III.C.6. UST

by Tim Turnitin

Submission date: 04-Aug-2023 03:21PM (UTC+0700)
Submission ID: 2141207451
File name: III.C.6._UST.pdf (429.84K)
Word count: 3252
Character count: 18433

http://jurnal.ustjogja.ac.id/index.php/incotes/index

E-Module Linier Program AS an Independent Teaching for Student

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To cite this article:

Ayuningtyas, A.D., Setiana, D.S., Apriandi, D. (2020). E-Module Linier Program AS an Independent Teaching for Student. In D. S. Setiana, A. Setiawan, D. Supriadi, K. H. Najib, T. Ardhian, N. A. Handoyono, I. Widyastuti, & L. Tiasari (Eds.), *International Conference on Technology, Education and Science* (pp. 37–42). Yogyakarta.

International Conference on Technology, Education and Sciences

InCoTES 2020 ISSN: 978-602-6258-18-2

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Article Info

Keywords

E-Module
Independent Teaching
Covid-19

Abstract

In the current conditions of the Covid 19 pandemic, learning at all levels of education from kindergarten to tertiary institutions changes the learning process. Learning is currently done online or in a network (online). With this condition, learning media is needed that can help students to learn lecture material independently, one of which is using the E-Module. This E-Module consists of the formulation of linear program problems, solving linear program problems with the graph method, the substitution method, and the simplex method.

Keywords: E-Module, Independent Teaching, Covid-19

Introduction

Information and Communication Technology (ICT) in the 21st century is something that can no longer be avoided by its impact on human life in meeting their daily needs. ICTs play an important role in the workplace, business, education and entertainment. Additionally, many people recognize ICT as a catalyst for change; changes in working conditions, handling and exchange of information, teaching methods, learning approaches, scientific research, and access to information (Mikre, 2011). In the field of education, ICT has enormous potential as a means of developing skills in the learning process. Technology will help make it easier to develop all types of skills in thinking, from the most basic level of thinking to critical thinking skills (Muderawan, 2011).

In the era of the Industrial Revolution 4.0 and with the current conditions of the Covid 19 pandemic, technology has become the main thing in all areas of life, including education. All schools and colleges in almost all countries affected by Covid-19 have a policy of home learning or distance learning. Distance learning does not have direct face-to-face interaction between teacher and learner (Munir, 2009). In practice, teachers must find and prepare various ways so that learning materials can be conveyed and received well by learners. Online learning is carried out using various platforms or applications such as ZOOM, Google Hangout Meets, Edmodo, Google Classroom, and many more. In addition, educators are also required to prepare all learning tools that support online learning. One of them is preparing teaching materials in the form of modules that can be studied independently by students (Mardia & Sundara, 2020).

Based on the evaluation of online learning in Matrix and Determinants courses, Economic Mathematics, and Applied Mathematics, it is found that students still experience difficulties in implementing online learning such as difficult signals, fast quotas run out, and some still do not understand the course material properly. Students feel that they can understand the lecture material by using video then do practice questions discussed in groups and discuss the material together with the lecturer. Students feel comfortable and compatible with such learning rather than just using web meetings. With the video explaining the material, students can play the video and read the material given over and over again.

With the problems and input from students, a learning medium is needed. According to (Greenhow & Lewin, 2015; Setyansah & Apriandi, 2019; Arsyad, 2015; Afgani, Darmawijoyo, & Purwoko, 2008; Dabbagh & Kitsantas, 2012; , learning media can improve student understanding. The learning media to be developed combines material exposure, video explanation, and practice questions. For this reason, it is necessary to make learning media in the form of an Electronic Module (E-Module) which can help students understand the lecture material. Students can read material, play videos, or do practice questions. According to Muhtadi (2018) the electronic module (e-module) itself is almost the same as an e-book. The difference is only in the content of the two. E-module is a module in digital form, which consists of text, images, or both containing digital electronics material accompanied by simulations that can and are suitable for use in learning.

Related to the effort to implement learning that helps students learn independently is by making an E-Module in which there is a video that can be opened anytime and anywhere so that students can study according to their abilities. For this reason, it is important to make an E-Module on linear programming material with linear programming problem solving materials using the graph method, the substitution method, and the simplex method.

