

Designing Student Worksheets (LKM) Based on the Rigorous Teaching and Learning (RTL) Model

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ABSTRACT

This research aims to design Student Worksheets (LKM) for the Discrete Mathematics course, where the LKM design is structured so that the LKM can be used in the Rigorous Teaching and Learning (RTL) learning model. The results of the lecturers' reflections found that the main problem lies in the content of the material in textbooks which is not interesting, students are often unable to understand the textbooks they own, especially in solving the questions given. This has implications for 1) lack of motivation to learn, 2) lack of understanding of the material, 3) fear of expressing opinions, and 4) lectures are less effective and less enjoyable. Therefore, teaching materials need to be packaged appropriately according to the substance and conditions of students in LKM. The research design used in this research is Thiagarajan's 4-D development model. This model is a system of educational development approaches that are carried out in 4 sessions, namely Define or Introduction where in this session preliminary analysis, student analysis, and needs analysis are carried out, Design or Planning where in this session validation and limited trials are carried out, as well as Disseminate or Disseminate where in this session the LKM is given to the teaching lecturers. This research produces an LKM that is used in Discrete Mathematics courses.

Keywords: student worksheet, discrete mathematics, rigorous teaching and learning

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Introduction

Learning mathematics is one of the most important lessons at every level of education (Pono & Lutfi, 2012; Wanti, 2017) . With mathematics, someone will be able to think more critically, and creatively, be able to solve problems, and think logically (Purwanto et al., 2019) . Therefore, it is very important to provide an interesting and enjoyable learning experience so that students can receive mathematics learning well. To provide interesting learning, we need a way to improve the quality of learning (Febriani, 2016), namely by determining the right way of learning for these students. With the demands of the 21st century, with the main aim being to build individual learning abilities and support their development to become lifelong, active, and independent learners, students are expected to be more active in the ongoing learning process (Etistika Yuni Wijaya et al., 2016; Mellick, 2018).

According to Syah (Rusno, 2011) some factors influence student activity in learning, namely internal and external factors, where internal factors are factors that originate from the students themselves

which include 1) Physiological factors which include physical health, 2) psychological factors which include: attention, talent, interest, motivation, maturity, and readiness. (Rusno, 2011) found that the internal factors mentioned by Syah were the dominant factors influencing students' activeness in the learning process. To create activity in students, it is very necessary to apply active learning strategies that lead to managing learning individually or in groups and placing students as subjects who must plan, explore, interpret, and evaluate their learning results. Teachers as facilitators must always be ready to serve students' learning needs (Andrias, 2011). Teachers are required to be able to create active and enjoyable learning situations so that they can support the optimal absorption of material by students (Febriani, 2016).

Activeness in the learning process is a very important internal affective domain. Educational experts and researchers have emphasized that activity can support successful learning. (Ibrahim, 2021) in a study revealed empirical findings that student activity in the active learning process is very effective in increasing student learning success. According to (Pratiwi, 2017) there is a positive and significant influence of student activity on learning outcomes. Utomo and Ruijter (Febriani, 2016) also stated that "Learning actively in varied ways while paying attention to the structure will be understood better and will be remembered longer." These findings reinforce the importance of the active aspect in participating in learning. Efforts to increase student activity require practicing educational innovations that can make students more active when exploring education, one of which is the educational model used (Ibrahim, 2021; Rustini, 2021).

One learning model that requires student activity is Rigorous Teaching and Learning (RTL). According to Rhodes (Hamid, 2016) Hamid emphasized that there are 3 characteristics of students who participate in rigorous learning, namely: 1) they display a set of attitudes that include task intensity, orderly arrival, and prolonged attention. 2) emotionally, they display excitement, interest in learning, and a sense of belonging, 3) they display cognitive engagement by taking on academic challenges, a positive self-concept, and a willingness to continue learning. RTL has core components that will increase the effectiveness of teachers in advancing student learning. If this component is applied in the lecture process, it is assumed that students will achieve great learning outcomes according to the expected educational focus. According to (Rustianingsih & Manoy, 2013) RTL meets the effective criteria for increasing student activity and results in positive student responses.

Active and fun learning is learning that can be enjoyed by each student so that each individual can devote their attention to the learning process (Indartiwi et al., 2020). Meanwhile, study and learning activities will be disliked if students are in an atmosphere of pressure, threat, fear, feeling, lack of enthusiasm, feelings of boredom, laziness, and monotonous learning (Febriani, 2016). This problem also

arises in learning Discrete courses, especially in the Mathematics Education Study Program at Tanjungpura University. From observations of the lecture process, aspects of student activity in attending lectures need serious attention.

