0	0

7	AUD406	Assessment	3	0	0	1	0	0	0	0
8	AUD407	Health and Nutrition	3	1	0	0	0	0	0	0
9	AUD408	Learning Media AUD	3	0	0	0	1	0	0	0
10	AUD601	Selected Topics in Early Childhood Education	3	0	1	0	0	0	0	0
11	AUD601	Statistics	3	0	0	0	0	1	0	0
12	AUD602	Educational Supervision AUD	2	0	0	0	0	0	1	0
13	AUD603	Problem AUD	2	0	0	0	1	0	0	0
14	AUD604	Education Seminar	2	0	0	1	0	0	0	0
15	AUD605	Parenting	3	0	0	0	0	0	0	1
16	AUD607	Education for Children with Special Needs	2	0	0	0	1	0	0	0
17	AUD608	Protection and Empowerment of Children's Rights	2	0	0	0	1	0	0	0

Based on Table 4, each lecturer teaches the subjects determined by the program chair based on the program meeting. The Early Childhood Education program has two available rooms: room *B2.4* and room *A1.7*. The division of classes is applied to each combination of lecturers and subjects according to the classes and subjects available.

Table 5. Course Matrix with Early Childhood Education Lecturers

Simpul x	***V 1***	***V 2***	***V 3***	***V 4***	***V 5***	***V 6***	***V 7***	***V 8***	***V 9***	***V 10***	***V 11***	***V 12***	***V 13***	***V 14***	***V 15***	***V 16***	***V 17***
V_1	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
V_2	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
V_3	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0
V_4	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0
V_5	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0
V_6	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
V_7	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
V_8	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
V_9	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1
V_{10}	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
V_{11}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V_{12}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V_{13}	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1
V_{14}	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
V_{15}	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V_{16}	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
V_{17}	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0

Based on Table 5, the highest degree obtained is three, and the lowest degree is 0. For the nodes with the highest degree of 3, they contain nodes $(V_1, V_2, V_3, V_4, V_5, V_6, V_8, V_9, V_{10}, V_{13}, V_{17})$, degree 2 contains nodes (V_{16}), degree 1 contains nodes (V_7, V_{14}), and degree 0 contains nodes (V_{11}, V_{12}, V_{15}). After performing node coloring using the Welch-Powell algorithm, five different colors were obtained. The colors used for the node coloring are red, yellow, green, purple, and blue. From these five colors, it can be interpreted that the class schedule for the Early Childhood Education program for the 2024/2025 academic year consists of five days a week, namely Tuesday to Saturday, starting from semesters 2, 4, and 6. The graph coloring can be seen in Figure 3 below.

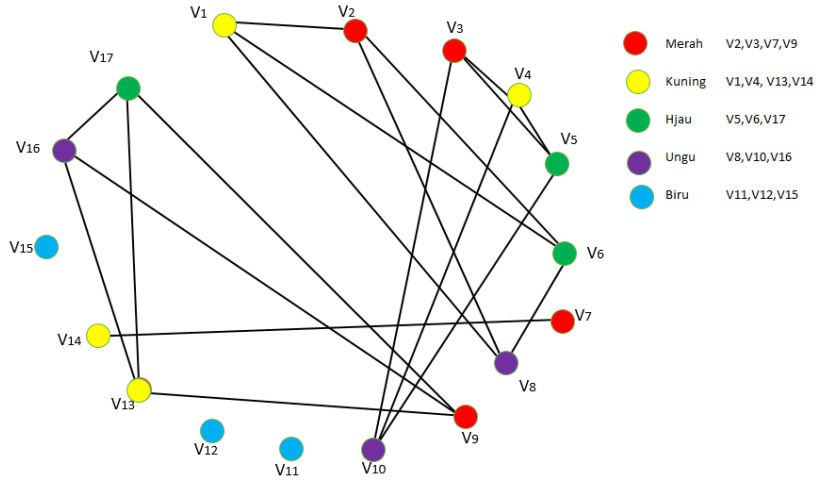

Figure 3. Scheduling Chart for Early Childhood Education Program

The results of the node coloring in the grouping of courses, the teaching lecturers, and the classrooms created by the researcher are shown in Table 6 below:

Table 6. Course schedule for the Early Childhood Education program

No	Course Code	Course Name	Credits	Lecturer Name	Day	B2,4	A1.7
1	AUD201	Religious Morality AUD	3	Nanik Setiawati, M.Pd	Wednesday	08.00 - 10.30	
2	AUD202	Learning Planning	3	Nanik Setiawati, M.Pd	Tuesday	08.00 - 10.30	
3	AUD203	ScienceAUD	3	Desi Karmila, M.Pd	Tuesday	10.30 - 12.10	
4	AUD204	Mathematics AUD	3	Desi Karmila, M.Pd	Wednesday	10.30 - 12.10	
5	AUD401	Creative Development AUD	3	Desi Karmila, M.Pd	Thursday	08.00 - 10.30	

