

Interactive online-based learning materials development

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Abstract

This study aimed to develop interactive online-based learning materials on linear programming subject. This learning materials development was orientation system approach oriented. The development model used was instructional development model (2004) and Trollip and Alessi (2001). Learning materials development steps were analysis of needs and objectives formulation, instructional analysis, learners' initial behaviors and characteristics identification, specific instructional objectives writing, benchmark reference test writing, learning strategy arranging, learning materials developing, design making and formative evaluation implementing, revision, expected instructional system gain. The conclusion in general, the validation of instructional design experts (90%), subject matter experts (96%), and media experts (92%), so the recommendation was the learning materials can be used. The results of individual test (90.79%), small group test (93.38%), and field test (88.09%) on interactive online-based learning materials development can be used. Based on the experts' validation and testing, interactive online-based learning materials were worth using.

Key words: learning objectives, learners' characteristics, learning materials, interactive online

1. Introduction

In quality, the quality of education in Indonesia is still left behind other countries both in Asia and in the world. According to the data published by the United National Development Programme (UNDP), Human Development Index in Indonesia in 2011 ranks 124th of 187 countries surveyed [1]. The important factors causing low HDI in Indonesia are net enrollment rate and gross enrollment rate (NER and GER) of education in Indonesia that are still low on average. NER data on

SD/MI is 94.44%; *SMP/MTs* is 54.81% and *SMA/MA* is 31.46% [2]. Meanwhile, in the latest report of Property Tax Development Program in 2013, Indonesia ranks 121st of 185 countries in Human Development Index (HDI) with the number of 0,629. Therefore, Indonesia is left behind two ASEAN neighboring countries, i.e. Malaysia that ranks 64th and Singapore that ranks 18th, while the HDI in Asia Pacific region is 0.683.

The government has made many efforts to improve the quality of education administration comprehensively and thoroughly. One of them is the quality of higher education administration. This effort is clearly listed in Act Number 20, Year 2003 on National Education System, which states that:

Education means conscious and well-planned effort in creating a learning environment and learning process so that learners will be able to develop their full potential for acquiring spiritual and religious strengths, develop self-control, personality, intelligence, morals and noble character and skills that one needs for him/herself, for the community, for the nation, and for the State [3].

Conceptually, there are many factors that can affect the quality level of higher education in Indonesia. One factor is the quality of learning that can be seen through the quality of learning outcome and the quality of graduates produced.

The learning process that was originally teacher centered or teacher oriented [4] which emphasized the role of teachers which then became learner centered or learner oriented which focuses on the learner [5], has been implemented gradually in learning in higher education in line with the changes made at the level of curriculum, learning tools, and the direction and purpose of education. However, the levels of learning patterns, technique of assignment, technique of assessment, and the use of technology have not changed yet.

The use of technology in learning through interactive online-based learning materials development by computer media both intranet and internet-based which enable lecturers and students to discuss and learn in virtual world not limited by time is still not optimal. This condition occurs in almost all subjects, including linear programming.

The process of developing learning materials on linear programming subject is conducted through Instructional Development Model. It is because Instructional Development Model has obvious relevance to the development of learning (including e-learning) on a small scale, so it is suitable for developing software with interactive online-based learning system design. Besides, the development of Instructional Development Model learning materials also uses a system approach that emphasizes the relationship between the components, so that it will increase the chances of integrating all the variables that affect learning in linear programming instructional design that implicates [6]:

1. An increase in productivity. Time and travel can be minimized through e-learning, so that the lecturers' productivity will not be lost due to the traveling activity he had to do to give the learning process.
2. Creating value to the organization. Competency renewal must be provided on an ongoing basis, and through e-learning, the competency will be able to keep producing creativity and innovation of human resources, and ultimately it provides value to the organization.
3. Efficiency. Competence development process can be performed in a short time, and includes a substantial amount.
4. Flexible and interactive. E-learning activity can be done from any location if the users have access to and connection with the source of knowledge, and interactivity is possible directly or indirectly, and whether can display a complete visualization (multimedia) or not.

