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Development of a linear programming module based on the dick and carey program to improve problem solving skills of students at the faculty of teacher training and education Batanghari university Jambi

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ABSTRACT

In the learning process, lecturers provide materials in teaching mode, and students only listen to lectures and concentrate on lectures. The lecture model is still used because students always have difficulties in understanding the material when given assignments or modules. This study aims to develop a linear program module/teaching material that meets the needs of the students of teacher training and education faculty, used the research and development (R&D) method with the Dick and Carey model. The subjects were the students of teacher training and education faculty in the 4th semester of the 2019/2020 academic year, totaling 10 students from Batanghari University, Jambi. The results showed that based on the experts' validation of the module was its effectiveness in increasing students' understanding or how it compared to the previous module. The feasibility percentage of design validation; 93.3%, media validation; 91.3%, and material validation; 93.7%; followed by the one-to-one test with percentage of 93.7%, the group test; 93.5%, and the field test; 87%. In conclusion, the development of linear programming module is feasible and can be used for students of teacher training and education faculty. The implication of this research is that it can be used as a description of the creation of a module using the research and development (R&D) method with the Dick and Carey model.

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Introduction

Mathematics learning has a significant impact on students' capacity for intellectual growth and problem solving (Hanifa 2024). Mathematics learning teaches students how to solve problems creatively and face challenges head-on. Students gain the ability to create problem-solving strategies, test theories, and seek evidence to support their conclusions. These abilities are very useful when trying to solve difficulties in social, professional, and personal areas. In real life, learning mathematics is often full of difficulties. Many students have difficulty understanding mathematical concepts thoroughly and even more so applying these concepts to real-world situations (Mardia and Sundara 2020). Students may not be able to absorb mathematics material well if they do not have the drive and interest in the subject (Johan 2018; Darling-Hammond et al. 2020). To overcome these obstacles, an organized, methodical, creative, and efficient learning design is needed.

University is one of the places for educated workers to train and educate children in the country. It has the right to organize courses individually with respect to course standards (Oktaviani 2024). As a developer of education, the university has to make some innovations. One of the innovations is continuous module development. According to Ahmadi, A., & Amri (2020), modules are classified into four categories, namely visual modules - print and non-print, audio, audio-visual, and interactive teaching materials. Printed modules are widely used because they are easy to understand and use. Printed modules are also able to serve what should be delivered to students, especially if lecturers/teachers are able to create their own modules that can be adapted to learning needs easily.

Ahmadi, A., & Amri (2020) added that there are many types of modules, such as handouts, books, modules, student worksheets, brochures, leaflets, wall charts, and photos or images. Modules or teaching materials consist of knowledge, skills, and behaviors that need to be learned by students for achieving predetermined competency objectives (Hamdani, 2011). Modules are one of the sources of knowledge, skills, and behavior in the form of learning resources that contain material, delivery methodology, and evaluation that teachers can use during learning activities.

In general, lecture modules still use several books with separate materials. In addition, the explanation is still abstract and requires a high level of focus to understand the course. In the learning process, lecturers provide material in teaching mode, and students only listen to lectures and concentrate on the lectures. The lecture model is still used, but students always have difficulty understanding the material when given assignments to understand linear programming material with existing modules. Learning modules are one of the instruments that have the potential to improve the quality of learning and student understanding. Lack of adequate learning resources, suboptimal student understanding, or lack of innovation in learning approaches (Haryanti, Kustinah, and Widayanti 2023). Therefore, this study was conducted to identify student needs, analyze weaknesses in existing learning, and develop modules that can increase the effectiveness of Linear Program learning. From this, module development is needed.

The Dick and Carey development model was chosen because in the development of linear programming modules because this model has clear and structured steps. Detailed task analysis with specific instructional learning objectives and a reliable system makes the Dick and Carey model suitable for evaluating module development. In addition, the instructional development model and its simple and easy-to-understand output model are expected to provide uniqueness (Suzatmika and Rohman 2023). Aji (2016) One model that has been proven effective in developing mathematics learning designs is the Dick and Carey model. This model was developed by Walter Dick and Lou Carey, and has become a popular approach in education(Alexon and Kurniawan 2022). The Dick and Carey learning model consists of several structured and logically ordered steps.(Kuning and Setiani, 2022) By using the Dick and Carey model, it can design a more interactive, relevant, and motivating learning experience for students.

