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Development of Learning Models Computer and Network Engineering Expertise Concentration Based on Flipped - blended Learning

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The objectives of this research are: (1) analyzing the need for learning models; (2) designing learning tools; (3) analyzing the effectiveness of the learning model. The research method used is the development research method or Research and Development. The process of developing this learning model refers to the ADDIE development model which includes: (1) Analysis: performance analysis and needs analysis; (2) the design stage composes teaching modules, model books, LMS designs, and manual books. Preparation of research products and tools based on literature reviews that have been carried out by researchers; (3) Development through individual trials and small group trials. Then produce a product prototype (4) Implementation conduct field tests at YPPP Wonomulyo Vocational School by implementing a learning model prototype, and collecting user responses to the

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learning model applied; (5) Evaluation in the form of a review of research products and tools. The research results showed that at the small group testing stage and user responses were in the very good category. The learning model for concentrating computer and network engineering skills based on flipped-blended learning is effective based on observer assessments and user responses. Therefore, it is recommended that the learning model for concentrating computer and network engineering skills based on flipped-blended learning can be used as a reference for managing learning that is fun, makes things easier, increases motivation and optimizes student learning outcomes.

Keywords: Flipped-blended learning; learning management system; computer and network engineering.

1. INTRODUCTION

Vocational High School (SMK/*Sekolah Menengah Kejuruan*) is one component of vocational education [1]. The curriculum itself is a dense curriculum because it contains three programs, namely normative, adaptive and productive [2]. Several vocational schools in Indonesia have implemented the Independent Curriculum. The independent curriculum is a competency-based curriculum to support learning recovery (Kemendikbud, 2022). One of the characteristics of the Merdeka curriculum is implementing project-based learning to support character development in accordance with the Pancasila student profile. In the independent curriculum, schools are given the freedom and independence to provide learning projects that are relevant and close to the school environment [3].

Implementation of the Independent Curriculum in Vocational Schools requires active participation from all parties, including teachers, students, parents and the government [4]. In this way, it is hoped that an effective and enjoyable learning process can be created for students, thereby improving the quality of education in Indonesia. The implementation of the independent curriculum in Indonesia is still faced with several problems such as a lack of teacher readiness in implementing the Independent Curriculum [5]. Meanwhile, in Government Regulation Number 14 of 2005 concerning Teachers and Lecturers, Article 4 states that the position of teachers is as professional staff whose function is to increase the dignity and role of teachers as learning agents who function to improve the quality of national education (Government Regulation Number 14 of 2005 concerning Teachers and Lecturers, 2005).

In line with research conducted by [6] which states that current learning which focuses on teachers is less effective if used as the only source in transferring knowledge to students. The rapid progress of technology should be directly proportional to the application of technology to learning [7]. Also stated that the role of information and communication technology has its own benefits in improving the quality of education.

Teachers are learning agents and are one component that can contribute to creating quality graduates [8]. Teachers are required to be more innovative, creative, and able to keep up with developments in providing quality learning by creating a learning model that is in line with the demands of the 21st Century, namely producing graduates who have the 4C skills: (1) Creativity Thinking and innovation, (2) Critical Thinking and Problem Solving, (3) Communication, (4) Collaboration [9].

Teachers as learning agents can instill 4C skills by implementing innovative learning models in the learning process in class and outside the classroom and are able to implement the Merdeka curriculum in their learning [10]. Teachers play an important role in determining the success of students' learning experiences. Teachers are obliged to create a learning environment that encourages student involvement and motivation. By providing interesting learning opportunities, teachers can help develop students' potential and facilitate their academics [11].

Based on initial observations carried out in April 2022 at three vocational schools in West Sulawesi, namely SMK YPPP Wonomulyo, SMKN 1 Tinambung, and SMKN 1 Tapango, it was found that in phase f, the concentration of computer and network engineering skills, if implemented fully face to face, was not yet possible. covers the entire material, because the time required for one practice with one discussion requires 2x45 minutes, apart from that students also need to master the concept first before carrying out practical activities.

