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APPLICATION OF ASSIGNMENT PROBLEM IN POSTGRADUATE COURSE ALLOCATION AT IGNATIUS AJURU UNIVERSITY OF EDUCATION

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Abstract
This study investigated the application of assignment problems in postgraduate course allocation among lecturers in the Mathematics/Statistics Department, Ignatius Ajuru University of Education (IAUE). The objectives of this study were to identify the criteria to use to ensure equity and effectiveness in postgraduate course assignment among lecturers in the Mathematics/Statistics Department through review, to determine the lecturers' effectiveness levels in postgraduate course allocation using a questionnaire and to determine the optimal solution in postgraduate course allocation based on lecturers' effectiveness levels in using Hungarian method approach. Some literatures were reviewed by various authors related to the topic of this seminar. A total of 11 lecturers were selected using the purposive sampling technique. The data used for this study was collected through an online survey questionnaire. The data was analyzed using the Hungarian method. The study period was based on second-semester postgraduate timetable schedules in the Mathematics/Statistics Department. The Hungarian method adopted for this study proved effective since all the analyses performed reached the optimal solution. However, the study recommended that the university and department should endeavour to integrate assignment problems in allocating courses to lecturers based on competence, experience and availability to achieve the maximum level of effectiveness in imparting quality education to students.

Keywords: Assignment problem, Postgraduate Course Allocation, Mathematics, Statistics

Introduction

Postgraduate course allocation among lecturers is a complex process that can be challenging to manage. It requires careful consideration to optimize performance and meet the needs of both the students and the lecturers. The course allocation process is done in such a way that lecturers are assigned to the most suitable lectures and the courses are allocated to the available lecturers. The assignment problem is a classic problem in operation research and has been used to solve many different types of problems, such as scheduling problems, routing problems, and resource allocation problems, in areas such as network designs and logistics, as well as postgraduate course allocation among lecturers in tertiary institutions. It is a special case of the linear programming problem that is typically formulated as an optimization problem, such that the objective is to minimize the cost or time associated with the course allocation as well as to maximize the levels of lecturers' effectiveness.

The assignment problem can be solved using a variety of algorithms, such as the Hungarian algorithm, the simplex method, and the Branch and Bounce method. In a study by Boussios et al. (2012), the assignment problem was used when they proposed a multi-objective optimization model based on a genetic algorithm. The result showed that the proposed model was able to achieve a good solution in a relatively short amount of time. It is the responsibility of the Head of Department or the course coordinator to allocate courses to lecturers based on time, cost, experience, availability, competence, preference, level of effectiveness, satisfaction and other factors at the beginning of each semester of the academic year. Although, it is impossible for a lecturer to teach all the courses available in the curriculum in an institution. It is for this reason that the assignment problem is adopted to ensure equity and fairness as well as to maximize the levels of effectiveness in course allocation among lecturers.

Many universities have so far adopted the assignment problem to improve the efficiency and load balancing of their course allocation among lecturers. For example, Feng et al. (2017) used a genetic algorithm in their study to solve

the application of the assignment problem in university course allocation. They found out that their proposed algorithm was able to achieve a better solution than the traditional method. Similarly, a study by Li et al. (2018), used a fuzzy multi-objective optimization approach to solve the assignment problem in university course allocation. The result showed that their proposed approach was able to reduce the total cost assignment, while also taking into consideration the preference of the lecturers. The assignment problem is a technique used in decision making depending on the objective to either minimize or maximize a function of interest. Furthermore, this study applies the assignment problem based on the Hungarian method in postgraduate course allocation among lecturers to maximize the lecturers' levels of effectiveness as regards the courses, department and the institution under study.

This study aims to apply the assignment problem to postgraduate course allocation among lecturers in the Mathematics/Statistics Department, Ignatius Ajuru University of Education using the Hungarian method approach. This will be achieved by identifying the criteria to use to ensure equity and effectiveness in postgraduate course assignment among lecturers, determining the lecturers' effectiveness levels in postgraduate course allocation using a questionnaire, and also determining the optimal solution in postgraduate course allocation based on lecturers' effectiveness levels in Mathematics/Statistics Department.