The subjects of this study were 4th semester students of the 2019/2020 academic year at Batanghari Jambi University. The 10 students selected were graduates of vocational high schools, where they received mathematics subjects at school only explained the general overview material. From this, it is necessary to develop Dick and Carey modules that can help students master learning objectives, and program packages that are arranged and designed in such a way for the benefit of student learning. So it can be concluded that the module is a program package that is arranged and designed in such a way as independent learning material to help students master their learning objectives. Therefore, students can learn according to their own speed, especially related to linear programming material.

Some previous studies have been conducted in module development. For exampleHaryati, Panggabean, and Wahyuni (2021) who analyzed the use of Lindo software in solving linear program problems. They developed learning materials in the form of software, not modules (Haryati, Panggabean, and Wahyuni, 2021). Another study comes from Ekeocha, Uzor, and Anetor (2018) who analyzed the learning media on only one chapter of linear program which is simplex method. They did not develop the entire linear program material.

From the previous studies above, it can be seen that there is an opportunity to develop a linear program module in the form of a printed book or e-book that discusses the entire material in the linear program course (Ika Prasasti Abrar and Suaidah, 2022). This research has characteristics in the results of product development, namely modules or teaching materials. This linear program module is prepared based on the syllabus, moreover the module application uses simple materials. Although the application is simple, this module still prioritizes detailed descriptions, step by step, making it easier for readers to understand the material when studying individually.

The Dick and Carey development model is relevant in developing a linear program module because this model has clear and structured steps (Richey, 2009). A detailed task analysis with specific instructional learning objectives and a reliable system make the Dick and Carey model suitable in evaluating module development. In addition, the instructional development model and its simple and easy-to-understand output model are expected to provide uniqueness (Zanuar Renaldie et al. 2023).One of the models that has proven effective in developing mathematics learning design is the Dick and Carey model. This model was developed by Walter Dick and Lou Carey, and has become one of the popular approaches in education. The Dick and Carey learning model consists of several structured and logically ordered steps. By using the Dick and Carey model, you can design a more interactive, relevant, and motivating learning experience for students.

Linear programming or PL for short is a mathematical method of allocating limited resources to achieve a goal or objective, such as maximizing profits and minimizing costs. PL is widely applied in economic, industrial, military, and social problems. It functions as a decision-maker, helping the government find the most appropriate alternative and the best solution (Obi and Agwu, 2017). The linearity characteristic of a case can be defined in several ways, including statistically, linearity can be checked using graphs or hypothesis tests, while technically, linearity is shown by the availability of proportionality, additivity, divisibility characteristics, and certainty of the main and boundary functions (Nahda and Granita, 2024). Based on the explanation above, this study aims to determine the learning process and modules as well as the development of modules used in linear program courses at the Faculty of Teacher Training and Education, Jambi Batanghari University..Based on the explanation above, this study aims to determine the learning process and modules as well as the development of modules used in linear program courses at the Faculty of Teacher Training and Education, Jambi Batanghari University.

Method

This research uses research and development methodology. Research and development methodology is used to produce or evaluate the effectiveness of a particular product. The research subjects were students who enrolled in linear program courses for the even semester of the 2019/2020 academic year, Department of Mathematics Education, Faculty of Teacher Training and Education, Batanghari University, Jambi. Data collection was carried out using questionnaires, interviews and observations.Interviews were conducted with students using structured interviews, interviews were conducted to obtain information about the Linear Programming Module Based on the Dick and Carey Program method. Observation in this study was used to see how this product could be understood by students. The respondents involved in this research were 10 students.These 10 students consist of 5 males and 5 females. Purposive sampling method where the technique in taking this sample has considerations that have been determined to the respondents, among them are students of Jambi University, The characteristics of students are having heterogeneous educational backgrounds such as; Senior High School (SMA), Vocational High School (SMK) and Madrasah Aliyah (MA), and having high motivation and enthusiasm in studying mathematics which can be seen from their struggle in solving mathematics problems and their reasons for choosing mathematics as their main major.