6	AUD402	Social Development AUD	3	Nanik Setiawati, M.Pd	Thursday	10.30 - 12.10	
7	AUD406	Assessment	3	Sri Yunimar Ningsih, M.Pd	Tuesday	13.00 - 15.00	
8	AUD407	Health and Nutrition	3	Nanik Setiawati, M.Pd	Friday	08.00 - 10.30	
9	AUD408	Learning Media AUD	3	Agus Saputra, M.Pd	Tuesday		08.00 - 10.30
10	AUD601	Selected Topics in Early Childhood Education	3	Desi Karmila, M.Pd	Friday	10.30 - 12.10	
11	AUD601	Statistics	3	Dwi Novri Asmara, M.Si	Saturday	08.00 - 10.30	
12	AUD602	Educational Supervision AUD	2	Ana Novitasari, M.Pd	Saturday	10.30 - 12.10	
13	AUD603	Problem AUD	2	Agus Saputra, M.Pd	Wednesday	13.00 - 15.00	
14	AUD604	Education Seminar	2	Sri Yunimar Ningsih, M.Pd	Wednesday		08.00 - 10.30
15	AUD605	Parenting	3	Fitria Sari, M.Pd	Saturday	13.00 - 15.00	
16	AUD607	Education for Children with Special Needs	2	Agus Saputra, M.Pd	Friday	13.00 - 15.00	
17	AUD608	Protection and Empowerment of Children's Rights	2	Agus Saputra, M.Pd	Thursday	13.00 - 15.00	

3. English Language Education Program

English language education program has 17 courses spread across the second, fourth, and sixth semesters. The distribution and instructors of the research courses are displayed in Table 7.

Table 7. Teaching Assignment of English Language Education Lecturers

No	Code Course	Course Name	Credits	Lecturer					
				RS	DWN	RH	MNK	N	ZL
1	ING206	Introduction To Linguistic	2	0	1	0	0	0	0
2	ING401	Listening For Academic Purposes	3	0	0	0	0	0	1
3	ING402	Public Speaking	2	0	0	0	0	1	0
4	ING403	Extensive Reading	3	0	1	0	0	0	0
5	ING404	Academic Writing	3	0	0	1	0	0	0
6	ING405	Introduction To Literature	2	0	0	0	0	0	1
7	ING406	Morphology And Syntax	2	0	0	0	1	0	0
8	ING407	Entrepreneurship*	2	0	0	1	0	0	0
9	ING408	Computer Assisted Language Learning (Call)	2	0	0	0	0	1	0
10	ING409	Translation And Interpretation	2	0	0	0	1	0	0
11	ING602	Language Acquisition	2	0	0	0	0	0	1
12	ING603	Research In Language Teaching	3	0	0	0	0	1	0
13	ING604	Teaching English For Young Learners	2	1	0	0	0	0	0
14	ING605	Instructional Material Development	2	1	0	0	0	0	0
15	ING606	Sociolinguistic	2		0	0	1	0	0
16	ING607	Topic In Tesol	2	0	1	0	0	0	0
17	ING607	Spoken English Activities	2	1	0	0	0	0	0

Based on Table 7, each lecturer teaches the subjects determined by the program head based on the program meeting. The available rooms for the English education program are two rooms, namely room *C1.5* and room *A1.7*. According to the classes and subjects available, the class distribution is applied to each combination of lecturers and subjects.

Table 8. Course Matrix with English Education Lecturers

Simpul x	*V 1*	*V 2*	*V 3*	*V 4*	*V 5*	*V 6*	*V 7*	*V 8*	*V 9*	*V 10*	*V 11*	*V 12*	*V 13*	*V 14*	*V 15*	*V 16*	*V 17*
V_1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
V_2	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
V_3	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
V_4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
V_5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
V_6	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
V_7	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0
V_8	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
V_9	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
V_{10}	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
V_{11}	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
V_{12}	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
V_{13}	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
V_{14}	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
V_{15}	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
V_{16}	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
V_{17}	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0

Based on Table 8, the highest degree obtained is two, and the lowest degree is one. For nodes with a degree of 2, the connected nodes $(V_1, V_2, V_3, V_4, V_6, V_7, V_9, V_{10}, V_{11}, V_{12}, V_{13}, V_{14}, V_{15}, V_{16}, V_{17})$, and degree 1 of connected nodes (V_5, V_8). After coloring the nodes using the Wilch-Powell algorithm, five different colors were obtained. The colors of the node coloring are red, yellow, green, purple, and blue. From these five colors, it can be interpreted that the schedule for the English study program for the 2024/2025 academic year has 5 days in one week, from Tuesday to Saturday, starting from semester 2, 4, and 6. The graph coloring can be seen in Figure 4 below.