Method

This research is a qualitative descriptive research. The subjects of this study were students of the Mathematics Education Study Program of the Sarjanawiyata Tamansiswa University Semester III. Data collection techniques used in this study were observation, interviews, and literature review. The data analysis process begins by examining the available data from various sources through interviews, observation and literature review. The analysis in this study includes four main things, namely data collection, data reduction, data presentation, and drawing conclusions.

Results and Discussion

During the Covid 19 pandemic like today, face-to-face learning in class was replaced by online learning which was implemented virtually using existing platforms such as Google Meet, ZOOM, Online Learning Systems, and others. Based on the evaluation of the implementation of learning in the previous semester, it was found that students had difficulty understanding the material by means of online learning. Students need teaching materials or learning media that can help understand the material independently and can be repeated at any time. Therefore, observations and interviews were carried out on third semester mathematics education study program students who were taking linear program courses.

Observations were made online through the UST Online Learning System. Observations are made by making observations when students discuss in discussion forums. From the observations it is known that students have difficulty understanding the material given. To further analyze the difficulties experienced by students, interviews were conducted with several students.

Interviews with several students were conducted via Whatsapp then followed by a question and answer discussion using Google Meet. From the interview results, it was found that students needed teaching materials and learning videos that could help students understand linear program material. This is because students do not have reference books because they cannot borrow books from the library or borrow books from friends, besides that, students are also confused when accessing material from the internet. Based on the results of observations and interviews, it can be seen that a linear program module is needed that can be accessed anytime and anywhere as well as a learning video that supports the explanation of the material.

With online learning as it is now needed an electronic module (E-Module) accompanied by a learning video. To make an E-Module along with a learning video, several supporting applications are needed. Applications that can be used in making videos and also E-Modules include Microsoft Word, Microsoft Power Point, Camtasia, Flip PDF Professional. Microsoft Word is used to write material, sample questions, and practice questions which are then created in PDF format. Microsoft Power Point is used to create material that will be used as a learning video. After the material is finished, the material explanation is recorded and edited using Camtasia. When the materials and videos are ready then made into a flip book using Flip PDF Professional.

The material to be discussed in the E-Module is linear program material, therefore a literature review is carried out regarding the linear program material reference. From the results of the literature review, it is found that the material for linear programming includes solving linear programming problems using the graphical method, the substitution method, and the simplex method with various kinds of problem forms. Linear programming problems can be in the form of linear programming problems or in the form of story problems. If it is in the form of a mathematical model, it can be solved immediately, but if it is in the form of a story problem, it must first be converted into a mathematical model with the formulation of a linear program problem. To solve linear programming problems, one of them uses the graphical method. The use of the graph method can be the extreme point method (corner point) and also the search line method. Solving linear programming problems with the graph method means that the problem must be answered by drawing a graph of all the constraints on the Cartesian coordinates to determine the feasible area used to determine the value of the objective function. The drawback of solving using the graphical method is that the linear programming problem that is solved is limited to only two variables. If there are more than two variables it will be difficult to solve with the graphical method. To overcome this problem, other methods can be used. If a linear program problem has two or more variables, it can be solved using the substitution method and the simplex method. The substitution method for solving linear programming problems is by finding the value of all the basis answers. To find all the basic answer values, value substitution is

carried out on all the constraints of the canonical form of the linear program problem. If there are enough variables in a linear programming problem it will be long enough to solve it. For this reason, if there are enough variables in a linear program problem, for example 4 or more variables, then you can use the simplex method. The simplex method is a method of solving linear program problems using simplex tables and is also solved using elementary line operations.

