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Designing Multimedia Learning for Solving Linear Programming

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Abstract

The purpose of the study is to design multimedia learning in solving linear programming (LP) to overcome the problems faced by students of mathematics education in solving LP. This study applies multimedia such as software LINDO, LINGO and Excel. It has been solved the problem by using the third LP software, and the results are adjusted for the results of solving by simplex method. Among of three softwares, the Excel program is better to be used than LINDO and LINGO program in order that students will be more innovative and creative. Due to both of these programs, algorithm simplex method is set up in its software, meanwhile the Excel program still requires regulation algorithm in the worksheet to obtain the optimum value.

AMS subject classification: 54A05, 54C10.
Keywords: Designing, multimedia learning, linear programming.

1. Introduction

Linear programming is one of compulsory subjects for students of mathematics education in order that students can apply mathematics in solving real problems. Provision of this course is also based on several reasons. Firstly, all the problems in real life can be modeled into a math problem. Secondly, LP is included applied mathematics which contains steps systematically to solve optimization problems in various sectors, including education sector. Some applications of LP are to solve problems in the field of education, it can be seen as the allocation of student majoring [1]. Scheduling problems [2], [3], [4], [5]. Determines the location of the test material [6], and mapping mathematical abilities of students [7].

In general, LP problems have three or more variables solved by the simplex method developed by George Danzing 1947. Solving LP with this method is done with some iteration to obtain optimal results. The more variables and constraints will be, the more iterations are performed. Consequently, learning becomes problematic for students of mathematics, namely the lack of interest in solving LP. Therfore, innovation is needed in learning it, so that the goal of lecture can be achieved well.

The aim of this study is to solve LP with multimedia software so that students will get easier to develop others multimedia to solve the problem LP, increase students' intrest and creativity, and the aim of lecturing can be achieved well. This paper is organized as follows. Section 2 presented multimedia learning. Section 3 is briefly described on linear programming. Solving linear programming with multimedia is presented in section 4. The conclusions can be found in section 5.

2. Multimedia Learning

At the beginning of the history of education, teachers are only one as a medium of learning. In the modern era, the teachers have realized that everything can be used as a medium of learning, including school environment and at the end, namely computer. Learning media is something that can be used to deliver a message from the sender to the receiver so that the learning process will occur. Media are physical means which are used to send messages to the students and stimulate them to learn [8]. Learning Media is a combination of hardware and software. There are several types of media, ie media graphics, audio and multimedia. Graphic media is a media using visual symbols, such as sketches, graphs, flow charts or other. Audio media is a medium that is associated with the sense of hearing. Multimedia can be defined as interative comunication system [9], and combination from data operator, such as internet and software [10], [11]. Multimedia is a media associated with the use of technology like computers and software [12], [13]. The adventagous of multimedia in teaching is to increase students' learning experiences [14], make time efficiency [15], [16], create a conducive learning environment [17], actively participate in learning process [18], [19), and improve students' enthusiasm and performance [20], [21], [22].

3. Linear Programming

Basically, the problem of LP refers to a mathematical program that has the objective functions and constraints of linear to minimize or maximize a problem in the field of optimization. LP problem can be stated as follows.

$$\begin{aligned} &\text{Max } Z = c^T X \\ &\text{Subject to } AX \leqslant b \\ &\qquad\qquad X \geqslant 0 \end{aligned}$$

where x is a decision variable, c and b are coefficients vector and A is a matrix. Simplex method is a method of splitting designed to solve LP problems that have three or more variables, and settlement is perforemed by iterations with the same steps until the optimum solution is achieved. LP settlement with the simplex method is based on the idea of the graphical method, where the optimum solution is always located at the corner point of the feasible region. The summary of simplex algorithm is (1) smallest reduced cost, (2) test for optimality, (3) incoming variable, (4) test for unbounded, (5) outgoing variable, (6) pivot on $\bar{a}_{rs}$ to determine a new basic feasible solution set $j_r = s$ and return on step 1 [23]. Up to this present, a lot of multimedia can be used in solving the LP, where algorithm simplex method has been applied in some software, such as LINDO and LINGO package. LINDO is a convenient, but powerful tool for solving linear, integer, and quadratic programming problems [24]. LINGO is a comprehensive tool designed to make building and solving linear programming problems [25]. Additional Software for solving LP like Excel program still needs to set the algorithm on a worksheet. Therefore, using the Excel program allows students to innovate, be creative and increase students' interest to solve further LP. For that reason, the third of the software will be applied to solving LP in the following discussion.