Researchers also found findings at YPPP Wonomulyo Vocational School when conducting the Skills Competency Test (UKK) in May 2022 which tested the network and cabling configuration. These two types of exams only produce a few students who can be declared to have passed the UKK. So the UKK implementing committee must carry out repeat exams until the students are worthy of being declared competent on the certificate later. Meanwhile, the material tested at UKK, namely network configuration and cabling material, is the basic material in phase F of the Computer and Network Engineering Skills Concentration [12].

Sam NE et al. [13] states that the Learning Objectives Flow (ATP) Concentration of Computer and Network Engineering Skills in phase f, namely: (1) network planning; (2) installation of network devices; (3) cable and wireless network installation; (4) Network management; (5) server administration. Each ATP has several achievements. In this research, researchers will raise 2 ATP themes, namely (1) Installation of Network Devices; and (2) Network Management to be treated in classes XI.3 and XI.2 of the Network and Telecommunications Engineering skills program at YPPP Wonomulyo Vocational School. The learning model used by teachers at YPPP Vocational School is not varied and still uses the traditional model.

Based on the description of previous research regarding the application of the Flipped - Blended Learning Model, it can be concluded that this model is practical and effective for use in universities, vocational training and also high schools. However, no research has been found that implements this learning model in vocational schools in Indonesia. Meanwhile, SMK itself has a solid curriculum based on the previously mentioned ATP. Another shortcoming is the lack of adequate course planning and design, in addition to guidance, intervention and feedback from teachers as class facilitators. Furthermore, with technological developments, of course the development of this model can play a more positive role in learning compared to the previous era because it was limited by technological limitations.

Based on the problems that have been described, the researcher wants to develop a Concentrated Learning Model for the Computer Engineering Skills Program and a network based on Flipped-Blended Learning at YPPP Wonomulyo Vocational School with the hope of creating a diversity of learning models as an alternative option to increase student competency, student-centered independent learning, and provide readiness for teachers to implement the Merdeka curriculum in their learning.

1.1 Flipped-Blended Learning (MFBL) Model

Sofya R et al. [14] stated that there are two components in the definition of MFBL, namely "moving educators outside the classroom" usually learning is delivered via electronic media and moving practice in the form of assignments and homework into the classroom. [15] explained that the implementation of MFBL was due to the obstacles faced by the traditional learning process, where when students were given homework, they were not fully able to do it themselves, they needed help from their parents. Not all parents of students have the ability to master the content or material studied by their children [16]. With MFBL, the obstacles in mastering the material faced by students will be assisted by experts, namely Educators. This strategy can also enable all students to still access learning materials even if they are sick or unable to attend class.

Yulhendri et al. [17] stated that flipped learning and blended learning were learning methods during the Covid-19 pandemic. In line with this[18] also conducted research using LMS in learning during the Covid era because this learning method changes the conventional learning model to online or online learning where the learning material has been previously sent to students via the network (Internet) so that it can be studied first independently at each student's home. Further research that also involves online media in learning is Research [19] The findings in this research have a positive impact on students' cognitive and motivational domains.

The MFBL syntax is (1) students make preparations before learning to gain knowledge and understanding. This process is carried out online or offline in a 50:50 proportion which can be carried out synchronously or asynchronously; (2) students access learning content online or offline, inside or outside the classroom. (3) given assignments in groups in class, given and explained the project to be created. Next, the project is done online outside of class; (4) the discussion process for monitoring project progress can be done online using a video conference platform or offline in class; (5) students present project results, obstacles and

conclusions offline in class; (6) evaluation is carried out on cognitive tests at the end of online learning [12]. As a learning strategy, MFBL is worth implementing because it can save time in its implementation [20]. The involvement of LMS online media has been proven to be effective and efficient for use in learning [21]. Learning with this MFBL strategy overcomes time limitations. The learning design can be seen in Fig. 1 as follows.