The E-Module in this linear program material contains an introduction, a description of the material, sample questions, and practice questions. In this E-Module a learning video will also be made that supports the explanation of sample questions. The introduction contains instructions for using the module and the contents of the module. In the material description, linear program material is explained. This E-Module is also equipped with example questions which are explained using the learning videos. After that, readers can deepen their understanding of the material by doing the exercises provided in the E-Module. One example of the E-Module content on linear program material is as follows:

PENYELESAIAN PROGRAM LINEAR DENGAN METODE SIMPLEKS

Algoritma simpleks adalah suatu prosedur iterasi untuk mendapatkan solusi dasar yang feasible dari sistem persamaan dan jawab yang optimum. Langkah pertama dari algoritma simpleks adalah mengubah pertidaksamaan-pertidaksamaan pada pembatas menjadi persamaan-persamaan. Koefisien-koefisien dari fungsi obyektif dan persamaan-persamaan dalam pembatas dan nilai-nilai pada ruas kanannya dicantumkan dalam suatu tabel yang disebut tabel simpleks. Kemudian dicari penyelesaian yang optimum. Langkah-langkah algoritma simpleks adalah sebagai berikut:

1. Bentuk masalah program linier menjadi bentuk kanoniknya (kendala menjadi SPL)
   Untuk program linear dengan kendala umum kita lakukan sebagai berikut:
   a. Masukkan variable slack S_k jika dalam kendala terdapat k buah kendala bertanda $\leq b$ dengan $S_k \geq 0$ yang akan mengubah kendala bertanda $\leq$ menjadi persamaan.
      Misalkan kendala,
      $a_1x_1 + a_2x_2 + \cdots + a_nx_n \leq b$
      Diubah menjadi
      $a_1x_1 + a_2x_2 + \cdots + a_nx_n + S_k = b$
      Dimana S_k adalah variable slack.
   b. Misalkan terdapat j kendala bertanda $\geq b$ maka kita masukkan variable surplus dengan $S_j \geq 0$ yang akan mengubah kendala bertanda $\geq$ menjadi persamaan. Akan tetapi dalam tabel awal akan terdapat kolom-kolom yang berlabel variable surplus S_j. Oleh karena itu, kita juga akan memasukkan variable artifisial q_j dengan $q_j \geq 0$ dimana akhirnya variable artifisial q_j harus bernilai nol agar titik sudut menjadi solusi layak pada soal aslinya.
      Misalkan kendala,
      $a_1x_1 + a_2x_2 + \cdots + a_nx_n \geq b$
      Diubah menjadi
      $a_1x_1 + a_2x_2 + \cdots + a_nx_n - S_j + q_j = b$
      Dimana S_j adalah variable surplus dan q_j adalah variable artifisial / atribut.
   c. Untuk kendala bertanda sama dengan (=) hanya memerlukan variable artifisial / atribut q_t dengan syarat seperti di atas. Jadi untuk kendala umum, setiap kendala akan memuat variable slack atau variable artifisial. Jadi variable slack dan variable artifisial pada tabel awalnya diambil sebagai variable basis terhadap titik sudut masalah bertambah. Tetapi kita masih belum mempunyai solusi basis layak untuk soal aslinya. Dengan kata lain variable artifisial harus dibuat menjadi nol.
      Suatu peubah artifisial hanya merupakan peubah boneka ("Dummy" variable) yang ditambahkan pada pertidaksamaan-pertidaksamaan atau persamaan-persamaan dari pembatas
   d. Pertanyaannya adalah "Bagaimana membuat tabel awal dan kemudian mereduksinya sedemikian sehingga variable artifisial tersebut menjadi nol?". Tekniknya adalah dengan memodifikasi fungsi tujuan P, yaitu:

      $$P = c_1x_1 + \cdots + c_nx_n$$

      Dimodifikasi menjadi
      $P = c_1x_1 + \cdots + c_nx_n + 0S_1 + 0S_2 + \cdots + 0S_k - Mq_1 - Mq_2 - \cdots - Mq_t$
      (Untuk soal maksimum) atau
      $P = c_1x_1 + \cdots + c_nx_n + 0S_1 + 0S_2 + \cdots + 0S_k + Mq_1 + Mq_2 + \cdots + Mq_t$
      (Untuk soal minimum)
      Dengan $q_1, q_2, \ldots, q_t$ adalah variable artifisial dan M adalah bilangan yang cukup besar. Metode ini disebut sebagai Metode "Big M"