4. The Result

The solving of LP, the simplex method and multimedia with the Excel program, LINDO and LINGO package will be shown the stages and the results are based on a model LP stated as follows.

$$\text{Max } Z = 3X1 + 6X2 + 4X3$$

$$\begin{aligned}\text{Subject to: } & 3X1 + 4X2 + X3 \leqslant 60\\ & 2X1 + 3X2 + X3 \leqslant 50\\ & X1 + 2X2 + 2X3 \leqslant 44\\ & X1, X2, X3 \geqslant 0\end{aligned}$$

4.1. Simplex Method

The summary stages of LP solving with simplex method is described as follows.
Stage 1. Standard form

$$\text{Max } Z = 3X1 + 6X2 + 4X3 + 0S1 + 0S2 + 0S3$$

$$\begin{aligned}\text{Subject to: } & 3X1 + 4X2 + X3 + S1 = 60\\ & 2X1 + 3X2 + X3 + S2 = 50\\ & X1 + 2X2 + 2X3 + S3 = 44\\ & X1, X2, X3 \geqslant 0\end{aligned}$$

Stage 2 Determining the initial table simplex proceed to the next stage, iterating with steps of testing and calculations respectively as the following; (1) smallest reduced cost, (2)

test for optimality, (3) incoming variable, (4) test for unbounded, (5) outgoing variable, (6) pivot on $\bar{a}_{rs}$ to determine a new basic feasible solution set $j_r = s$ and return on step 1. The iteration process is done to obtain the maximum value of the objective function. Results of the solving can be summarized in the tables below.

Table 1. Simplex Table

	C_j	3	6	4	0	0	0		
CB	*VB*	X_1	X_2	X_3	S_1	S_2	S_3	*LHS*	*RHS*
0	S_1	3	4	1	1	0	0	60	15
0	S_2	2	3	1	0	1	0	50	16,67
0	S_3	1	2	2	0	0	1	44	22
Z_j		0	0	0	0	0	0	-	
$Z_j - C_j$		-3	-6	-4	0	0	0		

Table 2. Results of the First Iteration

	C_j	3	6	4	0	0	0		
CB	*VB*	X_1	X_2	X_3	S_1	S_2	S_3	*LHS*	*RHS*
6	X_2	$\frac{3}{4}$	*1*	$\frac{1}{4}$	$\frac{1}{4}$	0	0	15	60
0	S_2	$-\frac{1}{4}$	*0*	$\frac{1}{4}$	$-\frac{3}{4}$	1	0	5	20
0	S_3	$\frac{2}{4}$	*0*	$\frac{6}{4}$	$-\frac{2}{4}$	0	1	14	9.33
Z_j		4,5	6	1,5	1,5	0	0	-	
$Z_j - C_j$		1,5	0	-2,5	-1,5	0	0		

Tabel 3. Result of the Second Iteration

	C_j	3	6	4	0	0	0		
CB	*VB*	X_1	X_2	X_3	S_1	S_2	S_3	*LHS*	*RHS*
6	X_2	$\frac{2}{3}$	*1*	0	$\frac{5}{6}$	0	$-\frac{4}{24}$	12,67	-
0	S_2	$-\frac{1}{3}$	*0*	0	$-\frac{2}{3}$	1	$\frac{4}{24}$	2,67	-
4	X_3	$\frac{8}{24}$	*0*	1	$-\frac{8}{24}$	0	$\frac{4}{6}$	9,33	-
Z_j		5,33	6	4	-0,33	0	1,67	113,33	
$Z_j - C_j$		2,33	0	0	-0,33	0	1,67		

The results of solving LP with simplex method, the value of the maximum, $Z = 113.33$ at $X1 = 0$, $X2 = 12.67$ and $X3 = 9.33$.