Implementation of Flipped - Blended Learning requires a flexible learning space design for ease in using multiple learning systems. As with the rotation model, the flexibility of the facilities (desks and chairs) including the lighting of the study room will greatly influence the success of this model.

2. METHODS

The development model used is the ADDIE model. This model consists of 5 stages, namely: Analysis, Design, Development, Implementation, and Evaluation. The data collection techniques used were observation techniques, questionnaires, literature studies and interviews. Meanwhile, the data analysis used is; (a) observation, literature study and interview techniques were analyzed using descriptive techniques; (b) questionnaires in the form of questionnaires were analyzed using percentage techniques. The percentage formula is as follows.

$$ah = \frac{\text{Tse}}{Tsh} \text{ x } 100\%$$

(Source: [23]
Information:
V-ah = Expert Validation;
Tse = Total empirical score achieved based on expert assessment;
Tsh = Total expected score

The conceptual framework of the development model carried out in this research can be seen in

Fig. 2 as follows

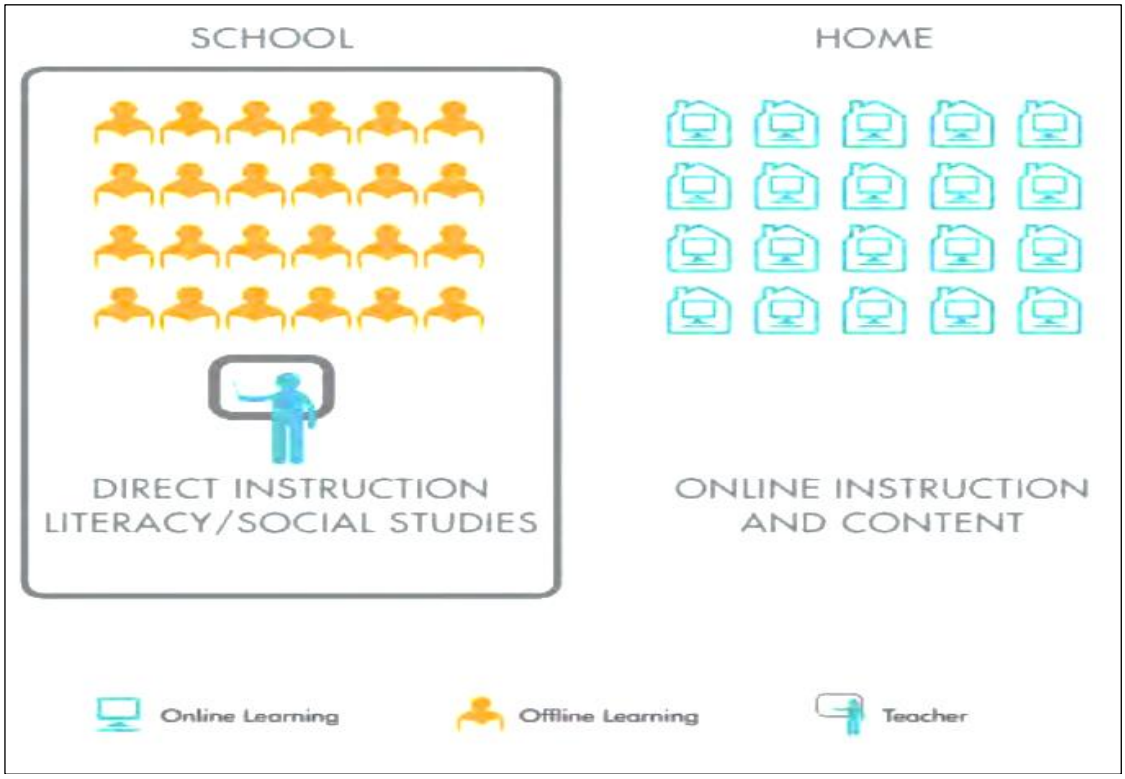

Fig. 1. Flipped Blended Learning
(Source: [22])