The method used in writing this article is the development of learning design that refers to the Dick & Carey model. There are 10 stages in designing learning according to this model, namely: 1) identifying general learning objectives, 2) conducting learning analysis, 3) analyzing student characteristics, 4) formulating specific learning objectives, 5) developing assessment instruments, 6) developing learning strategies, 7) developing and selecting learning materials, 8) designing and implementing formative evaluations, 9) revising learning designs, and 10) designing and implementing summative evaluations. The data analysis techniques used in the module developed are qualitative and quantitative data. Qualitative data was obtained from expert and teacher responses, while quantitative data was obtained from the modules developed. The module development procedure is carried out in several stages, including; (1) preliminary study, (2) development planning, (3) validation, evaluation and revision, and (4) implementation or implementation. Formative evaluation is carried out with (a) one-on-one experts, including; material experts, learning design experts, and media experts, (b) one to one learner, (c) small groups, and (d) field trials.

Results and Discussions

The fact showed that the lecturer's learning plan does not use a complete module for all learning materials. The materials learned are still separated from one source to another. In addition, the problems encountered in linear programming seem easy, but when it is modeled in mathematical form, it is difficult to determine them. Then the empirical facts showed that due to many errors in mathematical modeling and errors in the

completion stage, students' scores are in low category. Therefore, a new breakthrough is needed to develop the linear programming module that can be used anytime and anywhere.

Developing Module with Dick and Carey Model

Identifying Instructional Goal (s)

Clear and measurable learning objectives help guide lecturers in directing students towards achieving the desired learning outcomes. Learning objectives must be specific, measurable, relevant, and realistic. In general, the instructional objective after taking a linear programming lesson is that students can solve problems in everyday life. The first step in the stage of identifying learning objectives is to determine the indicators of ability or competence to be achieved. In the context of 1) Basic Solution (basis) of the System of Equations (2) Linear Inequalities System with the target of supporting your activities to understand the constraints (constraints) of a linear program, and (3) Mathematical Model of Linear Program Problems with the target.

Conducting Instructional Analysis

After identifying learning objectives, the next step is instructional analysis, which is a process used to determine relevant skills and knowledge needed by students to achieve competency in learning objectives. In conducting instructional analysis, several steps are needed to identify competencies in the form of knowledge, skills and attitudes that students need to have after following the learning process.The instructional analysis results are; 1) describing the research problem concept of linear program, 2) doing linear program calculation with graphic method, 3) calculating the simplex method, 4) calculating the two phases simplex method, 5) explaining primal and dual, 6) explaining transportation model (part 1), 7) explaining transportation model (part 2), and 8) explaining transportation model (part 3).

Analyzing Learners and Contexts

The stage of analyzing student characteristics in the Dick and Carey model is an important step in designing an effective learning design.. The target group of this study is students of mathematics department in the 4th semester in 2019/2020 academic years. The characteristic of the students is having heterogenic educational background such as; senior high school (SMA), vocational school (SMK) and Madrasah Aliyah (MA), and having high motivation and passion in studying mathematics which seen from their struggle in solving the mathematic questions and their reason in choosing mathematics as their major department.

Writing Performance Objectives

After analyzing the learners and contexts, the researcher writes on the objective of the lesson, such as; 1) students can formulate linear program problem to mathematic form, 2) students can count and solve the linear program problem with graphic, 3) students can count and solve the linear program problem with simplex method, 4) students can count and solve the linear program problem with two phases simplex method, 5) students can determine the dual from linear program primal and solve the dual problems, 6) students can arrange and solve the transformation model part I, 7) students can arrange and solve the transformation model part II, 8) students can arrange and solve the transformation model part III.

Developing Assessment Instruments

The development of the test instrument is based on the lesson objective, with assessment form including midterm exam, semester exam, task, and competence test.

Developing Instructional Strategy

The lesson strategy is done based on the sequence of the lesson activity, including the introduction, presentation and conclusion. The next components are consisting of the material, method, media, and tools and study duration.

Developing and Selecting Instructional Materials

Developing and selecting learning materials is an important process in designing effective and engaging learning experiences for learners. Learning materials include a variety of materials and resources used to deliver learning content to learners, both in the form ofThe linear program course is arranged by dividing the material into eight chapters, then these chapters will be printed into a book.