The assignment problem is a classic problem in operations research that seeks to allocate a set of tasks or activities to a set of agents in such a way that the overall cost of the assignment is minimized. This technique has been applied in a variety of contexts, including postgraduate course scheduling. In this context, the tasks to be assigned are typically courses or lectures and the agents are the lecturers in the study area of interest. The assignment problem can be used to allocate postgraduate courses to lecturers in an optimal way. For example, a university may have a set of lectures that may be taught, the university can then use the assignment problem to determine which lectures should be allocated to which lecturer to minimize the overall cost of the course assignment. The cost may include the lecturer's salaries, stipends, allowances, the cost of travel for the lecture delivery and any other cost associated with the course. Similarly, it has been used to allocate tasks to workers in a factory to maximize efficiency. Also, to allocate patients to doctors in a hospital to minimize patient waiting time.

Assignment problems are an important tool for solving course allocation among lecturers as they provide an efficient way to allocate resources. Assignment problems can be used to determine the optimal allocation of a set of resources to a set of tasks or activities to maximize efficiency and minimize cost. In the case of course allocation among lecturers, assignment problems can be used to determine the optimal allocation of lecturers to courses to maximize the utilization of resources and minimize the cost of course delivery. The assignment problem can be solved using various algorithms such as the Hungarian method, the Branch and Bound method and the simplex method. Each of these algorithms has its advantages and disadvantages. The constraints of the assignment problem are the capacity of each lecturer and the maximum number of courses they can teach. Al-Hussaini et al. (2018) from their study showed the use of assignment problems can also improve the equity and fairness of course collation among lecturers. The study found that the use of assignment problems can reduce the number of courses allocated to a single lecturer while having an equitable share of courses. This can help to ensure that all lecturers are given an equal opportunity to teach and that no one lecturer is overburdened with too many courses. The use of assignment problems in course allocation among lecturers has been studied extensively. For example, a study by Al-Hussaini et al. (2016) found that the use of the Hungarian algorithm, a popular algorithm for solving assignment problems, can significantly improve the efficiency of course allocation among lecturers. The study found that the Hungarian algorithm was able to reduce the total cost of course delivery by up to 10%.

Course allocation among lecturers is important for several reasons. First, it ensures that each lecturer is teaching courses that are within their area of expertise. This ensures that students receive the best possible instruction and that the courses are taught in a manner that is consistent with the lecturer's teaching style. Second, it helps to ensure that the workload of each lecturer is manageable and that the courses are being taught in a manner that is consistent with the lecturer's availability. Finally, course allocation is important for ensuring that the courses are being taught in a manner that is consistent with the curriculum and consistent with the lecturer's research interests. Course allocation among lecturers is a crucial aspect of academic institutions as it directly impacts the quality of education and student learning outcomes. The allocation of courses to the right lecturers ensures a balanced workload, expertise in subject matter, and effective teaching. Below are the importance of course allocation based on assignment problems:

1. Expertise and Subject Knowledge: Assigning courses to lecturers with relevant expertise and subject knowledge is crucial for effective teaching. Research by Darling-Hammond et al. (2017) suggested that

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matching lecturers' expertise with course content positively influences student learning outcomes. It ensures that students receive instruction from lecturers who have a deep understanding of the subject matter, leading to enhanced student engagement and comprehension.

2. Teaching Effectiveness: Effective course allocation enhances teaching quality. Studies by Darling-Hammond (2010) highlighted the importance of matching teaching styles and preferences to course assignments. When lecturers are assigned courses that align with their teaching strengths, they can adopt appropriate strategies, resulting in improved student satisfaction and success.
3. Workload Distribution: Equitable course allocation ensures a balanced workload among lecturers, preventing burnout and promoting overall job satisfaction. Research by Bryer (2012) suggested that fair distribution of courses reduces stress levels and enhances lecturers' well-being which in turn positively influences student-lecturer interactions and overall classroom atmosphere.
4. Continuity and Consistency: Allocating courses based on assignment problems allows for continuity and consistency in course delivery.
5. Professional Development Opportunities: Course allocation can be used strategically to provide lecturers with opportunities for professional growth.

When considering course allocation among lecturers using assignment problems, several criteria can be taken into account. Here are some factors to consider, along with citations to support the information:

1. Teaching expertise and qualifications: Assign courses to lecturers who have the relevant expertise and qualifications in the subject matter. This ensures that students receive quality instruction (Fisher, 2014).
2. Workload distribution: Distribute courses among lecturers in a fair and balanced manner to avoid overburdening any individual lecturer. This helps maintain a healthy work-life balance and prevents burnout (Li et al., 2019).
3. Availability and scheduling constraints: Consider the availability and scheduling constraints of lecturers when allocating courses. Take into account their other responsibilities, such as research commitments or administrative duties (Fisher, 2014).
4. Student feedback and preferences: Take into consideration student feedback and preferences when assigning courses to lecturers. This can help ensure that popular courses are taught by lecturers who are effective in delivering the content (Kumar & Sharma, 2010).