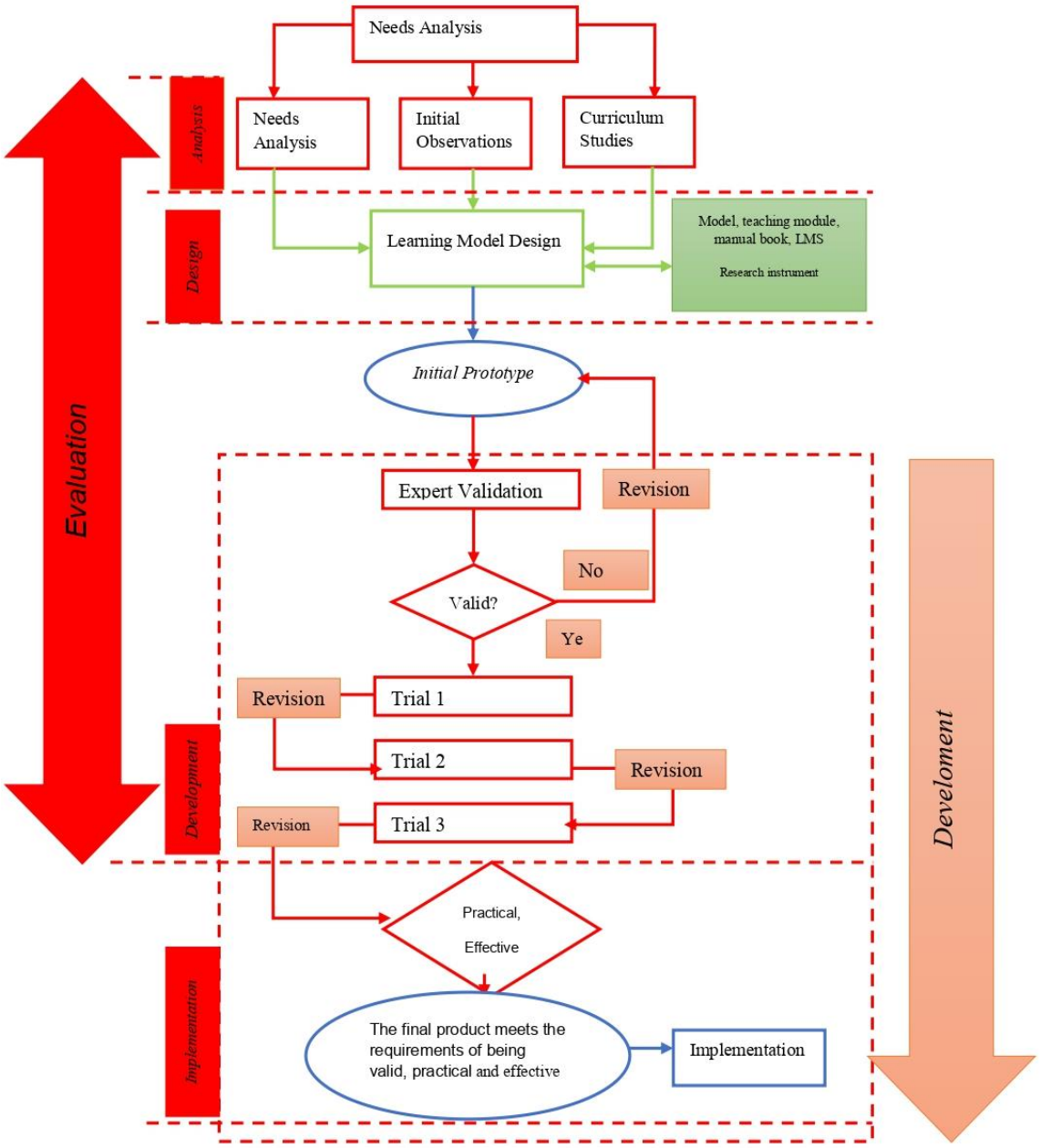

Fig. 2. Conceptual Framework for Developing a Learning Model Using the ADDIE Stages

3. RESULTS AND DISCUSSION

3.1 Learning Model Development Process

Development of a learning model for concentration of computer and network engineering skills based on flipped blended-learning using a 4D development model, namely (1) analysis (needs analysis and performance analysis); (2) design (planning); (3) development, (4) implementation; and (5) evaluation is carried out at each ongoing stage in accordance with needs. As for the conceptual framework

3.2 Analysis Stage

In this stage, the main activity is to analyze the need to develop learning models and analyze the feasibility and requirements for LMS media development. At this stage there are two problem identifications, namely: (1) performance analysis; and (2) needs analysis.