Based on the results of reflection on the Discrete lectures carried out, the main problem lies in the content of the material in the textbook, which is not exciting and makes students bored (inactive), especially when it is only packaged with lecture methods and assignments as has been the case so far. Through interviews conducted with several students who took Discrete courses, it was found that students were often unable to understand the textbooks they had, especially in solving the questions given; of the 28 students in 1 class, data was obtained that only around 22% passed. This has implications for 1) lack of motivation to learn, 2) lack of understanding of the material, 3) fear of expressing opinions, and 4) lectures could be more effective and enjoyable. Therefore, teaching materials must be packaged well with suitable substances, considering the conditions of students equipped with LKM.

According to (Febriani, 2016) there are at least three scientific arguments that confirm the effectiveness of using LKM to increase student activity. First, is the part of the teaching materials that will provide stimulus to students to make them more active. Second, worksheets are used as a learning resource by students. Third, worksheets can also be a means used by students to convey information that cannot be conveyed orally (see Ministry of Education 2006 (Khikmiyah & Midjan, 2017; Ratnasari, 2019)).

Based on the things that have been explained, it is important to design an attractive LKM to be used in the Discrete mathematics learning process based on the RTL learning model in the mathematics education study program of the Faculty of Teacher Training and Education (FKIP) Tanjungpura University (Untan) Pontianak. Specifically, the research question asked in this study is how to design LKM based on the RTL learning model.

This research was carried out to produce an LKM based on the RTL learning model and through this research, it is hoped that it can produce a product in the form of an LKM with preparation based on the RTL learning model which will then be applied in subsequent research. Furthermore, the findings of this research can be published in accredited journals and become study material and input for developing the RTL learning model to support the formation of student activity in the lecture process.

Methods

This model is a system of educational development approaches that are implemented through four sessions, namely Define, Design, Develop, and Disseminate below we describe the stages used in this research based on the 4-D model (Anugraheni, 2018; Hasbi et al., 2021; Prayogo & Suwono, 2021).



This research was conducted from May to November 2023 in the mathematics education study program at FKIP Tanjungpura University, even the semester of the 2023/2024 academic year in the Discrete Mathematics course.

No	Development	Stage Description			
	Stage				
1	Define	Preliminary analysis at this stage is carried out by analyzing the curriculum, as well as the learning objectives, and what students' needs for LKM.	Student analysis at this stage will explore information about the student's initial abilities regarding the material	Material analysis at this stage explores the concept of the material being taught and how it is related	
2	Design	Format selection at this stage will be the format used to design the LKM	The initial design at this stage will be a draft LKM with its components	In the design preparation at this stage, each component of the LKM will be explained	
3	Develop	Expert validation is carried out by submitting a complete LKM draft to be validated internally by experts.	Trial, the LKM that has been validated and revised is then carried out in a limited trial		
4	Desseminate	Valid LKM are distributed to lecturers who teach Mathematics Diskrit			

Table 1 Stages of LKM Development

In this research, the criteria for the validity of the LKM are suitability of the LKM to the learning objectives, material taught, student needs, and readability of the language in the LKM.

Results and Discussion

Define

preliminary analysis

At this preliminary stage, curriculum analysis is carried out on Discrete Mathematics material. This course studies Power Sequences and Series, Mc Laurin Expansion/Taylor series, Generating Functions, Generating Functions for combinations, Generating Functions for permutations, Introduction to Graph Theory which includes definitions/terminology, isomorphism and sub-graphs, graph connectivity, trees, planarity, and graph coloring. In Discrete Mathematics, you are required to have general skills, namely, students will have logical, critical, systematic, and innovative thinking and apply it to discrete mathematics.

Discrete Mathematics courses also require special skills, namely mastering mathematical theoretical concepts, especially geometry, mathematical logic, algebra, analysis, mathematical modeling, and



calculus which supports mathematics learning in primary and secondary education as well as further studies.

Meanwhile, the learning outcomes for the Discrete Mathematics course are that students can master and apply the concept of generating functions to solve problems of selecting, selecting, and distributing objects involving combination and permutation cases and students can master and explain the basic terminology in graph theory, and use it in solving problems.