In course allocation among lecturers, the level of effectiveness of lecturers in teaching delivery can be determined by conducting a variety of assessments. These assessments can include student surveys, student evaluations, peer evaluations, and observation of the lecturers' teaching style (Fisher, 2014). Based on the real-time information, several resources discuss the topic of rating lecturers' effectiveness based on assignment models. In many states, a lecturer's effectiveness is determined based on results from a single measure, typically classroom observations and sometimes value-added models. This suggests that assignment models may not be the sole factor in rating lecturers' effectiveness (Fisher, 2014). The use of assignment model techniques in allocating lecturers to courses in a university system can maximize efficiency and effectiveness. This indicates that assignment models can play a role in evaluating lecturers' effectiveness in course allocation (Al-Hussaini et al., 2018). Value-added models (VAMs) attempt to measure a lecturer's effect on his or her students' achievement. While VAMs are a relevant approach to evaluating lecturers' effectiveness they were not specifically focused on assignment problem models (Chetty et al., 2011).

The Hungarian Algorithm is a great choice for determining the optimal solution in course allocation among lecturers. It is a fast and efficient algorithm that finds the optimal solution in a short amount of time. It is also easy to implement and can be used to find the best solution for a wide variety of problems. The algorithm is based on the principle of minimizing the sum of costs associated with assigning each element in one set to an element in the other set, making it an ideal choice for solving the course allocation problem among lecturers. The application of the assignment problem for postgraduate course allocation has been studied by several researchers. For example, in a study by Dastjeral et al. (2015), the authors proposed a heuristic algorithm based on the assignment problem for postgraduate course allocation in Iranian universities. The authors found that the proposed algorithm could allocate courses considering the preferences of both lecturers and the students. In another study, Chen et al. (2018) proposed a mixed-integer linear programming (MILP) model based on the assignment problem for postgraduate course allocation in Chinese universities. The authors used a genetic algorithm to solve the MILP model and found that this proposed model can effectively allocate courses to lectures while considering the preferences of both the lecturers and the students. In a study by Wang et al. (2020), the authors proposed a multi-objectives optimization model based

on the assignment problem for postgraduate course allocation in Chinese universities and the result produced recommendation solutions which were much better than others. It is as a result of various findings from different researchers that assignment problems have been proven to be an effective tool and technique to be employed in solving course allocation or assignment among lecturers in the university.

Materials and Methods

The study is focused on lecturers in the Mathematics/Statistics Department whose names appear on the postgraduate schedule during the period of this seminar work (June 2023 – Nov. 2023). The study adopted a purposive sampling technique as a total enumeration method to understudy all the lecturers available on the postgraduate timetable schedules. The data used for this study were obtained from an online questionnaire survey among the lecturers available on the timetable during the period under review. It is made up of a total of eleven (11) lecturers making six (6) Mathematics lecturers and five (5) Statistics lecturers, a total of twenty-eight (28) courses making fourteen (14) Mathematics courses and fourteen (14) Statistics courses, excluding seminar courses. The questionnaire enabled the researcher to obtain information on the lecturers' demographic data and questions about this seminar work. The lecturers' effectiveness rating was assessed using a structured questionnaire that based on the departmental postgraduate timetable. The lecturers represent the row, the courses allocated to the lecturers represent the column, while the level of their effectiveness represents the entries and it was rated in percentage.

Data for this study are analyzed using an assignment problem based on the Hungarian method approach.
The Hungarian method is one of the widely used techniques to solve assignment problems. Kuhn (1995) in his study developed a method called the Hungarian method where he combined the idea of solving an optimal solution using assignment problems. The problem is a maximization problem with the objective function, max Z, where Z represents the level of the lecturer's effectiveness.

Results

Demographic Information of Respondents:

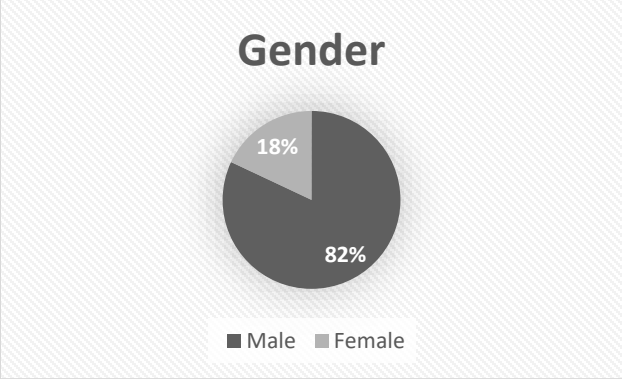

Figure 1: The pie chart above shows the gender distribution of the respondents representing 82% male and 12% female.