4.2. Excel Program

The solving of LP above use Excel program carried out as the following stage.
Stage 1. Creating and specifying spreadsheet
This phase is done in three steps, namely (1) creating a spreadsheet with models the

problem, (2) specifying the cell which contains the objective function, and (3) specifying the decision variable. The Summary of this stage is shown in Figure 1.

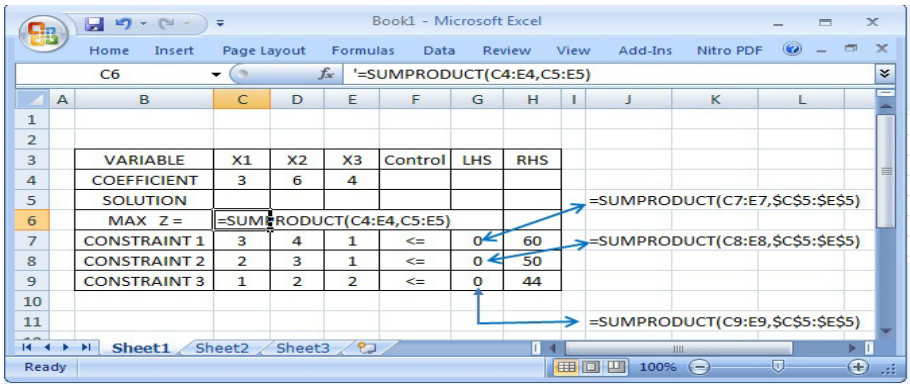

Figure 1: Spreadsheet LP with Contraints Indicated.

Stage 2. Define the constraint
This stage is done by specifying the cell which defines the constraints and inserting the target cells to be searched. It is shown in figure 2.

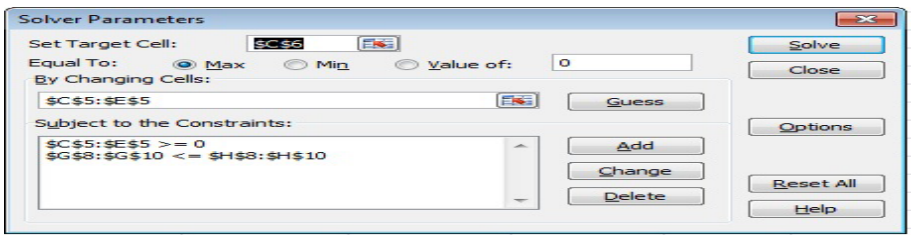

Figure 2: The Solver Parameters Dialog Box with Contstraints Added

Stage 3. Output
Solving the model by performing command solve on solver parameters dialog box, so that the result is shown in figure 3.

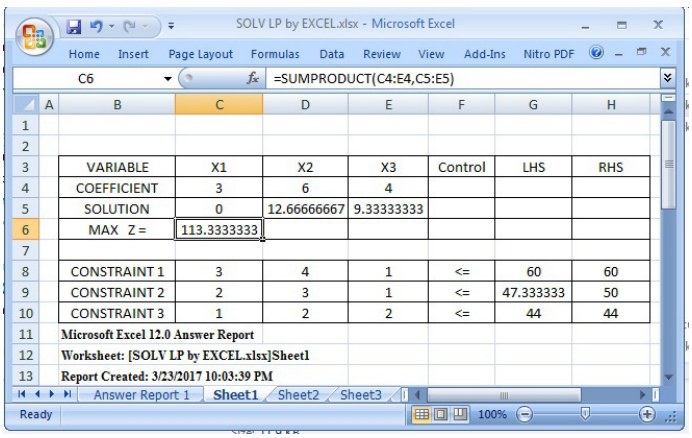

Figure 3: The Spreadsheet After Optimizing.

4.3. LINDO

Using software LINDO for solving LP above is done in two stages, that is entering LP models in the windows version of LINDO and solving. Both of them are shown in the following figure.