Student Analysis

Active and fun learning is learning that can be enjoyed by each student so that each individual can devote their attention to the learning process (Indartiwi et al., 2020). Meanwhile, learning becomes unpleasant if students are in a depressed atmosphere, feeling threatened, scared, helpless, unenthusiastic, lazy, bored, and in a monotonous (Febriani, 2016). This problem also arises in learning Discrete courses, especially in the Mathematics Education Study Program at Tanjungpura University. From observations of the lecture process, aspects of student activity in attending lectures need serious attention.

Based on the results of reflection on the Discrete lectures carried out, the main problem lies in the content of the material in the textbook which is not interesting and makes students bored or inactive especially when it is only packaged with lecture methods and assignments as has been the case so far. Through interviews conducted with several students taking Discrete courses, it was found that students were often unable to understand the textbooks they had, especially in solving the questions given. This has implications for 1) lack of motivation to learn, 2) lack of understanding of the material, 3) fear of expressing opinions, and 4) lectures are less effective and less enjoyable. Therefore, teaching materials need to be packaged appropriately according to the substance and conditions of students in the form of Student Worksheets (LKM).

Material Analysis

Course learning outcomes in the Discrete Mathematics course means that students can hold and apply the concept of generating functions to solve problems of selecting, selecting, and distributing objects involving combination and permutation cases and students can master and explain basic terminology in graph theory, and use it in solving problems. However, in this research, students will be able to hold and apply the concept of generating functions to solve problems of selecting, selecting, and distributing objects involving combination and permutation cases. So the material that will be included in this LKM is: Power sequences and series, Mc Laurin expansion and Taylor series, ordinary generating functions and exponential generating functions, generating functions for combinations, and generating functions for permutations.

Design

The LKM format used in this research refers to research conducted by (Hamid, 2016).

Meeting 1 to 3
11200000 1 1000
Faculty :
Study Program :
Course :
Course Code :
Time Allocation :
Learning Outcomes :
Indicator:
Matterial:
Learning Methods:
Langkah-langkah Pembelajaran:
A. Learning Steps :
B. Core Learning Activities :
1. Communicate explicitly and with clarity
2. Involve students in learning
3. Question, probe, and facilitate discussion
4. Provide feedback to students
5. Use various grouping structures
C. Final Learning Activities:
D. Final Test:
E. Learning Auds and Resources
1. Aids
2. Resources:
HOME WORK
Kelompok:
Nama:
1
1
2
3NIM:
5
4
7
5NIM:
5
6NIM:
V.



	LKM	
	(Meeting -01)	
Faculty	: KIP	
Study Programs	: Mathematics Education	
Courses	: Discrete mathematics	
Material	: Generating function	
Sub Material	: Barisan & Deret Kuasa, Ekspansi Deret Taylor/Mc Laurin.	
Time	: 3 x 50 menute	
Semester	: V/odd	

Instructions:

- Student worksheets are a medium for discussion within a group or between groups
- Fill in and complete the statement and answer the questions in the space provided on the LKM
- Each group is required to fill in and complete the answers to 2 (two) LKMs and then one LKM is submitted to the lecturer concerned and the other one becomes group documentation
- If you feel it is necessary, you are allowed to ask and clarify questions from the lecturer Material