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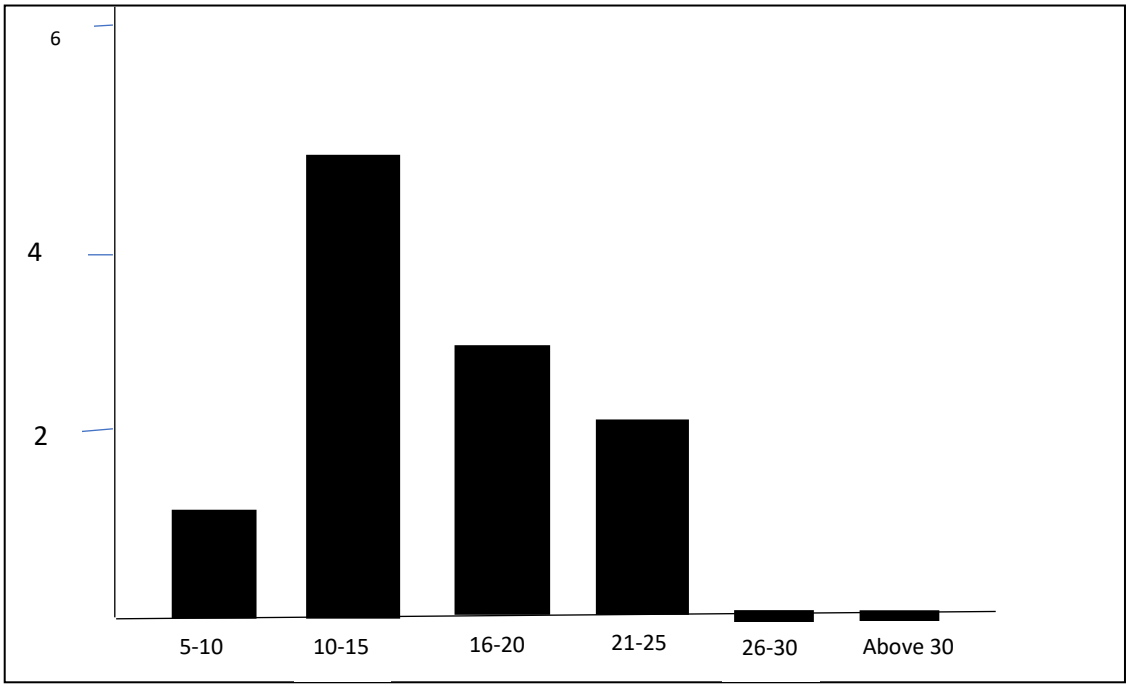

Figure 2: The bar chart above shows the years of experience of the respondents.

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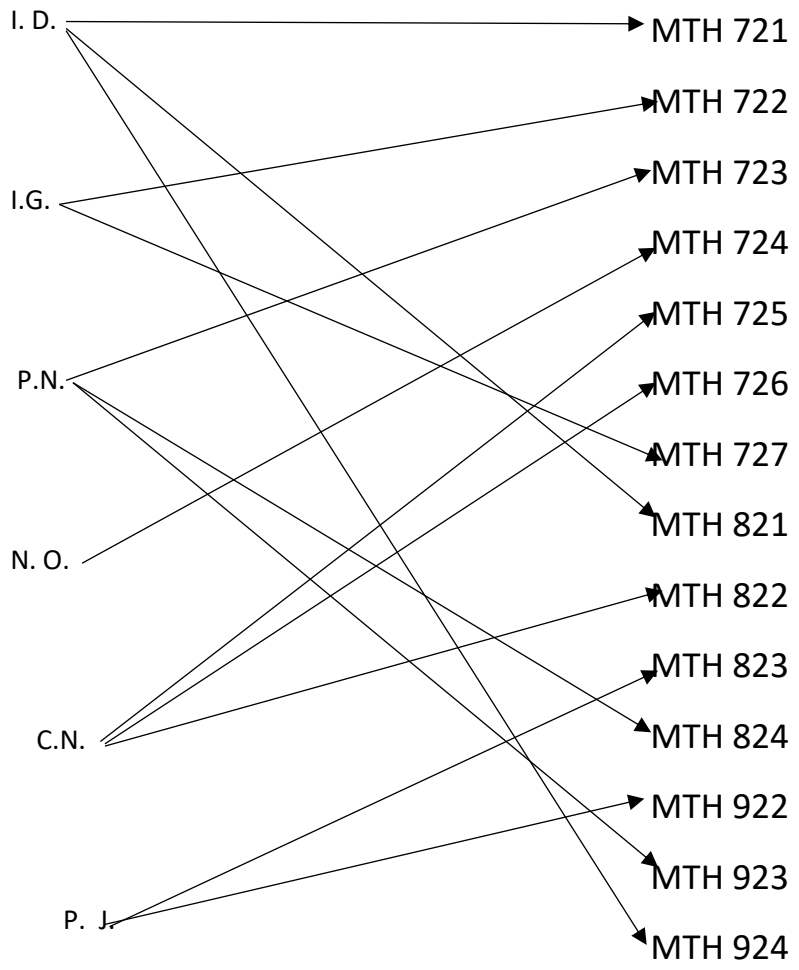