This development of interactive online-based learning materials on linear programming subject requires concrete, systematic, transparent measures and easy to apply, either by the designer as the product manufacturer or by the users as the

people who use the products developed. Interactive online-based learning is also known as e-learning that has different characteristics from conventional learning, i.e. interactivity, independence, accessibility, and enrichment [7]. This kind of model development characteristics will be in accordance with the instructional development model measures that have clarity in every stage, easy to implement, detailed and easy to follow. In addition, instructional development model has revision activities, from instructional analysis to the next steps. Thus, the revision could create relevant learning materials that can be applied in the model development of interactive online-based learning system design.

Online interactive learning is one of the most enjoyable lecture models, convenient and affordable to get a complete understanding on a variety of subjects related to computers on the internet. This model is designed in such a way so that students can learn on their own speed and can make their time to learn efficient and can be done anywhere and anytime, and allows everyone to get a chance to learn. In general, computer-based learning can be classified into two categories, i.e. stand-alone and networked computer (more alternative participant interactivity) [8].

Interactive online-based instructional design making aims to create an optimal learning by utilizing the available means in achieving learning objectives to produce the desired changes in knowledge and skills of students.

2. Research Methodology

This study aimed to develop interactive online-based learning conceptual model on linear programming subject in Mathematics Education Study Program at Batanghari University of Jambi. The study was conducted through a system approach which was done through solving problems steps, of which every step was understood, and produces an alternative solution. The method applied was research and development (R & D) method that will result in a product or test the effectiveness of a certain product. R & D method has three major characteristics, i.e.: (1) a product is manufactured to be used; (2) the product is used in the field (in educational practice); (3) the product is always validated during the study.

In this development of learning materials, several steps were conducted:

- 1) a preliminary study,
- 2) development planning,
- 3) validation, evaluation, and revision,
- 4) and implementation

3. Research Data

The analysis results of needs of interactive online-based learning development on linear programming subject through questionnaires and interviews with students, lecturers or colleagues and the product users showed that students wanted and needed new interactive online-based learning model (using the internet) as a means and learning facility. While the interviews results with lecturers or colleagues described that the learning system used all this time was still conventional, i.e. learning system that were only lecturing in explaining the materials and sample questions that caused students tend to be passive, less passionate, and less challenged in the learning process. In addition, the learning materials used were only textbooks and old books. So, a change in new learning patterns is needed that corresponds with the times. One of which is online learning using the internet to improve skills in the use of ICT and space and time do not limit the learning.

The interview with the product user, i.e. Head of Mathematics Education Study Program, Faculty of Teaching and Education, Batanghari University of Jambi illustrated that Batanghari University has been providing internet facility that is already online since the last few years, but there are no lecturers use in the learning process.

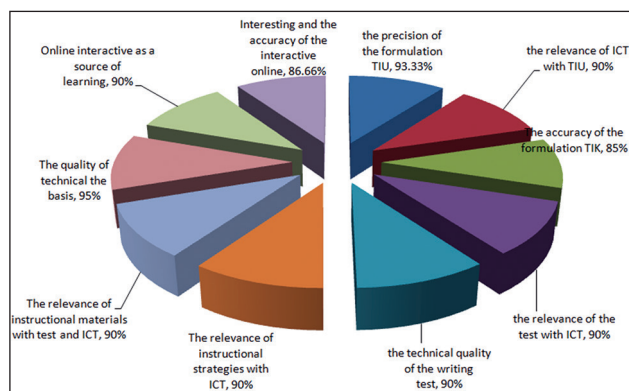


Chart 1. Second Validation Result by Instructional Design Experts [9].