Dalam masalah memaksimumkan fungsi obyektif, koefisien dari peubah-peubah artifisial dalam fungsi obyektif dipilih sekecil mungkin. Sedangkan dalam masalah meminimumkan fungsi obyektif, koefisien dari peubah artifisial dalam fungsi obyektif dipilih sebesar mungkin. Untuk menunjukkan besar atau kecilnya koefisien dari peubah artifisial pada fungsi obyektif biasanya dipakai huruf "M" (karenanya disebut cara "Big M"). Peubah artifisial akan diperlukan pada masalah memaksimumkan atau meminimumkan suatu fungsi obyektif jika terdapat pertidaksamaan pada pembatas berbentuk $\geq b$ atau/dan $= b$

2. Susun tabel awal simpleks

	c_j	c_1	$\cdots$	c_k	
c_b	$Basis\ (x_i/x_j)$	x_1	$\cdots$	x_k	$Jawab\ (b_i)$
0	s_1	a_{11}	$\cdots$	a_{1n}	b_1
$\vdots$		$\vdots$		$\vdots$	$\vdots$
0	s_l	$\vdots$		$\vdots$	$\vdots$
$\vdots$		$\vdots$		$\vdots$	$\vdots$
0	s_m	a_{m1}	$\cdots$	a_{mn}	b_m
	z_j				P
	$c_j - z_j$				

Keterangan:

1. Baris pertama dari tabel memuat koefisien-koefisien dari $x_1,\ x_2,\ \ldots,\ x_n$ pada fungsi obyektif
2. Koefisien-koefisien dari $x_1,\ x_2,\ \ldots,\ x_n$ pada pembatas terdapat pada baris 3, 4, 5, … pada table $(a_{ij} = koefisien\ teknis)$
3. b_i = nilai kanan fungsi kendala / suku tetap $(b_i > 0)$
4. Kolom yang diberi nama "basis" memuat peubah-peubah dasar. Pada permulaan peubah-peubah slack berada pada kolom basis ini.
5. Kolom yang diberi nama c_b berisi koefisien-koefisien dari peubah-peubah dasar pada fungsi obyektif
6. Baris yang diberi nama z_j memuat jumlah perkalian bilangan-bilangan yang ada pada kolom c_b dengan kolom x_j
7. Baris yang diberi nama $(c_j - z_j)$ memuat selisih dari koefisien x_j pada fungsi obyektif dengan z_j
8. Nilai P, fungsi obyektif pada tabel simpleks awal adalah nol. Pada tabel tampak pada kolom solusi baris terakhir.

3. Uji Keoptimumn
   a. Untuk masalah memaksimumkan fungsi obyektif, tabel sudah optimum apabila $c_j - z_j \leq 0$ (semuanya bernilai nol atau negatif).
   b. Untuk masalah meminimumkan fungsi obyektif, tabel sudah optimum apabila $c_j - z_j \geq 0$ (semuanya bernilai nol atau positif).

4. Mengubah penyelesaian layak basis
   Mengubah penyelesaian layak basis mempunyai makna mengganti suatu variable basis dengan variable basis baru.
   a. Mencari variable masuk (akan menjadi variable basis baru)
      - Jika masalahnya memaksimumkan fungsi obyektif, maka variabel dengan $(c_j - z_j)$ yang terbesar terpilih menjadi variable masuk. Misal $c_j - z_j$ terbesar maka x_k menjadi variabel masuk.
      - Jika masalahnya meminimumkan fungsi obyektif, maka variabel dengan $(c_j - z_j)$ yang terkecil terpilih menjadi variable masuk. Misal $c_j - z_j$ terkecil maka x_k menjadi variabel masuk.