Figure 3: Network diagram showing the number of courses taught by individual Mathematics Lecturers

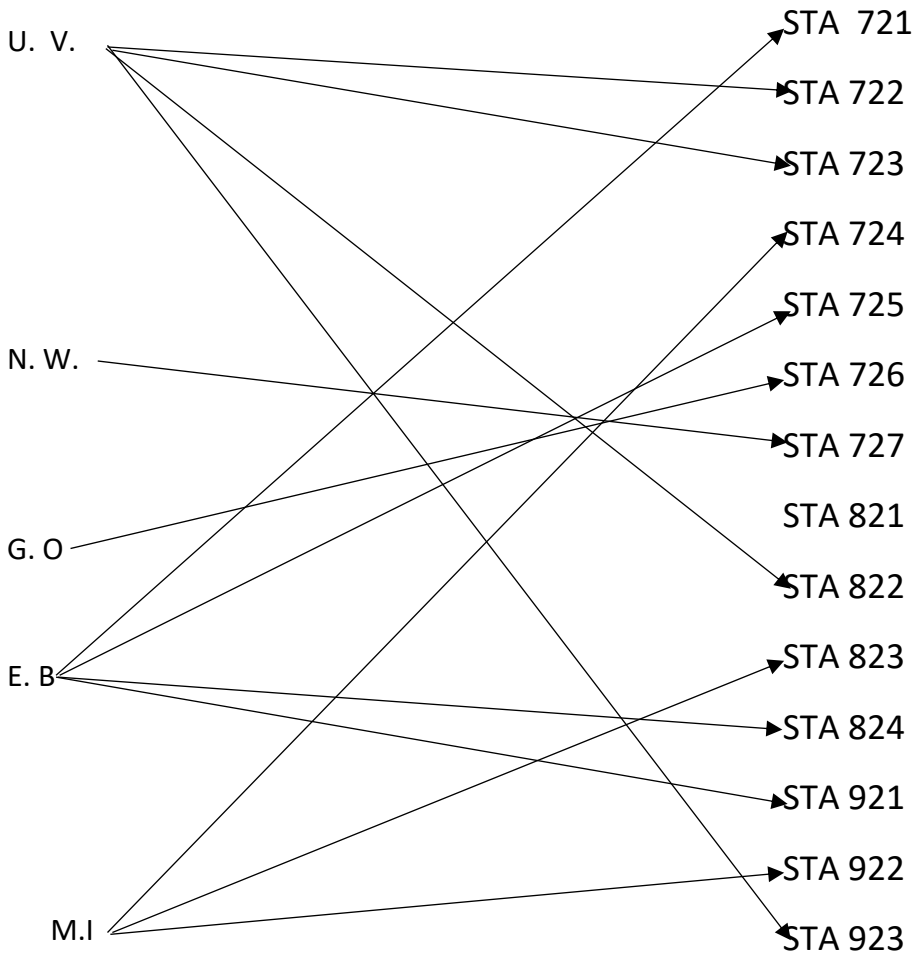

Figure 4: Network diagram showing the number of courses taught by individual Statistics Lecturers