Developing and Conducting Formative

Evaluation of instructionFormative evaluation is an evaluation process carried out during the learning process to collect useful information in improving and developing the instructional process. Formative evaluation is carried out in the middle or during the learning process, namely carried out every time a learning unit or sub-topic can be completed with the aim of knowing to what extent students have "been formed" in accordance with the predetermined teaching objectives.The formative evaluation result from one-to-one expert test are divided into three validation; a) the validation of instructional expert design, b) the validation of media expert

design, and c) the validation of material expert design. These validations can be seen in figure 1, 2 and 3 below;

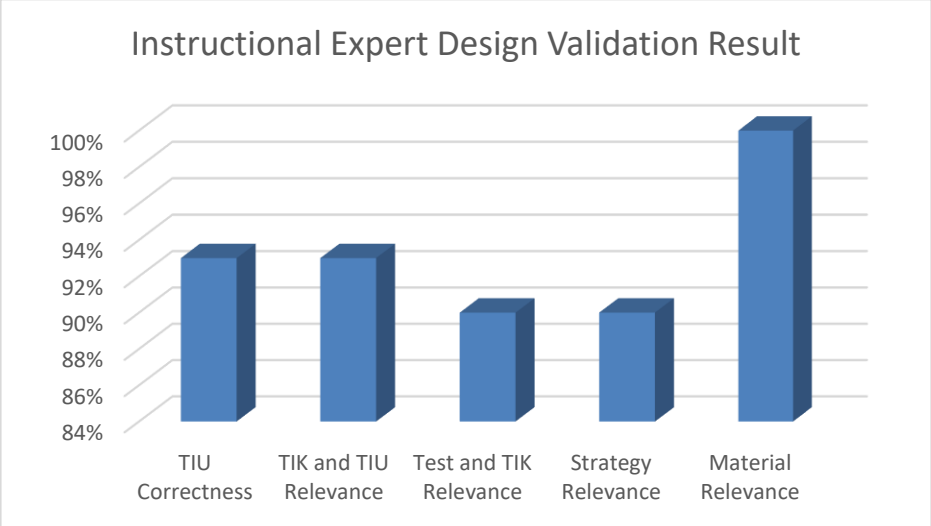

Figure 1. Validation Result of Instructional Expert Design

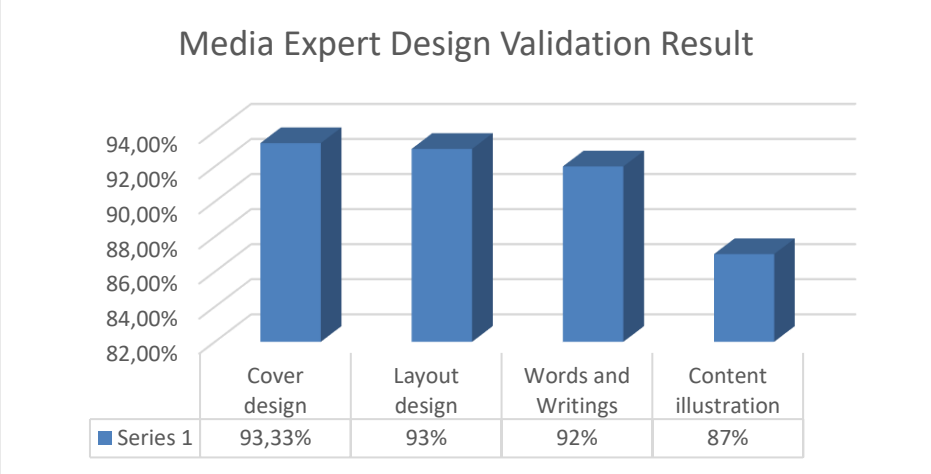

Figure 2. Validation Result of Media Expert Design

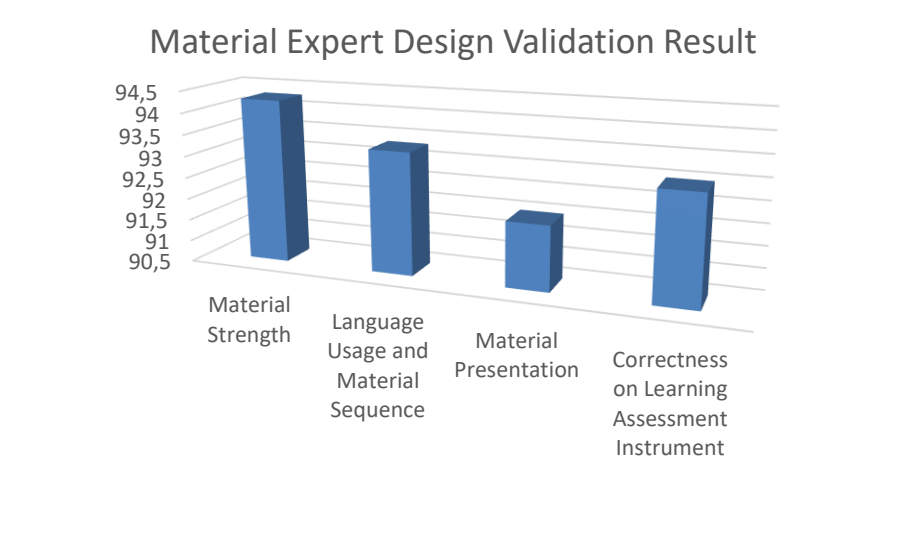

Figure 3. Validation Result of Material Expert Design