1. Performance Analysis

Performance analysis based on observations of the implementation of Computer and Network Engineering Skills Concentration learning in Phase F in the TKJT area of expertise in three vocational schools, namely (1) YPPP Wonomulyo Vocational School; (2) SMKN 1 Tinambung; (3) SMKN 1 Tapango which produces varied findings but generally finds findings regarding the learning process which still uses conventional/traditional learning models. Based on observations, the following information was obtained: (1) learning tends to be centered on the teacher using the lecture method; (2) the teacher dictates and students record the material in the learning process; (3) learning seems unidirectional, without providing opportunities for students to be actively involved in learning; (4) YPPP Vocational School has an LMS that is not used in learning in the TKJT area of expertise; (5) Teachers use textbooks as the main teaching material in learning; (6) in the UKK exam, only a few students can be declared to have met the passing standards on the certificate, so it is repeated several times.

2. Needs Analysis

Needs analysis based on the progress of YPPP Wonomulyo Vocational School which demands progress in every aspect. The most important aspect is the demand for progress in the learning process. This progress is supported by the existence of facilities and infrastructure in the form of LMS services, computer laboratories and internet access. With lab conditions that have 30 computer units, LCD, whiteboard and projector screen. Phase F concentration of computer and network engineering skills in class Therefore, it is deemed necessary to develop online learning that can be used as a complement to traditional learning and overcome the limitations of face-to-face in class, a means of accessing information for students and teachers in learning and a medium for interaction between teachers and students in the learning process without being limited by space and time. Based on the analysis that has been described, efforts are needed to develop a learning model for concentrating on computer and network engineering skills based on flipped-blended learning.

The needs analysis that supports the flipped-blended learning-based learning model for concentration of computer and network engineering skills is: (1) teaching module for concentration of computer and network engineering skills; (2) LMS online media; (3) a learning model book based on flipped blended learning; (4) LMS user manual.

3.3 Design Stage

Based on the discussion at the analysis stage, an LMS learning media design was then created that supports the Flipped-Blended Learning Model in Computer and Network Engineering Skills Concentration subjects in the form of: (1) Teaching modules; (2) Learning Model Book; (3) LMS; (4) LMS user manual for teachers and students.

3.4 Development Stage

The development stage goes through two stages, namely: (1) one-to-one trial, and (2) small group trial. Based on the trial stages, revisions are carried out and a development process occurs from the evaluation of each trial. The description is as follows:

1 One to one testing stage (Readability)

One to one or individual trials were carried out, after expert validation with 3 lecturers from the STMIK Hasan Sulur Wonomulyo Information Systems Department who were chosen randomly. At this stage, respondents were shown a prototype learning model for concentrating on computer and network engineering skills based on flipped-blended learning that could be read and understood by lecturer respondents. Below are several comments relating to individual trials as revisions to the model guidelines and learning tools being developed, namely: (1) include relevant and short videos in the LMS online media; (2) the syntax contained in the teaching module is adjusted to the Project-Based Learning approach; (3) in the teaching module on the first page, create an outline in the form of a Table containing the flow of learning objectives, learning objectives and elements.

Based on the qualitative data obtained, revisions were made in the form of (1) on the online portal https://lms-smkypppwonomulyo.my.id/ added short duration video of configuration implementation using the Cisco Packet Tracer simulator application; (2) the syntax used in the flipped-blended learning based teaching module is directed towards a

project-based learning approach by dividing students into groups; (3) in the teaching module a Table is created containing the elements, flow of learning objectives and learning objectives.