The results of the feasibility of the model in formative evaluation on the chart below shows that interactive online-based learning materials developed have a good validation of instructional design experts. In general, instructional design experts' assessment concluded that overall, the quality of interactive online-based learning materials on linear programming subject is in the very good category that is on the level of conformity to an average of 4.5 or 90%. An assessment of matter experts' validation on interactive online-based learning materials draft is presented in the following chart:

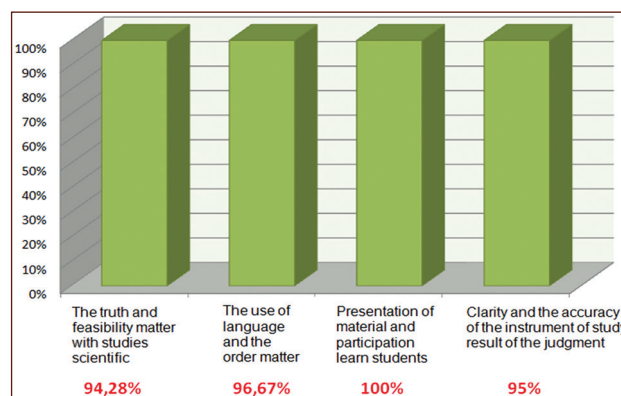


Chart 2. Chart of Subject Matter Experts' Validation Result [10].

Overall, validation results by subject matter experts on interactive online-based learning materials development draft on linear programming subject are categorized excellent with an average of 4.82 or 96.48%. The conclusion is that interactive online-based learning materials on linear programming subject is feasible to use, and the experts recommend to conduct individual test.

Validation by media experts on online-based learning materials draft on linear programming subject is outlined in the following chart:

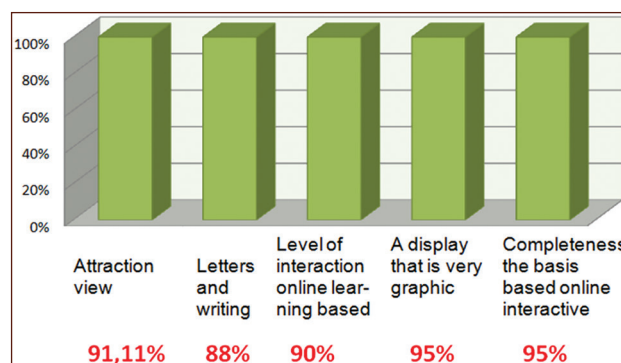


Chart 3. Media Experts' Validation Result [11].

Validation results of the three experts above can be presented in the chart below:

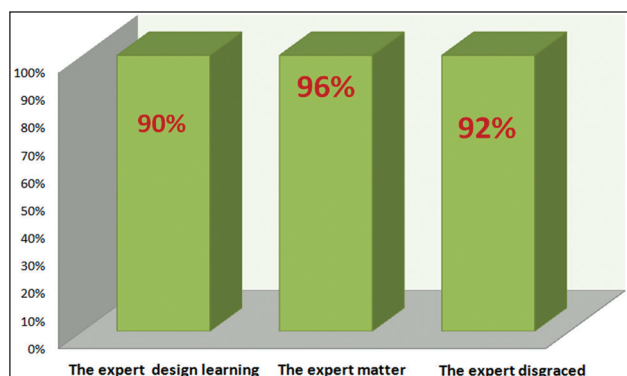


Chart 4. Validation Result of Experts Team on the Development Draft

Overall, field test on the acceptance of interactive online-based learning materials on linear programming subject developed, scored with an average of 4.4 or 88.09%. Thus, it can be concluded that the development product of interactive online-based learning materials on linear programming subject can be used, since field test is the characteristics of end users of learning materials developed.

The effectiveness of the results of field test is same with individual and small group tests, i.e. the level of effectiveness can be seen from the quality of interactive online-based learning materials developed. These results showed that interactive online-based learning materials were more effective, more attractive and can be used anywhere. Thus, it can be concluded that interactive online-based learning materials met the quality of value achieved and the effectiveness of online-based materials developed can be seen.