Initial Planning

After the format is determined, the LKM is designed

Satuan Acara Perkuliahan (SAP) SATUAN ACARA PERKULIAHAN PREFKULIAN KE-1 siti KE-1	Doten mengawali perkuliahan ini dengan apersepsi tentang limit dan memutanuliasikan jika limit tersebut ada, muteri apersepsi iai berkaitan dengan muta kuliah Kakhusi yang peranda dengorgamkan oleh makaistwa. Sadangtatya doten	(1). Dosen bersama-sama dengan tim observer melakukan evaluasi terhada struktur pengelompokkan yang talah ditetapian agar lebih fieksibel da responsi sehingga bia memakimatakan belajar mahasiwa.
Pakulas : KIP Pakulas : KIP Program Studi : Pendidikan Matematika	mengiatakan modal pembelajaran yang akan diterapkan yakai model régorosa tearking <i>and learning</i> (RTL) diantaranya menyampaikan saaran dan tujuan serta langkah-langkah yang alam dilakukan dalam pembelajaran ini.	(2). Doien bettemin dengan kelompok-kelompok kecil mahasitwa untu memenuhi kebutuhan belajar khusus dalam materi Matematika Diskrit.
Mata Kuliah : Matematika Diskrit Kode Matakuliah : KDM 614	B. Keriatan Inti Pembelaiaran:	C. Kegiatan Akhir Pembelajaran:
Alokasi Waku : 3 x 50 menit	Berkomunikasi secara ekuplisit dan dengan kejelasan	 Memberikan kesempatan kepada mahasiswa untuk merangkum mater pembelaiaran yang telah diberikan diantaranya tentang pengertian limi
Capaian Pembelajaran (CPMK)	 Detaoliminani securito subgini esperante benefazzarian nama yang (b). Doren meminim mahanisma dorihi benefazzarian pada kelompok tertera pada kelompok tersebut. Penetapan mama-nama pada kelompok berdasarian caronian hasil tes kemamyuan awal mahasinya (KAM). 	primotegaram yang man uropatah mannanya temah pregeruan ini fangsi, penggunaan irriteria $c - \delta$ uniti membuktikan milai limit fingsi yang diketahui, limit sepihak, limit tak hingga dan limit di tak hingga 2. Docem memberikan tes akitur perkulukan secara individu dan tuasa beru
 Mampu menguasai dan mengaplikasikan konsep fangsi pembangkit untuk menyebesikan masalah pemilihan, penyeleksian dan pendistribusian obyek yang melihatkan kasus kombinasi dan permutasi 	 Ostrakatika capitani kani ter Armanipula stati manasuwa (xx.u), Bargabaya anggota dalam (alkangota makimtani dorang, Chargabaya anggota dalam (alkangota makimtani dorang, Chargabaya anggota dalam (alkangota makimtani dorang, Chargabaya anggota dalam (alkangota makimtani dalam (alkangota makimtani dalam proses nembelatiram, ang yang akan dilakukan oleh malassiven dalam proses 	2. Dosen interimentata tes acuti percutatada secura intervioù dan tugas verup toa a soal i arbina untuk dikerjakan di rumah dan dikumpukan pad pertentuan berkennya.
Indikator		D. Tes Akhir:
 Mampu membuat ekspansi dari suatu fungsi f(x) yang didasarkan pada MeLaurin/ Deret Taylor untuk x = 0 	 Melibatkan para mahaniswa dalam belajar Dalam LKM-01 pertanyaan-pertanyaan yang diberikan berusaha menembanikan dan meneriktifkan penertahnan yang memerlukan 	 Teentukan fangsi pembangkit ekoponensial dari (a_n), a_n =
 Mampu menentukan fungsi pembangkit biasa dan fungsi pembangkit eksponensial dari suatu barisan, dan sebaliknya. Mampu menanahisi dan terampi dalam menerapkan konsep fungsi 	pemikiran mahasiswa dalam proses pengerjaannya. (2). Selama mahasiswa mengerjakan LKM-01, dosen akan melakukan pemantuna dan memberikan butuan apahla mahasinwa memerihikan.	$\begin{array}{llllllllllllllllllllllllllllllllllll$
pernbangkit untuk menyvlesalkan masalah yang terkait dengan kombinasi dan pernutasi. 4. Mampu membuktikan beberapa sifat dari suatu fungsi pembangkit yang diberitar	(3). Selama proses mengenjakan LKM-01, dosen haru memberkan isesengatan untik mendikotukan isi-si-sie mersika, membraikan konsisi dan mengintegrasikan pembelajaran baru dengan pembelajaran sebelumnya. (4). Mahajunya mengriskan LKM-01 secara beramana direma kolomokra	 Berapa benyak susuan 6 huruf yang mungkin dibentuk dari hurup dalar kata "ABFACADARA"? Ada berapa cata yang dapat dilakukan untuk menyeleksi 10 bush huruf dan kata "SHALIEP" anabida diserventakan andiar unduk sust."
Materi	(4). Voiminiva mengejakan LKNOVI secar deriaman dengan kedenpoknya berdasarkan contoh yang diberikan, selanjutnya mengumpulkan hasil pakariaan ke doren.	banyak tiga "L"? 5. Jika $P(x)$ adalah fungsi pembangkit biasa dari (a_n) . Tentukan (a_n)
 Barisan dan deret kuasa Ekspanni Mc Laurin dan deret Taylor Funni yomburkit biasa dan Funni yombunzkit eksponensial 	 Pertanyaan, menyelidiki, dan memfasilitasi diskusi (1). Dosen memberikan kesempatan kepada salah sata kelompok secara berrilitan das berrantiau untuk dibahas secara klasikal. Dalam proses 	a) $P(x) \equiv x^{\pm} \left(\frac{1}{1+x_{\pm}}\right)$ b) $P(x) \equiv \left(\frac{3}{1-x}\right) \left(\frac{3}{1-x}\right)$
 Fungsi Pembangkit untuk Kombinasi Fungsi Pembangkit untuk Permutasi 	pembahasan hasil kerja kelompok, ditekankan menggunakan komunikasi multi arah (dosen-mahasiwa dan antar mahasiwa dangan dosen sebagai fasilitann)	E. Alat Bantu dan Sumber Belajar
Metode Pembelajaran:	(2). Dalam proses diskusi dosen memberikan pertanyaan-pertanyaan yang membanskitkan rasa ingin tahu yang memerjukan pemikiran kreatif dan	 Alat Bantu: Satuan Acara Perkuliahan (SAP)
Metode dalam pembelajaran yakni menggunakan strategi pemanfastan Argumen Informal melahi model <i>Rigorou: Rocking and Learning (RTL)</i> . Lanckab-lanckah yang pertu ditemuruh dalam pembelaisaran RTL adalah: (1)	kritis serta analinis kepada mahasiswa untuk menguraikan inangelaborasi dan membaggun ide-ide serta mempertanyakan dan menantang ide-ide satu sama lain.	 Lembar Karja Mahaninwa-01 (LKM-01) Spidol Boardmarker, Karton, Lakban, Infocus dan Alat Tulis.
Lengthermington yang peris unempoin tentan periorminata keta sanata, (s) Berkomminasi secara tekpisita din dengan kejelasan, (2) Mellovikan para mahasiwa dalam belajar, (3) Perturyaan, menyelikiki, dan memfatilistasi diskasi, (4) Memberikan mupan balik kepuda siruwa, (5) Menggunakan bergagai truktur pengelompokan.	 Memberikan umpan balik kepada sitwa Down berama-sama denga mahasinwa memberikan umpan balik secara ekopisiri dan konstruktefi rumki menghindari kesalahpaharam dan kebingman dari menya tesha diselahiri adan seteraman ini. 	 Sumber Belajar. [1] Tommend, M. 1987. Discrete Mathematics : Applied Combinatorics and Graph Theory. California: The Benjamin Cummings Publishing Co. Inc.
Lanrkah-lantkah Pembelaiaran	 Memberikan kesempatan secara adil bagi mahasiswa untuk memberikan umpan balik sata sama lain. 	[2] Brualdi, R.A. 1982. Introductory Combinatorics. NY: Elsevier Scienc Publishing Co., Inc.
	umpan baluk satu sama lam. 5. Menegunakan berbagai struktur pengelompokan	[3] Chartrand, G., Leuniak, L. 1986. Graphs and Digraphs. Second Edition