Those figures above showed the assessment indicator for each validation. The instructional design validation has the average score for 93.3%, the media design validation 91.3%, and 93.7% for the material design validation score. The suggestion from expert design evaluation for the instructional method is the adjustment among the material, computer and technology, and the question within. For media design, the expert suggested to be consistent in word choice, word size, and to pay attention to the use of Indonesian language rule that must be in accordance with the EYD, also the problem given within the module should be expressed the object. While for the material design, it is necessary to pay attention to the sentence use, there are some mistakes in typing the sentence and the inconsistency of material presentation. After all of the suggestions has been corrected, the researcher can continue to one-to-one learner test.

One to One Learner Test

The result of one-to-one learner test indicated that the total score is 93.7% with assessment score as in figure 4 below;

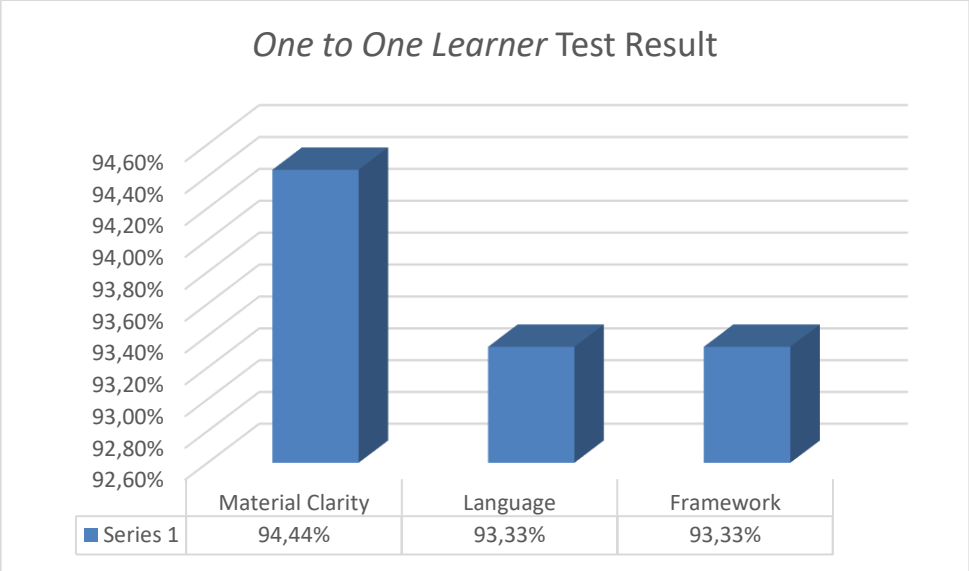

Figure 4. One to One Learner Test Result

From the figure 4 above, it can be seen that the whole response from one-to-one test is good. There is some mistyping in the module material but those had been fixed.

Small Group Trial

The subjects' respond on small group trial is 93.5% with assessment indicator as below;