Stage 1. Entering the model

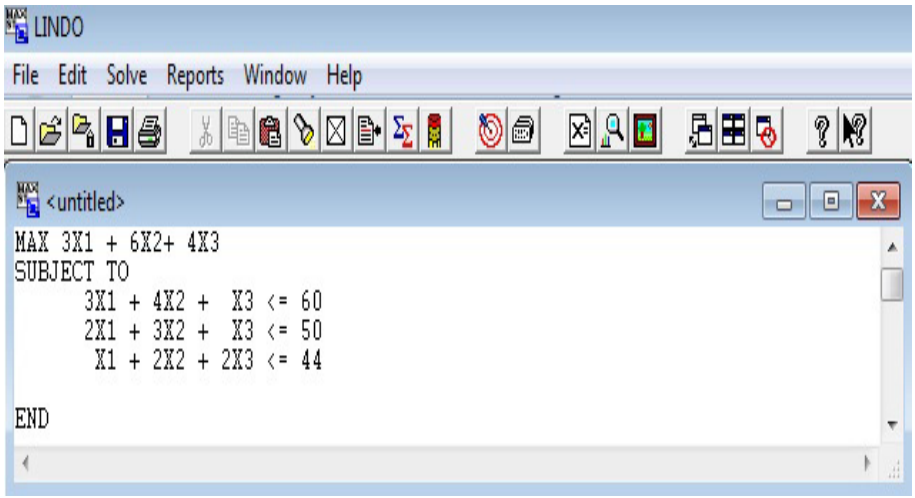

Figure 4: Entering the model in windows

Stage 2. Solving the model

To begin solving the model, select the solve command from the solve menu on the toolbar at the top of the window. LINDO will begin by trying to solve the model, and the result will be shown in figure 5.

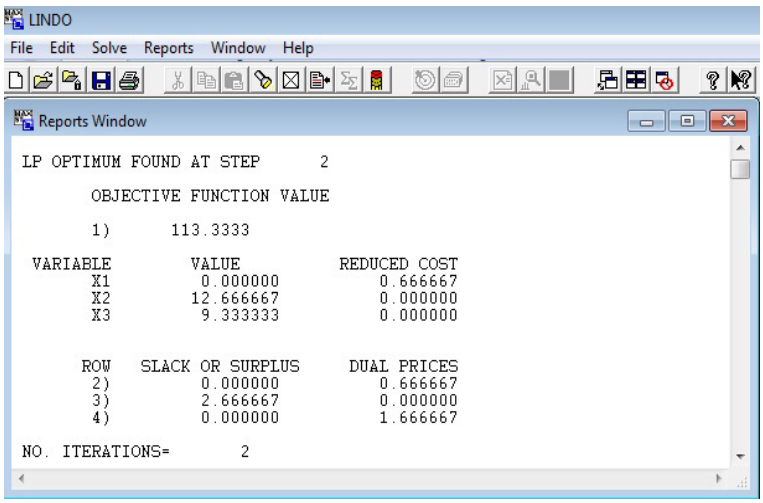

Figure 5: Output after solving

The result of LINDO shows a maximum value of the objective function, $Z = 113.3333$ at $X1 = 0$, $X2 = 12.66667$, and $X3 = 9.333333$.

4.4. LINGO

Using LINGO software for solving LP above is done in two stages, that is entering LP models in the windows version of LINGO and solving. Both of them are shown in the following figure.