 [4] Harju Tero. 2007. Graph Theory. Department of Mathematics University of Turku-Finland. Turku: Lecture Note. 	Lembar Kerja Mahasiswa (LKM-01)	Contoh deret kuasa dalam x, adalah sebagai berikut:
[5] Roberts, F.S. 1984. Applied Combinatorics. New Jersey. Prentice Hall Inc.	Kelompok: Nama;	$\sum_{n} a_n x^n = a_0 + a_1 x + a_3 x^2 + a_3 x^3 + a_4 x^4 + \cdots$
	NIM:	Perhatikan bahwa $a_0 x^{\alpha}$ dianggap sebagai a_0 , demikian pula apabila $x = 0$.
Dosen Mata Kuliah Koordinator,	2	Apabila deret kuasa terus but dapat dijumlahkan, misalkan $S(x)$ maka kita dapat menulli kanava menjadi:
	3NIM:	
Drs. Ade Mirza, M. Pd.	4	$S(x) = \sum_{n=0}^{\infty} a_n x^n = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x^4 + \cdots$
Drs. Ade Mirza, M. Pd.	ś	Apabila x berada dalam suatu selang, maka akan dapat diperoleh turunannya yakni:
	6	$S'(x) = \sum_{n} D_n(a_n x^n) = \sum_{n} n a_n x^{n-1}$
TUGAS RUMAH -01		$= a_1 + 2a_1x + 3a_3x^2 + 4a_4x^3 + \cdots$
Kerjakan Soal berikut pada lembar jawaban yang telah disediakan dan dikumpulkan pada pertemuan kedua.	LEMBAR KERJA MAHASISWA	Selanjutnya, perlu diingat kembali ekspansi Maclaurin pada fungsi $f(x)$ atau ekspansi deret Taylor pada $f(x)$ untuk $x = 0$. Ekspansi tersebut mempunyai bentuk:
Soul :	(Pertemuan ke -01)	
 Termitian fungsi genbangkit dari barisan berikut: a) (2, 2, 2, -) b) (2⁰, 2¹, 2², -) 	Fokultes : KIP Program Studi : Pendilikan Matematika Mata Kuluba : Matematika Diskrit	$f(x) = \sum_{n=0}^{m} \frac{1}{n!} f^{(n)}(0) x^n, \qquad n = 0, 1, 2, 3,$
c) $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2})$	Mata Kullah : Matematika Diskrit Materi : Fungsi Pembangkit Sub Materi : Boritan & Deret Kuasa, Ekspansi Deret Taylor/Mc Laurin.	$= f(0) + f'(0)x + \frac{1}{2!}f'(0)x^2 + \frac{1}{3!}f^{(0)}(0)x^3 + \cdots$
c) $\left(\frac{1}{23} + \frac{1}{34} + \frac{1}{34} + \frac{1}{34} + \dots\right)$ d) $(a_n), a_n = n^2 3^n$ 2. Tenniane Imagi pembangkit eksponensial (FPE) dari barisan-barisan berikut	Sub Materi : Barian & Deret Ruan, Ekspanni Deret Taylor/Mc Laurin. Alokasi Waktu : 3 x 50 menit Semaster : V/Ganjil	Dengan menggunakan formula tersebut, maka dapat diperoleh suatu formula untuk suatu fungsi $f(x)$.
a) $(a_n), a_n = n + 5$ b) $(b_1), b_2 = r!$		Misalkan untuk $f(x) = e^{it}$
 Misalian g(x) adalah fungsi pembangkit dari (a_n), dan h(x) adalah fungsi pembangkit dari (b_n). Buktikan bahwa: 	Petunjuk: Lembar kerja makasiswa adalah media untuk berdiskusi dalam satu kelompok	$f(x) \equiv e^x$ ====> $f(0) \equiv e^x \equiv 1$
a) $\frac{\mu(v)}{(v_1v_2)}$ adalah fungsi pembangkit dari $a_0 + a_1 + \dots + a_n$	 Lentota verja mazasiswa adalar media untuk teriniskusi dalam satu kelompok atau antar kelompok Isi dan lentikupi peruvataan serta jawablah pertanyuan pada tempat yang telah 	$f'(x) = \sigma^x$ ====> $f'(0) = \sigma^a = 1$ $f''(x) = \sigma^a$ ====> $f''(0) = \sigma^a = 1$
	 isi dan sengkapi peruyutan serta jawaotan pertanyaan pada tempat yang telah disediakan pada LKM Setiap kelompok wajib mengini dan melengkapi jawaban pada 2 (dua) buah LKM 	$f^{(3)}(x) = e^x$ $f^{(3)}(0) = e^x = 1$