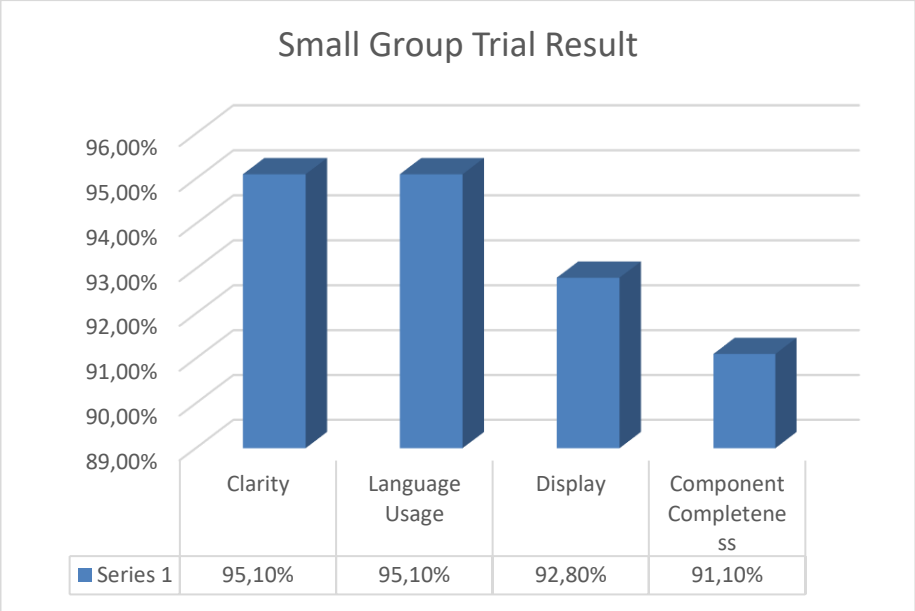

Figure 5. Small Group Trial Result

The response from small group trial is categorized as very good and no additional comment from the participant. It can be concluded that the module is feasible to be continued for field trial.

Field Trial

The field trial result showed 87% for the average validation score with assessment indicators as in figure 6 below;

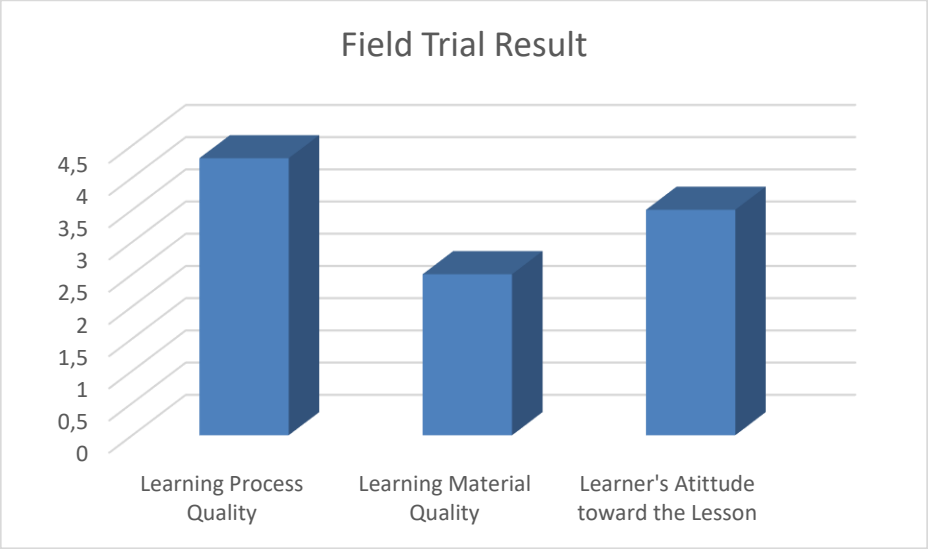

Figure 6. Field Trial Result

From the field trial result, the participants showed that the learning lesson is going well. Even though the lesson is done through online system, due to COVID-19 pandemic, but the lesson is still going very well. The students that participated in field trial have understood the technology information aspect, especially those that related to the online lesson. Moreover, the learning process also showed no problem at all and went well.

Learning design is one of the important things in learning activity because the learning quality will be depended on the design that arranged in learning plan (Purwinda Anggrella, Raudina Izzati, and Sudrajat, 2023). Therefore, designing the learning lesson should be done continuously based on the condition and situation that is happening at that time. Designing the lesson should be done in unity, start from defining the TIU, learning analysis, student's characteristic, Computer and Information Technology, test, learning strategy and developing the module which continued by formative evaluation and revision. Thus, it will create a learning system, including the module.

Module is one of the sources used in learning. Education workers, especially lecturer, have obligation to make module due to increase the learning quality (Tarigan, Sipahutar, and Harahap, 2021). Module is like the tip of the spear's knowledge. A good module is a module that can be used by students, either in face-to-face learning activity or individual, such as remote learning activity (Rauddin and Ruslan, 2022). Module must be able to provide valid knowledge that will be learnt in one course and able to be used for remote or online learning activity (Purnamasari, Siswanto, and Malik, 2020). Therefore, based on the result above, the linear program module has already completed the conditions above that is contained with; valid knowledge and can be used for remote activity.