2 Small group trials (limited trials)

The small group trial (limited trial) consisted of 10 students from the Information Systems Study Program in semester V and 3 observers who were Lecturers in the Information Systems Study Program at STMIK Hasan Sulur Wonomulyo. The small group trial aims to find out that the Flipped-Blended Learning Based Computer and Network Engineering Skills Concentration Learning Model in the field actually meets the practicality criteria. The results of testing the practicality of the model in small group trials (limited trials) which consisted of the implementation of the model on student activities in learning as assessed by 3 observers with a scale of 2 were converted to Observed Yes or No, and student responses to learning were as follows.

Based on the data in Table 1 above, it was found that the aspects of syntax, reaction principles, and supporting systems respectively obtained 86.67%, 86.67%, and the supporting system was 100% in the very practical category. Meanwhile, the social system obtained 83.3% in the quite practical category. The student responses to learning to concentrate computer and network engineering skills based on flipped-blended learning are shown in Table 2 as follows.

Based on Table 2, it was found that students' responses in learning stated that they strongly agreed with a mean of 23.50, agreed 18.50, while those who said they disagree only got a mean score of 0.5. Student comments on learning activities vary, but in general they provide constructive comments on the implementation of learning. The majority of students commented that the model applied created independence, convenience, conduciveness and fun.

So it can be concluded that in general students gave a positive response with a percentage of 88.58% to the implementation of the flipped-blended learning model of computer and network engineering expertise concentration based on flipped-blended learning.

Product Revisions for small group trial activities in the learning model book for concentration of computer and network engineering skills based on flipped-blended learning, namely: (1) grouping model syntax into 3 groups, namely: teacher activity syntax on LMS media, student syntax on LMS media, syntax in face-to-face learning in class; (2) make a preliminary analysis as outlined in the table included in the learning model book.

Revisions made to teaching modules; (1) using an appropriate and proportional teaching module format; (2) the questions on the LKPD are adjusted to Bloom's theoretical framework; (3) Assessment is adjusted to learning outcomes.

Table 1. Student Activities on the Implement ability of Learning Models Based on Observer Assessments

Rated aspect	Validator			Average	%	Category
	O1	O2	O3			
Syntax	0.80	1.00	0.80	0.87	86.67	Very Practical
Social system	1.00	1.00	0.50	0.83	83.33	Quite Practical
Reaction principle	0.80	1.00	0.80	0.87	86.67	Very Practical
Support system	1.00	1.00	1.00	1.00	100.00	Very Practical
Overall Average				**0.89**	**89.17**	**Very Practical**

Source: Data Processing Results (2023)

Table 2. Student Responses in Learning In small group trials

Aspects that are responded to	Response				%
	STS	T.S	S	SS	
Interest in the learning process	0	0	21	19	86.88
Ease of the learning process	0	1	27	32	87.88
Quality of teachers during learning	0	1	12	17	88.33
Lecture activities	0	0	14	26	91.25
Average	0	0.5	18.50	23.50	88.58

Source: Data Processing Results (2023)

Revisions made to the LMS: (1) changing the LMS template with an attractive background color; (2) adding formative tests in the form of quizzes at each session/topic; (3) improving the language in existing instructions for online learning on the portal https://lms-smkypppwonomulyo.my.id/

After the process of revising the learning model book for concentration of computer and network engineering skills based on flipped-blended learning, teaching modules, and LMS media, a small group trial (expanded trial) was carried out.

3.5 Implementation Stage

The implementation phase carried out expanded trials (field trials) which were carried out in Phase F in class Field trials (expanded trials) were carried out to measure (1) students' cognitive changes; (2) student responses; And (3) the teacher's response to the implementation of the learning model. At this stage, a learning model for concentrating on computer and network engineering skills based on flipped-blended learning with 7 meetings is applied. The description of the meeting for concentration learning on computer and network engineering skills based on flipped-blended learning can be seen in Table 3 as follows.