   b. Mencari variable keluar (akan digantikan oleh variabel masuk)
      Berdasarkan kolom variabel masuk (kolom pivot / kunci) kemudian menentukan nilai R. Menentukan R dengan cara $R = \frac{b_i}{a_{ik}}$, dengan $a_{ik} > 0$.
      Pada kolom koefisien x_k tentukan rasio R, pilih R terkecil maka s_l menjadi variable keluar. Baris yang memuat variable keluar disebut baris pivot / kunci.
   c. Kemudian susun tabel baru dengan susunan variable basis barunya adalah $s_1, s_2, \cdots, s_{l-1}, x_k, s_{l+1}, s_m$ dan a_{lk} menjadi elemen pivot. Elemen pivot adalah elemen yang terletak pada perpotongan kolom pivot dan baris pivot. Elemen pivot akan menjadi dasar perhitungan untuk tabel simpleks berikutnya. Pada kolom ke-k, a_{lk} harus menjadi 1 dan $a_{ik} = 0, \forall i \neq l$, sehingga a_{ik} menjadi vektor basis baku baru.

Perubahan tersebut dilakukan dengan OBE dan berlaku untuk semua elemen pada baris yang sesuai sehingga diperoleh tabel baru.

5. Lakukan langkah 3 dan 4 hingga optimum tercapai.

Contoh Soal:
Selesaikan soalberikut dengan menggunakan metode simpleks !

1. Maksimumkan $P = 6x + 4y$
   Terhadap kendala : $x + y \leq 3$
   $2x + y \leq 5$
   $x, y \geq 0$

2. Minimumkan $Z = 10x + 5y$
   Dengan pembatas : $4x + 3y \geq 20$
   $6x + 2y \geq 22$
   $x, y \geq 0$

3. Maksimumkan $F = x_1 + x_2$
   Terhadap kendala: $-2x_1 + x_2 \leq 2$
   $2x_1 + x_2 = 9$
   $3x_1 + x_2 \geq 11$
   $x_1, x_2 \geq 0$

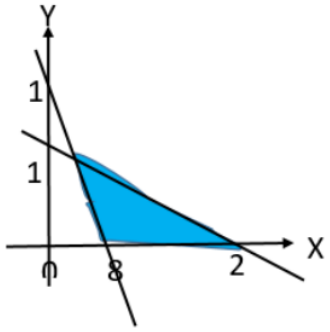
Latihan Soal
Selesaikan soal – soal berikut ini dengan menggunakan metode simpleks!

1. Maksimumkan $f(x_1, x_2, x_3, x_4) = 5x_1 + 3x_2 + 2x_3 + 0x_4$
   Terhadap kendala : $4x_1 + 5x_2 + 2x_3 + x_4 \leq 20$
   $3x_1 + 4x_2 - x_3 + x_4 \leq 30$
   $x_1, x_2, x_3, x_4 \geq 0$

2. Minimumkan $P = 10x + 3y + 10z$
   Terhadap kendala : $5x + y + z \geq 20$
   $x + y + 4z \geq 30$
   $x, y, z \geq 0$

3. Minimumkan: $F = 5x + 4y$
   Dengan constrain : $2x + y \geq 6$
   $-x + 3y = 4$
   $3x + 5y \leq 30$
   $x, y \geq 0$

4. Dengan menggunakan Metode Simpleks, tentukan nilai maksimum $F = x + 2y$ pada daerah yang diarsir berikut:



5. Seseorang yang melakukan diet dengan mengkonsumsi protein tinggi dan karbohidrat rendah membutuhkan setidaknya 100 unit protein dan maksimal 24 unit karbohidrat per hari. Diet tersebut meliputi diet 3 makanan cair khusus A, B, dan C. Kandungan dan daftar harga makanan diet tersebut ditunjukkan pada Tabel 1. Berapa banyak botol untuk masing-masing merk makanan diet yang harus dikonsumsi setiap hari untuk memenuhi kebutuhan protein dan karbohidrat yang dibutuhkan dengan biaya minimal? Berapa biaya minimalnya?

Tabel 1

	Unit per botol		
	A	B	C
Protein	10	10	20
Karbohidrat	2	3	4
Biaya per botol	$6	$4	$9

Conclusion

To support learning linear programming online, it is necessary to make an E-Module on linear program material. With the E-Module in linear program material equipped with learning videos where the E-Module contains an introduction, a description of the material, sample questions, and practice questions for problem solving materials using linear programming using the graph method, the substitution method, and the simplex method are expected to be help students study and understand linear program material.

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III.C.6. UST

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