 b) (1 - x)g(x) addah tinggi pembangtor dara a_n - a_{n-1} c) (z)(x) = (z) (x) (z) addah tinggi pembangtor dara (C_n a_n + C₂)_n, dengan C₁ datah bilangan teng. 4. Caritah a_n ita fangsi pembangkir eksponensial dari (a_n) addah G(x) = e⁺(1 + x)² 	 Seriag katompok vagio mengin aan mempunga jawatom para a (utar) tuan Letva dan selanjutuya satu LKM diserahkan pada dosen yang bersangkutan dan satu lagi menjadi dokumentani kelompok 	$f^{(4)}(x) = e^x$ ====> $f^{(4)}(0) = e^x = 1$
$e^{x}(1 + x)^{d}$ 5. Carilah a_{n} yang FPE-nya adalah $G(x) = \frac{x(1+n)}{(1+n)}$	 7. Jika dirasa perlu, Anda diperkenankan bertanya dan mengklarifikasi kepada dosen 	$f^{(n)}(x) = e^x \implies f^{(n)}(0) = e^x = 1$
 Outside of program of the article of (1) = (1-8) 	1. Baritan dan Deret Kuasa	Jadi diperoleh:
	Pada perkolikahan kalkubus (voku-boku kalkubus), banyuk dibahar mengenai deret-deret yang terdiri dari konstratus-konstanta yang berbennik $\sum u_{i,i}$ dengan $u_{i,i}$ adalah sebuah bilangan. Demikian pela kalkut dengan deret yang berbennik deret sunan fungai. Deret	$f(x) = e^x = 1 + 1 \cdot x + 1 \cdot \frac{1}{2!} x^2 + 1 \cdot \frac{1}{3!} x^3 + \cdots$
	winningan. Demixican prina namya osngan osngan osres yang berbamak osres tuant rungis. Dene yang berbamak fungsi ni secara unum diqari ditilai sebagai $\Sigma_{n_i}(x)$. Deret fungsi yang berbentuk $\Sigma u_n(x)$ ini dikenal dengan deret kuasa (power zeriez).	= $1 + x + 1$, $\frac{1}{n}x^2 + 1$, $\frac{1}{n}x^3 + \cdots$ atau dapat juga ditulis sebagai berikut.
	are consistent to the second configure operation in the field of the second γ	
$e^x = \sum_{n=1}^{\infty} \frac{1}{n!} x^n = 1 + x + \frac{1}{2!} x^2 + \frac{1}{3!} x^3 + \dots$, $ x < \infty$	2. Operasi Pada Fungsi Pembangkit	Selanjutnya berdasarkan teori tersebut, Anda diminta melengkapi penyelesaian soal
$\sum_{n=0}^{n} n!$ $2!^n$ $3!^n$ $(n!^n)^n$ Demikian pula untuk functi yang lain, dapat dibuat yantu formula dengan menerumakan	Pada operasi fingsi pembangkit, menurut sudut pandang kombinatorik, yang paling menarik adalah operasi perkalian dari dua buah fungsi pembangkit. Sedangkan, untuk	I. Tentukan barisan jika fungsi pembangkit biasa adalah $G(x) = \frac{x^2 + x^4}{1 + x^4}$
cara yang sama. Dari formula tersebut, dapat diperuh beberapa ekspansi deret fungsi yang penting dan banyak digunakan di sini adalah sebagai berikut.	meantik adalah operasi perkalian dari dua buah fungsi pembangkit. Sedangkan, unuk operasi penjumlahan (*) dan pengurangan (·) prinsipnya sama dengan operasi yang telah basa (bernisti linist).	Penyelessian:
Rumus ekspansi 1.1:	Misalkan A(x), B(x), dan C(x) adalah fungri pembangkit biasa dari berturut-turut barisan: (a_n) , (b_n) , $d\alpha n$ (c_n) , maka diperoleh hubungan (rumus 1, 2, & 3) sebagi berikut:	Diketahu i $\mathcal{G}=\frac{x^6+x^6}{1-x}$ atau dapat ditulis $\mathcal{G}(x)=x^6+x^6\left(\frac{1}{1-x}\right)=A(x), \mathcal{B}(x)$ dengan