Stage 1. Entering the models

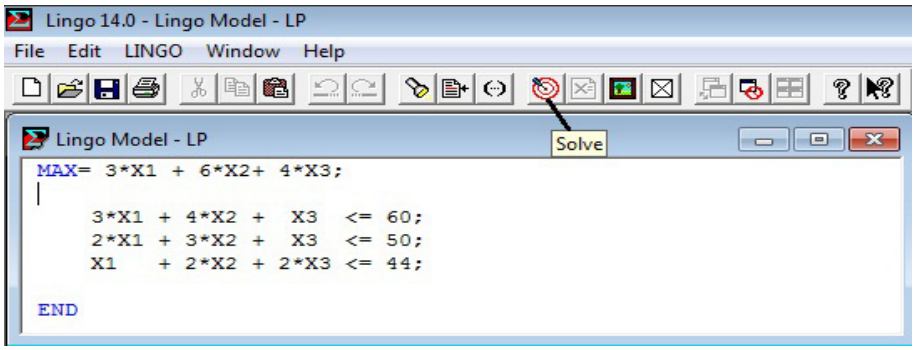

Figure 6: Entering the model in windows

Stage 2. Solving the model

To begin solving the model, select the solve command from the solve menu on the toolbar at the top of the window. LINGO will begin by trying to solve the model, and the result will be shown in figure 7.

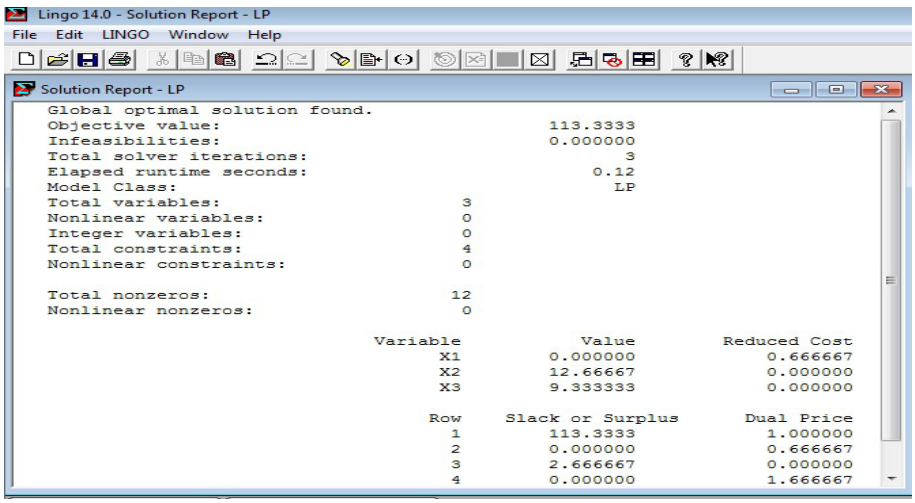

Figure 7: Output after solving

The output of LINGO shows a maximum value of the objective function, $Z = 113.3333$ at $X1 = 0$, $X2 = 12.66667$, and $X3 = 9.333333$.

5. Conlusion

The use of multimedia learning is very necessary in mathematics learning, including learning linear programming (LP) in mathematics education. Many multimedia software can be used to facilitate solving LP, such as LINDO, LINGO and Excel. Excel program is better to be used among of them in order thats students can innovate and be creative. Since both of these programs, the algorithm simplex method has already been set in the software, while the Excel program still needs to set the algorithm in the worksheet.

References

[1] Anwar, A.A., and Bahaj, A. S. (2003). "Student Project Allocation Using Integer Programming". IEEE Transactions on Education. Volume 46, No. 3, 53–59.

[2] Daskalaki, S., Birbas, T., and Housos, E. (2004). "An Integer Programming Formulation for a Case Study in University Timetabling". European Journal of Operational Research 153, 117–135.

[3] Ribic, S., and Konjicija, S. (2010). "Two Phase Integer Linear Programming Approach to Solving the School Timetable Problem". Proceedings of the ITI, 32^{nd} Int. Conf. on Information Technology Interfaces, Cavtat, Croatia, 1–5.

[4] Hutomo, I. (2011). "Implementation of Integer Linear Programming Algorithm for Room Scheduling Information Systems at the Faculty of Computer Science". Journal of Information Systems. Volume 7, Issues I, 26–33.

[5] Aizam, N. A., and Sithamparam, T. (2016). "General Basic 0-1 Integer Programming Model for Timetabling Problems". Malaysian Journal of Mathematical Sciences, 10 (S): 143–154.