Table 1 PGD Mathematics

	Course code						
Lecturer	**MTH 721**	**MTH 722**	**MTH723**	**MTH 724**	**MTH 725**	**MTH 726**	**MTH 727**
I. D.	–	–	–	–	–	–	–
I. G.	80	80	–	–	–	–	80
P. N.	30	20	30	10	–	20	20
N. O.	–	90	–	90	80	–	80
C. N.	70	–	–	–	70	70	70
I. G.	80	80	–	–	–	–	80
C. N.	70	–	–	–	70	70	70

Table 1.1 PGD Mathematics reduced table in rows

	Course code						
Lecturer	**MTH 721**	**MTH 722**	**MTH723**	**MTH 724**	**MTH 725**	**MTH 726**	**MTH 727**
I. D.	90	90	90	90	90	90	90
I. G.	10	10	90	90	90	90	10
P. N.	60	70	90	80	90	70	70
N. O.	90	0	90	0	10	90	10
C. N.	20	90	90	90	20	20	20
I. G.	10	10	90	90	90	90	10
C. N.	20	90	90	90	20	20	20

Table 1.2 PGD Mathematics reduced table in columns

	Course code						
Lecturer	**MTH 721**	**MTH 722**	**MTH723**	**MTH 724**	**MTH 725**	**MTH 726**	**MTH 727**
I. D.	0	0	**0**	0	0	0	0
I. G.	0	0	80	80	80	80	**0**
P. N.	**0**	10	30	20	30	10	10
N. O.	90	0	90	**0**	10	90	10
C. N.	0	70	70	70	**0**	0	0
I. G.	0	**0**	80	80	80	80	0
C. N.	0	70	70	70	0	**0**	0

Table 1.3 Optimal Solution

Lecturers (Initials)	**Courses**
I. D.	MTH 723
I. G.	MTH 727
P. N.	MTH 721
N. O..	MTH 724
C. N.	MTH 725
I. G..	MTH 722
C. N.	MTH 726

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Table 2 MSc Mathematics

Lecturers	MTH 821	MTH 822	MTH 823	MTH 824
P. J.	–	–	–	–
I. D.	100	–	–	–
C. N.	–	–	80	–
P. N.	30	20	30	10

Table 2.1 MSc Mathematics reduced table in rows

Lecturers	MTH 821	MTH 822	MTH 823	MTH 824
P. J.	100	100	100	100
I. D.	0	100	100	100
C. N.	100	100	20	100
P. N.	70	80	70	90

Table 2.2 MSc Mathematics reduced table in column

Lecturers	MTH 821	MTH 822	MTH 823	MTH 824
P. J.	0	0	0	0
I. D.	0	100	100	100
C. N.	80	80	0	80
P. N.	0	10	0	20

Table 2.3

Lecturers	MTH 821	MTH 822	MTH 823	MTH 824
P. J.	0	**0**	0	0
I. D.	**0**	20	100	20
C. N.	80	0	0	**0**
P. N.	0	10	**0**	20

Table 2.4 Optimal Solution

Lecturers	Courses
P. J.	MTH 822
I. D.	MTH 821
C. N.	MTH 824
P. N.	MTH 823

Table 3 PhD Mathematics

Lecturer	MTH 922	MTH 923	MTH 924
P. J.	–	–	–
I. D.	–	–	100
P. N.	–	–	10

Table 3.1 PhD Mathematics reduced table in rows

Lecturers	MTH 922	MTH 923	MTH 924
P. J.	100	100	100
I. D.	100	100	0
P. N.	100	100	90

Table 3.2 PhD Mathematics table in columns

Lecturers	MTH 922	MTH 923	MTH 924
P. J.	0	0	0
I. D.	100	100	0
P. N.	10	10	0

Table 3.3 PhD Mathematics final reduced table

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Lecturers	MTH 922	MTH 923	MTH 924
P. J.	**0**	0	0
I. D.	90	90	**0**
P. N.	0	**0**	0

Table 3.4 Optimal Solution

Lecturers	Courses
P. J.	MTH 922
I. D.	MTH 924
P. N.	MTH 923

OR

Lecturers	Courses
P. J.	MTH 923
I. D.	MTH 924
P. N.	MTH 922

Table 4 PGD Statistics

	Course code						
Lecturer	**STA 721**	**STA 722**	**STA 723**	**STA 724**	**STA 725**	**STA 726**	**STA 727**
E. B	90	100	100	90	100	100	90
U. V.	60	80	80	70	70	–	90
P. N.	100	–	–	0	–	0	90
Prof. I	0	0	0	20	–	10	10
G. O.	–	–	–	–	–	–	–
E. B	90	100	100	90	100	100	90
U. V.	60	80	80	70	70	–	90