The development procedure of linear program module is oriented on the instructional design system using Dick and Carey model (Munthe, 2021). It is needed to pay attention to the users' necessity in developing the module, and in this case, students will be used the developed module for their learning activity. Orr et al. (2022)Determining the instructional objective is the beginning step in doing the development itself. In module development, it is important to make sure that the users' necessity is compatible with the objective. If it is not compatible, then the module will have no advantage/benefit for students, and students cannot find solution in overcoming the learning problem. Learning objective is an ability or competency that is expected to be owned by students after doing a certain learning process (Sanjaya 2008; et al. 2024).

In learning analysis, the researcher classified the objectives and determine the steps that will be done by people when they do the objective (knowing the subordinate skills) (Zulmaulida and Saputra, 2014). The last step in analyzing learning process is define the skill, knowledge, and behavior, which is the students starting

point in doing the lesson. This analysis will produce the mapping concept that describe the relationship of all identified skills. Therefore, the material arrangement will be more detail. After analyzing the process, the next is analyzing the students' characteristic by defining who will use the module and where the module is used. In this step, it is needed to see the skills, motivation and behavior of the students.

Specific instructional objective is a standard for designer in developing the assessment test, developing the assessment test standard, developing the strategy and formative evaluation (Ole 2020; Triana et al. 2023; Ukashatu 2021). In assessment test standard must involve the skills that should be mastered by lecturer. After developing the module, it is then continuing with evaluation by the experts of material, design and media to see if the module is feasible. Besides, in every age level has different ability in analyzing and understanding a material. Therefore, trial test is done in one-to-one test, small group trial and field trial (Dewi, 2020). The formative evaluation showed a good result. It is proved that the module development has been in accordance with the scientific principles (Rosnini and Serani, n.d.;Arifin and Efriani 2024; Ananda and Usmeldi 2023); Sabila, 2024). During the learning process that is done remotely because of COVID-19 pandemic, the lesson gets positive respond and result. Students are able to study on linear program individually because the module can be used anywhere and anytime.

Previous research by Mardia and Sundara (2020) results from presentation, content and language validation by media experts, material experts and language experts obtained a presentation validation score of 4.00, content validation obtained a score of 3.6, and language validation obtained a score 3.83, which means that the content of the independent learning-based linear program module is valid in terms of presentation, content and language. Meanwhile, analysis of the practicalization questionnaire by students obtained a score of 90%, showing that the linear program module based on independent learning was in the practical category. Practicality can be seen from an attractive and systematic appearance, the use of problem solving steps, clarity of the content of the material presented, ease of use of the module, and the words used are easy to understand according to student characteristics.

v of a REACT-based mathematics module on linear programming material to improve students' practical mathematical connection abilities for use in learning, namely getting a positive response from students of 85% and a positive response from teachers of 84.38%; 3) the results of the development of a REACT-based mathematics module on linear programming material to improve students' mathematical connection abilities effectively for use in learning; 4) students' mathematical connection abilities in linear programming material who learn using REACT-based mathematics modules are better than using mathematics textbooks. Based on the results of research and development by (Widyaningrum, 2020), it was found that this development research has produced modules as teaching materials for linear programming courses using local wisdom using POM QM for Windows by following the steps, namely: potential and problem stages, data collection, product design, design validation, product design revision and limited product testing.

Conclusions

The procedure in designing and developing the linear program module using Dick and Carey model has been successful. Dick and Carey model is suitable in designing and developing the module's learning system which is completed with material, method, strategy, and evaluation in the form of printed book and e-book. A good module is a module that follow the steps and the formative evaluation to see its validation. Formative evaluation is done in some expert validation, one to one test, small group trial and field trial. The results of the study showed that based on expert validation, the module was classified as feasible. The percentage of design validation feasibility; 93.3%, media validation; 91.3%, and material validation; 93.7%; followed by one-on-one trials with a percentage of 93.7%, group tests; 93.5%, and field tests; 87%. Thus, the development of a linear program module is feasible and can be used for students of the Faculty of Teacher Training and Education. Mostly, the validation result is getting a good result. Thus, it can be concluded that linear program module is feasible to use by students of teacher training and education faculty in Batanghari University Jambi.The limitation of this study is that the research object is only focused on the Dick and Carey model, which is only one of many other models. The contribution of this study is as a description of the design and development of a module learning system specifically for students majoring in Mathematics education.

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