[6] Junoh, A. K, et al. (2012). "Classification of Examination Marks according to Bloom's Taxonomy by Using Binary Linear Programming". IACSIT Press, Singapore, IPCSIT. Vol. 36, 20–25.

[7] Tambunan, H. (2016). "Mathematical Model for Mapping Students' Cognitive Capability". International Journal of Evaluation and Research in Education (IJERE). Volume 5, No. 3, 221–226.

[8] Briggs, L.J. (ed.) (1977). "Instructional Design: Principles and Applications". New Jersey: Englewood Cliffs.

[9] Reisman, S. (1994). "Multimedia Computing: Preparing for the 21^{st} century". Harrisburg: IDEA Group Publishing.

[10] Jager, A.K. and Lokman, A.H. (1999). "Impacts of ICT in Education: Tthe Role of the Teacher and Teacher Training". Paper Presented at the European Conference on Educational Research, Lahti, Finland, on 22nd – 25th September. Available online at http://www.leeds.ac.uk/educol/documents/00001201.htm. Accessed on $18^{s}t$ Mart 2017.

[11] Babajide, J.F.T. and Bolaji, O.A. (2003). "Perception of lecturers and pre-service teachers towards the use of communication media in teaching pure and applied sciences in related disciplines". Proceedings of Conference, Lagos: pp. 23–40.

[12] Philips, R. (1997). "The Developers Handbook to Interactive Multimedia (Practical Guide for Education Application)". London: Kogan Page.

[13] Mayer, R., and Moreno, R. (2002). "Aids to Computer Based Multimedia Learning". Learning and Instruction, 12 (1), 107–119.

[14] Agnew, P.W., Kellerman, A.S., and Meyer, J. (1996). "Multimedia in the Classroom". Boston: Allyn and Bacon.

[15] Ogunbote, K.O. and Adesoye, A.E. (2006). "Quality Assurance in Nigerian Academic Libraries Networked Multimedia Services". Journal of Library and Information Science, Volume 3. No. 1 & 2 pp. 100–111.

[16] Ng, K. H; and Komiya, R. (2000). "Introduction of Intelligent Interface to Virtual Learning Environment". Paper Presented at the Multimedia University International Symposium on Information and Communication Technologies 2000 (M2USIC'2000), October 5–6, Petaling Jaya, Malaysia.

[17] Omagbemi, C.O., Akinola, B.A. and Olayiwola I.B. (2004). "Academic Libraries, the Internet and it's Potential Impact on Teaching and Learning in Nigerian Tertiary Institutions". Journal of Library and Information Science. Volume 1 (1), pp. 34–46.

[18] Neo, T. K., and Neo, M. (2004). "Integrating Multimedia Into the Malaysian Classroom: Engaging Students in Interactive Learning". The Turkish Online Journal of Educational Technology. Volume 3, Issue 3 Article 4, pp. 31–37.

[19] Ogochuku, N. V. (2010). "Enhancing Students Interest in Mathematics via Multimedia Presentation". African Journal of Mathematics and Computer Science Research. Volume 3 (7), pp. 107–113.

[20] Ayub, at al. (2014). "Adoption of Wxmaxima Software in the Classroom: Effect on Students' Motivation and Learning of Mathematics". Malaysia Journal of Mathematical Sciences, 8 (2), 311–323.

[21] Panjaitan, B. (2016). "Designing a Learning Media using Matlab for Matrix and Its Operations". Global Journal of Pure and Applied Mathematics. Volume 12, Number 5, pp. 4431–4441.

[22] Sunandar., Buchori, A., and Rahmawati, N. D. (2016). "Development of Media Kocerin (Smart Box Interactive) to Learning Mathematics in Junior High School". Global Journal of Pure and Applied Mathematics. Volume 12, Number 6, pp. 5253–5266.

[23] Danzing, G.B., and Thapa, M. N. (1997). "Linear Programming". Spinger.

[24] LINDO. (2003). "LINDO User's Manual". Chicago, Illinoes: LINDO Systems, Inc.

[25] LINGO. (2016). "The Modeling Language and Optimizer". Chicago, Illinois: LINDO Systems Inc.