An overview of individual, small group and field tests is presented in the chart below:

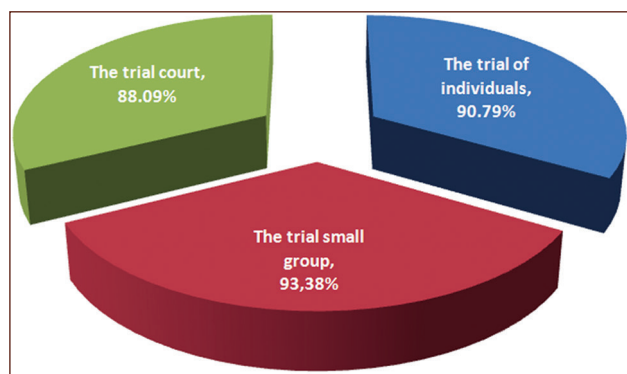


Chart 5. The level of acceptance of individual, small group and field tests

The pre-test and post-test scores showed that $t_{hitung} > t_{tabel}$ ($5,0444 > 1,72913$). It was concluded that *there was an effect* of learning materials in the learning process on linear programming subject.

4. Discussion

4.1. The Role of Learning Materials of Linear Programming in Learning

Learning materials aim to facilitate learners to study the materials or information conveyed to learn effectively and efficiently to achieve instructional objectives. It gives an indication that a learning process will be effective and efficient if it begins with a design of learning materials designed in accordance to the needs of learners.

The quality of learning depends on the quality of learning materials design undertaken by learners by lecturers in higher education. The role of lecturers in designing learning materials is a major thing and very important because the learning materials will be studied should meet the needs of students as learners. Lecturer is an agent of change who can bring a better education. It means that the learning materials used in learning process are the learning materials that meet the rules in terms of science. Yet, based on the results of observations, questionnaires, and interviews, they gave different facts.

The results of observations on the study conducted so far were still using conventional teaching and learning by only using lecturing method with learning materials from old textbook. The learning performed were only material delivery and lecturing, giving problems examples and tasks in the form of exercise so that students are only as good listeners and less active in the learning process. In addition to learning process, the learning materials used do not meet the rules of educational technology study, i.e. reviewing the analysis of needs and learning objectives formulation, instructional analysis, identifying initial characteristics and behavior, formulating specific instructional objectives, benchmark reference test, strategy, development of the learning to formative and summative evaluation. It is seen from the books used were old books, so the conditions of learning will be different with the students today who are influenced by the developments in information technology. This

means that the initial characteristics and behaviors of the students must be reviewed and adapted to current conditions. The differences in characteristics and behaviors as the analysis in learning affect the ability of lecturers to plan the learning strategies implemented. It means that the differences in the characteristics of students will produce different learning strategies in each of the characteristics already analyzed.

Other things were there were also learning materials that do not have specific instructional objectives, the design of the evaluation outline that is not in accordance with learning objectives as well as the materials developed that are not in accordance with the needs of the students because lecturers not develop the materials or learning materials, causing a gap, and then learning materials are not in accordance with the needs of students. General instructional objective is a reference for lecturers in designing an assessment of benchmark reference test (compiling test instrument), developing learning strategies, developing materials and the basis for selecting the media used.

Learning materials play an important role in all learning activities. Learning materials serve as a representation of lecturers' explanation that can be used as learning activities guidelines including targets and goals to be achieved. In addition, learning materials serve as the means to achieve instructional objectives that have been set. Therefore, preparation of instructional materials shall be guided by prescribed general instructional objectives.

In addition to the results of observations, the results through questionnaires also provided information that the learning performed in the delivery of competencies and learning objectives were sometimes given and sometimes were not. While the learning resources were only in the form of text book with lecturing learning model (traditional). Delivery of content were in the form of an explanation of material by lecturing, giving problems examples and continue with the exercise. The references used were still limited to books and there were no other sources. The learning performed conventionally made students tend to be passive and less motivated.

Then in terms of information technology, students have already used computers and have used the internet to find the information needed. So, students wanted a change of learning that is in ac-

cordance with the development of science and technology. One of them is through the internet by interactive online learning materials designed in accordance with the needs of the students. This type of learning will be able to make students learn more independently, not limited by space and time. The combination of interactive online-based learning materials is a learning infrastructure and facility.