(1) $e^x = \sum_{n=1}^{\infty} \frac{1}{2} x^n$. (x)	(1) $A(x) + B(x) = (\sum_{n=0}^{m} a_n x^n) + (\sum_{n=0}^{m} b_n x^n) = \sum_{n=0}^{m} (a_n + b_n) x^n$ (2) $A(x) - B(x) = (\sum_{n=0}^{m} a_n x^n) - (\sum_{n=0}^{m} b_n x^n) = \sum_{n=0}^{m} (a_n - b_n) x^n$	A(x) merupakan FPB dari (a_n) dan B(x) merupakan FPB dari (b_n) . Karena itu, kita dapatkan barisan-barisan sebagai berikut.
(1) $e^{x} = \sum_{n=0}^{\infty} \frac{1}{n!} x^{n}$, $ x < \sim$	Untuk operasi perkalian, jika $A(x)$. $B(x) = C(x)$, maka kita dapat memperoleh	(a _n) =
$=1 + x + \frac{1}{2}x^2 + \frac{1}{2}x^3 + \dots$	hubungan antara $\dot{\alpha}_{a}$, $\dot{\alpha}_{a}$, $\dot{\alpha}_{a}$, sebagai berikut. Karena $A(x)$, $B(x)$, $dan C(x)$ masing-masing adalah fungsi pembangkit biasa, maka	(b ₄) =
(2) $\sin \pi = \sum_{n=0}^{\infty} \frac{(-1)}{(2n+1)} \pi^{(2n+1)}$, $ \pi $	diperoleh:	
$(a) \sin a = \sum_{n=0}^{\infty} (2n+1)!^n$ $\leq \sim$	$A(x) = \left(\sum_{n=1}^{\infty} a_n x^n\right) = a_n + a_1 x + a_2 x^2 + a_1 x^3 + \cdots$	Selanjutnya, misalkan ${\cal G}(x)$ adalah FPB dari $(c_n).$ Dengan menggunakan konvolusi maka diperoleh:
$=x-\frac{1}{2}x^{3}+\frac{1}{2}x^{3}-\cdots$	$S(x) = \left(\sum_{n=0}^{\infty} b_n x^n\right) = b_0 + b_1 x + b_2 x^2 + b_3 x^3 + \dots$	
(3) $ln(1 + \pi) = \sum_{n=1}^{m} \frac{(-1)^{n+1}}{n} \pi^n$, $ \pi < 1$		
	$C(x) = \left(\sum_{n=0}^{\infty} c_n x^n\right) = c_0 + c_1 x + c_2 x^2 + c_3 x^3 + \cdots$	Jadi, barisan dari $G(x)$ adalah
$= x - \frac{1}{2}x^2 + \frac{1}{3}x^3 - \cdots$	Salanjutnya, bila kita kalikan $A(\mathbf{x})$ dnegan $\mathbf{B}(\mathbf{x})$ maka diperoleh:	
$(4) \frac{1}{(1-x)} \equiv \sum_{n=0}^{\infty} x^n , x < 1$	$A(x), B(x) = a_0b_0 + (a_0b_1 + a_1b_0)x + (a_0b_2 + a_1b_1 + a_2b_0)x^2 + \cdots$ Schingga diperoleh	II. Carilah barisan bilangan real (a_n) yang memenuhi
x = 0 = 1 + x + x ² + x ² +	$c_0 = a_0 b_0$	$\sum_{n=0}^{N} a_{n}b_{n-k} = 1, \text{ untuk setiap } n \in N$
$(5) \left(\frac{1}{2} - x\right)^2 = \sum_{n=1}^{\infty} n x^{n-1} , x < 1$	$c_1 = (a_0b_1 + a_1b_0)$	「
$(1) \sum_{n=1}^{n} x^n + 4x^3 + 4x^3 + \cdots$	$c_2 = (a_0b_2 + a_1b_3 + a_2b_0)$	Penyelessian: Misalizan $G(x) = \sum_{n=0}^{\infty} a_n x^n$
(6) Teorema Binomial	$c_n \equiv (a_n b_n + a_1 b_{n-1} + a_2 b_{n-2} + \dots + a_n b_n)$	/
Untuk suatu bilangan real u, dan k bilangan bulat non negative, maka	Jära ditulis dalam bentuk sigma, maka diperoleh:	$[G(x)]^2 = \left(\sum_{n=0}^{\infty} a_n x^n\right) =$
$(1 + x)^u \equiv \sum_{k=0}^{\infty} {u \choose k} x^k$, $ x < 1$	$c_n = \sum_{k=1}^{n} a_k b_{n-k} \qquad(*)$	Berdasarkan Konvolasi diperoleh :
$\frac{k-2}{k-2}$	$\frac{d}{d-d}$ Untuk barisan-barisan dari $(a_n), (b_n), dan (c_n)$ yang memenuhi (*) tersebut, maka	Derozenska romvonsu aperosen :
$\operatorname{dengan} \binom{w}{k} = \begin{cases} & & & k > 0 \\ 1 & & & k = 0 \end{cases}$	(c _n)disebut konvolusi dari (a _n) dan (b _n), ditulis dengan notasi (c _n) = (a _n) + (b _n) Jadi, diperoleh 3) A(x), B(x) =	
u = x, 1		
	$A(x)$, $B(x) = \sum_{n=0}^{\infty} \left(\sum_{k=0}^{\infty} a_k b_{n-k} \right) x^n$	