Table 4.1 PGD Statistics reduced table in rows

	Course code						
Lecturers	STA 721	STA 722	STA 723	STA 724	STA 725	STA 726	STA 727
E. B	10	0	0	10	0	0	10
U. V.	40	20	20	30	30	100	10
P. N.	0	100	100	100	100	100	10
Prof. I	100	100	100	80	100	90	90
G. O.	100	100	100	100	100	100	100
E. B_2	10	0	0	10	0	0	10
U. $V._2$	40	20	20	30	30	100	10

Table 4.2 PGD Statistics reduced table in columns

Lecturers	STA 721	STA 722	STA 723	STA 724	STA 725	STA 726	STA 727
E. B	10	0	0	10	0	0	10
U. V.	30	10	10	20	20	90	0
P. N.	0	100	100	100	100	100	10
M. I.	20	20	20	0	20	10	10
G. O.	0	0	0	0	0	0	0
E. B_2	10	0	0	10	0	0	10
U. $V._2$	30	10	10	20	20	90	0

Table 4.3 PGD Statistics final reduced table

	Course code						
Lecturers	**STA 721**	**STA 722**	**STA 723**	**STA 724**	**STA 725**	**STA 726**	**STA 727**
E. B	10	0	**0**	10	0	0	10
U. V.	30	**0**	10	20	10	80	0
P. N.	**0**	90	100	100	10	90	10
M. I.	20	10	20	**0**	10	0	10
G. O.	0	0	0	0	0	**0**	0
E. B_2	10	0	0	10	**0**	0	10
U. $V._2$	30	0	10	20	10	80	**0**

Table 4.4 Optimal solution

Lecturers	Courses
E. B	STA 723
U. V.	STA 722
P. N.	STA 721
M. I.	STA 724
G. O.	STA 726
E. B	STA 725
U. V.	STA 727

Table 5 MSc Statistics

Lecturers	**STA 821**	**STA 822**	**STA 823**	**STA 824**
M. I.	10	20	20	20
E. B	100	100	90	100
U. V.	0	80	0	70
M. I.	10	20	20	20

Table 5.1 MSc Statistics reduced table in rows

Lecturers	**STA 821**	**STA 822**	**STA 823**	**STA 824**
M. I.	90	80	80	80
E. B	0	0	10	0
U. V.	100	20	100	30
M. I.	90	80	80	80

Table 5.2 MSc Statistics reduced table in columns

Lecturers	**STA 821**	**STA 822**	**STA 823**	**STA 824**
M. I.	10	0	0	**0**
E. B	**0**	0	10	0
U. V.	80	**0**	80	10
M. I.	10	0	**0**	0

Table 5.3 Optimal Solution

Lecturers	**Courses**
M. I.	STA 824
E. B	STA 821
U. V.	STA 822
M. I.	STA 823

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Table 6 PhD Statistics

Lecturers	STA 921	STA 922	STA 925
M. I.	0	10	0
E. B	100	90	100
U. V.	0	0	70

Table 6.1 PhD Statistics reduced table in rows

Lecturers	STA 921	STA 922	STA 925
M. I.	100	90	100
E. B	0	10	0
U. V.	100	100	30

Table 6.2 PhD Statistics reduced table in columns

Lecturers	STA 921	STA 922	STA 925
M. I.	0	10	0
E. B	0	10	0
U. V.	70	70	0

Table 6.3 PhD Statistics final reduced table

Lecturers	STA 921	STA 922	STA 925
M. I.	**0**	10	0
E. B	0	**0**	0
U. V.	70	60	**0**

Table 6.4 Optimal Solution

Lecturers	Courses
M. I.	STA 921
E. B	STA 922
U. V.	STA 925
OR	
Lecturers	**Courses**
M. I.	STA 922
E. B	STA 921
U. V.	STA 925

Discussion

The goal of any assignment problem is to allocate equal number of resources to the same number of activities. The tables summarizing the optimal solutions in Tables 1.3, 2.4, 3.4, 4.5, 5.3, and 6.4 above show the results of course of allocation obtained with the help of Hungarian method. Based on the postgraduate timetable schedule under study, the result in Table 1.3 suggests that the Mathematics/Statistics Department should allocate MTH 723 to I.D, MTH 721 to P.N., while the other courses remain unchanged. Table 2.4 suggests that the MTH 824 be allocated to C.N., MTH 823 and MTH 823 are allocated to P.N. while other course allocations remain unchanged. In Table 3.4, all the course allocation remains unchanged for PhD Mathematics. Table 4.5 suggests that STA 723 be allocated to E.B. while 727 is allocated to U.V. All other courses allocation remains unchanged. In Table 5.3 STA 824 is allocated to M.I., STA 821 is allocated to E.B. and the other course allocations remain unchanged. In Table 6.4, STA 921 or STA 922 can be allocated to M.I. and STA 921 or STA 922 can be allocated to E.B. and the other course remain unchanged. If the solution suggested by the analysis is followed by the Head of Department or course coordinator, the Department will experience the maximum level of effectiveness on the course allocation among lecturers