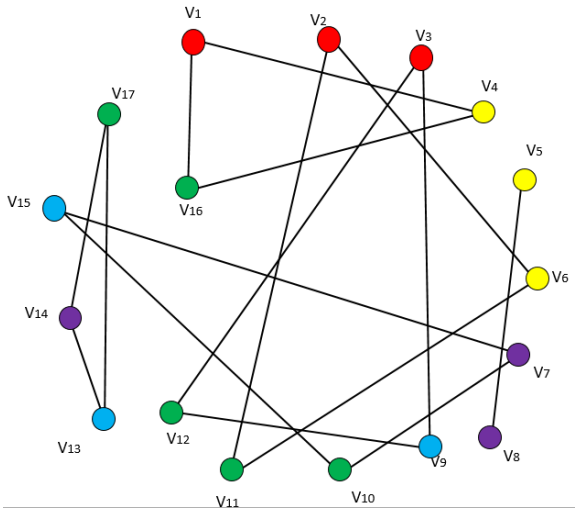

Figure 4. Schedule Chart for the English Education Study Program

The results of the node coloring in the grouping of courses, the teaching lecturers, and the classrooms created by the researcher in Table 9 below:

Table 9. Schedule of Lectures for the English Language Education Program

No	Course Code	Course Name	Credits	Lecturer	Day	C1.5	A1.7
1	ING206	Introduction To Linguistic	2	Dodi Widia Nanda, M.TESOL	Tuesday	08.00 - 09.20	
2	ING401	Listening For Academic Purposes	3	Zumrotun Lutfiah, M.A	Tuesday	10.30 - 12.10	
3	ING402	Public Speaking	2	Norasiah, S.S.,M.Pd	Tuesday	13.00 - 14.20	
4	ING403	Extensive Reading	3	Dodi Widia Nanda, M.TESOL	Wednesday	08.00 - 10.30	
5	ING404	Academic Writing	3	Rauldatul Husni, M.Pd	Wednesday	10.30 - 12.10	
6	ING405	Introduction To Literature	2	Zumrotun Lutfiah, M.A	Wednesday	13.00 - 14.20	
7	ING406	Morphology And Syntax	2	Martiya Nurni Khairita, M.Hum	Friday	08.00 - 09.20	
8	ING407	Entrepreneurship *	2	Rauldatul Husni, M.Pd	Friday	10.30 - 11.20	
9	ING408	Computer Assisted Language Learning (Call)	2	Norasiah, S.S.,M.Pd	Saturday	08.00 - 09.20	
10	ING409	Translation And Interpretation	2	Martiya Nurni Khairita, M.Hum	Thursday	08.00 - 09.20	
11	ING602	Language Acquisition	2	Zumrotun Lutfiah, M.A	Thursday	10.30 - 11.20	
12	ING603	Research In Language Teaching	3	Norasiah, S.S.,M.Pd	Thursday	13.00 - 15.00	

13	ING604	Teaching English For Young Learners	2	Riyadi Saputra, M.Pd	Saturday	10.30 - 11.20	
14	ING605	Instructional Material Development	2	Riyadi Saputra, M.Pd	Friday	13.00 - 14.20	
15	ING606	Sociolinguistic	2	Martiya Nurni Khairita, M.Hum	Saturday	13.00 - 14.20	
16	ING607	Topic In Tesol	2	Dodi Widia Nanda, M.TESOL	Thursday		08.00-09.20
17	ING607	Spoken English Activities	2	Riyadi Saputra, M.Pd	Thursday		10.30-11.20

The English Language Education Study Program, Early Childhood Education Study Program, and Mathematics Education Study Program all required at least two lecture classes per week, according to the findings of the scheduling analysis. When it comes to scheduling, the Wilch-Powell algorithm is far more efficient than human scheduling. It is evident that there are five coloring pages for these three programs. Each color can be utilized for courses for a whole day because UNDHARI's Faculty of Teacher Training and Education (FKIP) operates on a five-day work week (Tuesday, Wednesday, Thursday, Friday, and Saturday). If there were more than five colors available, this would be different. This will have an impact on how many classes each major requires. More classes will be required the more discoloration there is.

CONCLUSION

Based on the research results, supported by detailed discussion, an effective lecture schedule was obtained for the Mathematics Education Study Program, the Early Childhood Education Study Program, and the English Language Education Study Program at the Faculty of Teacher Training and Education (FKIP) of UNDHARI. The research objective was to obtain an effective lecturer schedule with a small number of classes. In this study, scheduling was developed using the Wilch-Powell algorithm by connecting lecturers with courses (Graph). The initial concept in the Wilch-Powell algorithm involved forming courses into a matrix between lecturers and courses. Based on the compiled matrix, five different colors were obtained for the Mathematics Education Study Program, Early Childhood Education Study Program, and English Language Education Study Program, with a total of 4 classes needed (A1.7, B2.4, B2.5, C1.5). Based on research with five colors (red, yellow, green, purple, and blue), it has been confirmed that nodes with different colors are not adjacent. If there are adjacent nodes with the same color, they must be placed in different

classes. Because one classroom can only be used for three lecture groups per day. The five colors represent the courses for each study program, ensuring no class schedules overlap. As for the shortcomings of this research, they are for program lecturers who teach in other faculties and teach general courses that cannot yet be determined using the Wilch-Powell algorithm. The concrete solution to this problem is to first complete the schedule in their respective faculties, and only then determine the schedule for general courses and courses outside the faculty.

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