Figure 1. LKM that has been designed

Develop

The LKM that has been designed has been validated by three Mathematics Education Study Program lecturers who are experts in their field. This LKM is validated from the content, namely the suitability of the LKM to the learning objectives, learning materials, and readability of the language in the LKM. From the three validators, revisions were obtained in the material, formula writing, and readability. After the revisions were carried out, the LKM was declared valid because it was in accordance with the learning objectives, material, and readability and was suitable for limited testing. After being declared



valid, the LKM was tested limited to 42 Mathematics students taking discrete mathematics courses consisting of 2 classes.

Desseminate

LKM that has been declared valid is then given to every lecturer who teaches Discrete Mathematics courses.

Conclusion

The LKM designed in research uses the strategy of utilizing Informal Arguments through the Rigorous Teaching and Learning (RTL) model. The RTL steps used are; (1) Communicate explicitly and with clarity, (2) Engage students in learning, (3) Question, probe, and facilitate discussion, (4) Provide feedback to students, (5) Use a variety of grouping structures. However, the preparation of this LKM has shortcomings, the LKM was tested on students who had taken the Discrete Mathematics course in the previous semester, so it was indicated that the students had forgotten the material studied in this course. Furthermore, you can develop Discrete Mathematics LKM to be used more effectively and efficiently by students.

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