Conclusion

The assignment problem has been considered a good tool for solving problems associated with allocation. This study showcased its application in allocating courses among the lecturers in the Department of Mathematics/Statistics at IAUE. The incomplete data from the lecturers' effectiveness rating in the questionnaire were regarded as zero as used in the analysis. During assigning these courses to the lecturers from the analysis of the respondents which was obtained from an online survey, it has been proven that an optimal solution has been reached and a maximum level of efficiency and effectiveness could be assessed. Also, where the optimal solution could not be reached after the

row and column reduction, the entries with more than one zero were crossed off by using the minimum number to subtract through the entries that were uncovered to obtain or attain the optimal solution. However, the assignment problem is always possible with a square matrix, otherwise a dummy variable is introduced.

Recommendations

This study therefore recommends that:

1. The head of the department or course coordinator endeavours to integrate assignment problems into course allocation to get the best from lecturers and to improve the quality of education offered to students in the department.
2. The Departments in the university should also allocate courses to lecturers based on competence, experience, and availability to achieve the maximum level of effectiveness in knowledge delivery.
3. Finally, lecturers should be trained and retrained so that their impact on the students will match that of their counterparts in other institutions.

References

Al-Hussaini, A., Al-Hussaini, A., & Al-Hussaini, A. (2016). Optimization course allocation among lecturers using the Hungarian algorithm. *International Journal of Advanced Computer Science and Applications, 7*(7), 5-10.

Al-Hussaini, A., Al-Hussaini, A., & Al-Hussaini, A. (2018). Fair course allocation among lecturers using the Hungarian algorithm. *International Journal of Advanced Computer Science and Applications, 9*(2), 33-37.

Boussios, D., Folaris, P., & Papadimitriou, S. (2012). A multi-objective optimization model for postgraduate course allocation among lecturers. *International Journal of Production*.

Bryer, T. (2012). The importance of lecturers' satisfaction in postgraduate course allocation. *Journal on Higher Education, 23*(2), 128-136.

Chen, X., Liu, C., & Zhang, Y. (2018). A mixed integer linear programming model for postgraduate course allocation based on assignment problem. *Applied Soft Computing, 62*, 834-851.

Chetty, R., Friedman, J. N., & Rockoff, J. E. (2011). Measuring the impacts of teachers, evaluating bias in teacher value-added estimates. *American Economic Review, 101*(2), 267-271.

Darling-Hammond, L. (2010). *The flat world and education: How America's commitment to equity will determine our future*. New York Teachers' College Press.

Darling-Hammond, L. (2017). Effective Teacher Professional Development. Palo Alto, (A Learning Policy Institute).

Dastjerdi, M. V., Rezapour, S., & Sadeghi, R. (2015). A heuristic algorithm based on assignment problems for postgraduate course allocation in Iranian universities. *International Journal of Advanced Manufacturing Technology, 79*(9-12), 2043-2052.

Feng, X., Leee, Y. & Moon, I. (2017). "An integer Program and a Hybrid Genetic Algorithm for the University Timetabling Problem" Optimization Methods and Software.

Fisher, D. (2014). Assessing teaching effectiveness. *New Direction for Teaching and Learning, 139*, 7-17.

Kuhn, H. W. (1995). The Hungarian method for the assignment problem. *Naval Research Logistics Quarterly, 2*(1-2), 83-97

Kumar, A., & Sharma, S. (2010). Lecturer satisfaction postgraduate course allocation: A case study. *International Journal of Education Management, 24*(2), 203-211.

Li, Y., Liu, T., & Li, Y. (2018). Fuzzy multi-objective optimization approach for university course assignment. *International Journal of Fuzzy System, 17*(14), 914-921.

Wang J., Huang, Y., & Li, T. (2020). An optimization model for postgraduate course allocation based on assignment problem. *International Journal of Education Technology in Higher Education, 17*(1), 1-9