Another instrument spread was conducting interviews with lecturers or colleagues. The results of the interviews provided information that an online learning had never conducted. The learning undertaken so far was still conventional. The medium used was still using whiteboard and wrote using markers. While facility like projector was sometimes used, besides medium such as Wi-Fi was never used at all in linear programming learning. So, lecturers and colleagues suggested learning to use the internet network (online) and can discuss in the study session. It will make learning better and not limited by time and space. In addition, online learning can also improve the understanding in terms of matters since students learn independently and master technological development. The interviews led to a conclusion that a change or a new breakthrough that in accordance with the times is necessary. One of which is an online learning, which uses the internet to improve students understanding in terms of material and to improve skills in the use of ICT, and time and space do not limit the learning.

In addition to interviews with lecturers and colleagues, the interview was also conducted with the product user, i.e. Mathematics Study program, Faculty of Teaching and Education, Batanghari University of Jambi. The interview result gave information that the Faculty of Teaching and Education in Batanghari University already has Wi-Fi that has been used for the last few years, but there are no lecturers use it for online learning. According to the user, online learning needs to be performed to stay up-to-date. Online interactive learning is already suitable for use in Batanghari University since the students and lecturers can operate computers and internet networks. However, before an online learning performed, lecturers are expected to design learning materials that will suit the characteristics and circumstances of students in Batanghari University. Thus, the learning will be more effective and

efficient. If there are lecturers who want to develop the learning, the user-in this case is Mathematics Study Program, Faculty of Teaching and Education, Batanghari University-will provide support both in terms of socialization and other assistance needed. From the results of these interviews, a conclusion can be drawn that Batanghari University of Jambi has provided facility, i.e. the use the internet that is already online since the last few years but there are no lecturers use it, and the development of interactive online-based learning materials on linear programming subject in Batanghari University of Jambi is needed.

Based on the above conditions, then innovation in learning needs to be made. The simplest way is to develop learning materials that are in accordance with the characteristics and capabilities of students. However, in line with the development and progress in communication and information, it will be better when the designing in learning materials is interactive online-based to understand the material independently and cause an interest feeling to learn and can also master the information and communication technology.

4.2. Interactive Online Learning Materials Concept Model

The learning material made was a process made through the steps of instructional system designing. Instructional system design is a systematic approach in planning and developing the means and tools to achieve instructional objectives and needs. All these system concepts (objectives, materials, methods, media, tools, evaluation) in relation to one another is a regular systematic unity. These components are first tested for their effectiveness before their use being distributed. It means that the development model of learning materials will produce a new product wherein the process passes an organized procedure that includes the steps of analyzing, designing, developing, implementing and assessment of learning. Furthermore, instructional design as a field of science can be classified as a discipline related to the understanding and improvement of an aspect in education, i.e. learning process.

Interactive online-based learning model concept is an online learning as one of the most enjoyable lecture models, convenient and affordable to get

a complete understanding on a variety of subjects related to computers on the internet, because there will be a merging of learning materials, such as text, audio, images, tables, and even video in interactive online learning. This model is designed in such a way so that students can learn at their own speed and can make their time to learn efficient and can be done anywhere and anytime, and allows everyone to get a chance to learn. Interactive online-based learning materials on linear programming subject adopt Instructional Development Model, while the flow of the interactive media program development adopts a prototype model. Prototyping is a software development method that is widely used. With this prototyping method, the developers (lecturers) and users (students) can interact during the system manufacturing process. A user who simply defines in general what he/she wants without mention in detail what output he/she needs, processing, and what data he/she needs often occurs.

Thus, the conceptual model of interactive online-based learning materials on linear programming subject is using online learning. Online learning has a variety of communication options that can be used in learning process, such as discussion forums, e-mail, and so on. The aspects merged in online-based learning materials may take the forms of text, tables, images, sound, and video. Learning materials at every meeting has been prepared in accordance with the syllabus.

4.3. Interactive Online-Based Learning Materials Procedural Model

The development of interactive online-based learning materials is based on the development of instructional system design that serves as a guide in learning activities, so that the interactive-based learning material is one reference that can be used in teaching the students. The designing in teaching materials is using a combination of instructional development model and Trollip and Alessi's model. Instructional development model is performed to design learning materials in the form of a manual called draft 1, while Trollip and Alessi's model is used to design the medium used, i.e. web, called draft 2, while the draft 3 is the final draft of which is the combination of draft 1 and draft 2, thus, interactive online-based learning is formed.

Instructional development model on draft 1 starting from analysis of needs and objectives formulation, i.e. an analysis of the needs required by the users by taking samples from students, lecturers and colleagues, the product users, as well as observations on the implementation of learning. Analysis results of needs showed that students required development of interactive online-based learning materials and continued with the establishment of a general instructional objectives. To achieve general instructional objectives, instructional analysis is needed to determine the limits of the competence that must be owned by students, which have been mastered and which ones have not. The next step is to analyze initial characteristics and capabilities of students, so they can determine where the material begins and what strategy to use. Then, continued with the determination of specific instructional objectives and benchmark reference test, as well as the development of learning strategies that could develop learning materials contained in draft 1 that contains learning materials.

Draft 2 is a development in terms of the media used. Draft 2 is an explanation of the components, subcomponents which were then included in final draft. It means that draft 2 is the web home of interactive online-based learning materials by filling learning materials from draft 1 to draft 2. The result of posting this thing into final draft is interactive online-based learning materials in physical form.

The results of the development of interactive online-based learning materials on the review of (1) instructional design perspective, (2) material perspective, and (3) learning media perspective.

The review of learning design perspective

Heeding the advices and comments from instructional design experts, developers make improvements to the design of interactive online-based learning materials. The improvements include improvements on the language or sentences and confirmation of expected learning objectives, so that it will form clear, precise, and straightforward formulation. Then, improvement on behavior of each ICT to be revealed clearly, the improvement in the verb of 'operational' in ICT to be made from simple to complex, making sentences more rational so that ICT is easy to understand. The next improvement in test items described in the condi-

tion that the achievement of a lesson will be obtained after the condition have been created. Then in terms of images and graphics in test items to be made clear so that the description of the images can be well understood. The next improvement is on learning materials to be made more attractive, the font to be adjusted to the rules of writing, tables and images displayed to give explanation that is easy to understand so that it will obtain good results in interactive online learning materials.

The improvements above need to be done, so that interactive online-based learning material can be used as a source of learning that can be used by students. The improvements were done to increase the quality of appearance and presentation of learning materials. Good learning materials presentation should consist of a detailed material description, sample questions, exercises, summaries, competency testing and references.

Interactive online-based learning materials on linear programming subject is a sequence of material that contains information that is studying linear programming. Therefore, interactive online-based learning materials must be made as attractive as possible. The attractiveness will raise motivation for learning materials users. Shortcomings in terms of attractiveness will cause the users lazy to learn.

Material perspective

The results of the subject matter experts' validation of interactive online-based learning materials developed reflected the feasibility of learning materials. Overall, the results of the material validation were very good and eligible for use in one-to-one-learner test. According to subject matter experts, the indicator of truth and worthiness of material with a scientific assessment had been correct and eligible for use—meaning it was very good. Then, on the indicator of language use and material order, the material was in accordance with the applicable rules. From the indicator of material presentation and students learning participation, it had been feasible. Then on indicator of clarity and precision of learning outcome assessment instruments, it had been appropriate and clear.

Thus, the results of validation by subject matter experts recommend for individual testing (one to one learner). However, interactive online-based learning materials specifically did not suggest any

improvement or review in detail, but there were some things that need to be corrected in the learning materials correction results, such as errors in typing, images layout, and parts of the composition of learning materials. The parts that were already corrected and subject matter experts had approved the correction, so it was recommended to proceed to the individual testing step (one to one learner).

Learning media perspective

The results of validation by subject matter experts recommended that media in terms of attractiveness was categorized excellent. The display of learning materials was in accordance with the name or domain of interactive online-based learning materials. In addition, the theme display, ease of navigating operation, and color were in accordance with the name of online-based learning materials and ease of login. Font and writing of interactive online-based learning materials used were in accordance with the rules of Indonesian writing. Meanwhile, the interactive capacity, chat, discussion process, download and upload had been very good with adequate operation speed.

Specifically, the results of validation by learning media experts showed very good results. However, there were little improvements, i.e. theme and color should be relevant to mathematics, as well as the integration of color. All these things had been corrected and approved by media experts, so that recommended to proceed to individual testing (one to one learner).

4.4. Interactive Online-Based Learning Materials Physical Model

Physical form of interactive online-based learning materials is a result of several drafts developed, i.e. in learning materials in the form of learning materials of linear programming, which consist of 8 chapters and included in the web. Each meeting has material description, exercises, summary, and a competence test. The physical form is a way by opening Mozilla Firefox or Google Chrome, type <http://www.pembelajaranonlineinteraktif.id> and learning main page will appear. On the main page, there are homepage, curriculum vitae and about menu. Each has a function to return to its original

position, click home. Curriculum vitae provides information about CV of the designer or programmer, and about menu is a sequence of program development and dissertation making.

Implementation of learning started by clicking login then fill Student Number, password and captcha requested then click Submit Form. To start the course, students simply click on Select Subjects in the upper left corner of the screen in the program. Please select the subjects. As selected, new menu at the top lined to the right will be displayed, i.e. Home, Syllabus, *SAP*, Material & Exercise, Competency Test, *UTS*, *UAS*, See Scores, Discussion, and Logout. Then click on the syllabus menu to see the subject matter. In addition, *SAP* menu is the menu to see what materials will be studied. Click *SAP* menu then the options will appear of which meeting will be studied. After clicking meeting, the lecture time will automatically start running and will be visible on the menu under the photo of students. Furthermore, students simply clicking material and exercises to understand the material will be studied. If there are difficulties, students may click discussion menu, i.e. navigation to ask and discuss with other students and with lecturer.

Each meeting has a competency test that will be tested at the end of the meeting, by clicking competency test. After learning is finished, students can see their scores every time the meeting ends, and proceed by clicking logout menu to terminate or out of the lecture.

This physical form has advantages and disadvantages, which the advantages were easy to access and can carry out discussions with other students and with lecturers. Based on the results of the validation test by experts, individual testing (one to one learner), small group, and a large group (field trial) recommended that the learning was worth using. However, the shortcomings of this physical form were the lecture should be done on a prescribed schedule on a regular schedule, which means that lecture can only be conducted in the hours and days that have been determined. However, repetition of the material that had been learned can be opened anytime and anywhere.

5. Conclusion

Based on the process and results of the study with all its limitations, it can be concluded that the learning implementation of linear programming subject still used conventional learning, i.e. still using learning by lecturing method, which puts the lecturer as the only source of study (lecturer is dominant in the implementation of learning). The learning process that only performed in the classroom was intended that students can master the subject matters in accordance with the syllabus and books references provided. The learning materials used were only old textbooks. So, a new breakthrough such as the development of learning materials is needed for constantly updating the interactive online-based material on linear programming subject. The process of developing a conceptual model of interactive online-based learning materials on linear programming subject was using online learning such as discussion forums, email and so on. The aspects merged in online-based learning materials may take the forms of text, tables, images, sound, and video. Learning materials at every meeting had been prepared in accordance with the syllabus. In designing learning materials, a combination of instructional development model was used for manual learning materials with Trollip and Alessi's model to design the medium used, i.e. web. The result of the design developed then validated by the experts who were recommending that the development product of interactive online-based learning materials on linear programming subject had been carried out in accordance with the methods, procedures, principles, and had been based on the development model, preliminary research, product development and formative evaluation. The experts team recommended that the developed model was worth using. The implication of the development of learning materials will increase the impact on learning materials access via online quickly and facilitate lecturers and students to do the learning not limited by time and space. Therefore, this model was recommended to be applied in all education either by face to face or remote learning.

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