Syntax of the learning model for concentration of computer and network engineering skills has stages in learning activities which are divided into 3, namely: (1) syntax model for teacher activities in online learning on the LMS (2) syntax model for student activities in online learning on the LMS; (3) syntax for face-to-face learning model in class. The syntax for the model of teacher and student activities in online learning in the LMS can be seen in the Learning model book. Meanwhile, the syntax of the face-to-face learning model in class can be seen in Table 4 as follows.

3.6 Evaluation Stage

Each stage carries out an evaluation, in the form of product revisions as explained in each stage above. In the field trial stage (expanded trial), the data obtained to collect the effectiveness of implementing the flipped blended learning-based computer and network engineering skills concentration learning model are in the form of: (1) teacher response data, (2) student response data. The description is as follows.

Data Analysis of Teacher Responses to Learning Models

Collecting data on teacher responses to collect data on effectiveness and practicality. Data was collected from 5 teachers from the Computer, Network and Telecommunications Engineering Study Program at YPPP Wonomulyo Vocational School. The recapitulation of the questionnaire instruments provided can be seen in Table 5 as follows.

The bar diagram of the recapitulation of teacher responses based on aspects of validation, reliability, objectivity aspects and practicality aspects in the form of percentages can be seen in Fig. 3 as follows.

Table 3. Description of Learning Meetings *Flipped- Blended Learning*

Meeting	Type of activity	Activity Description
Number 1	Face to face	Providing material on LMS usage, providing VLAN material
2nd	On line& Face to face	On line: In Phase 0 Providing material on routing implementation, answering quizzes (independently); answer the pretest questionsFace to face:group discussion
The 3rd	On line& Face to face	On line: In Phase 0 Providing material for improving routing configuration, answering quizzes (independently) Face to face:group discussion
To 4	On line& Face to face	On line: In Phase 0 Providing internet gateway & NAT material, answering quizzes (independently) Face to face:group discussion
5th	On line& Face to face	On line: In Phase 0 Proxy Server material provision, answer the quiz (independently)Face to face:group discussion
6th	On line& Face to face	On line: In Phase 0 Providing Bandwidth management material, answering quizzes (independently) Face to face:Group discussion
7th	On line	Providing Load Balancing material and answering post-test questions.

Source: Learning Model Book Products (2023)

Table 4. Syntax of the face-to-face learning model in class at the 2nd meeting routing material

Phase	Teacher Activities	Student Activities
Phase 0(Students study learning materials at home)	The teacher distributes learning material regarding Routing in the LMS which will be studied at the next meeting and directs students to study the content. Students independently study the material at home and make notes or questions that are not yet understood.	Students independently study Routing material at home, make notes or questions they don't understand, answer quizzes, and answer pre-test questions
Phase 1(Come to class to do assignments related to LKPD-2)	Teachers to ask questions regarding the material that has been studied in the LMS If no one asks questions, the teacher gives simple questions related to the routing material	Students ask questions about things they don't understand based on what they read and do in the LMS Students discuss with each other and answer questions asked by their friends
Phase 2(Applying project and simulation skills in the classroom)	The teacher divides students into 3-5 people/groups to complete the LKPD	Students work on LKPD in groups
Phase 3(Measuring students' understanding in class at the end of the lesson material)	The teacher asks students to present the results of their group work and asks students to conclude the learning material they have learned At the end of the lesson the teacher gives evaluation questions to the students	Students present the results of their group work and at the end of the lesson students conclude the learning material they have learned At the end of the lesson, students work on evaluation questions given by the teacher

Source: Learning Module Book Products (2023)

Table 5. Recapitulation of teacher responses to learning models

Rated aspect	Average	%	Category
Validation	3.73	93.33	Very good
Reliability	3.70	92.50	Very good
Objectivity	3.60	90.00	Very good
Practicality	3.67	91.67	Very good
Overall average	3.68	91.88	Very good

Source: Data Processing Results (2023)

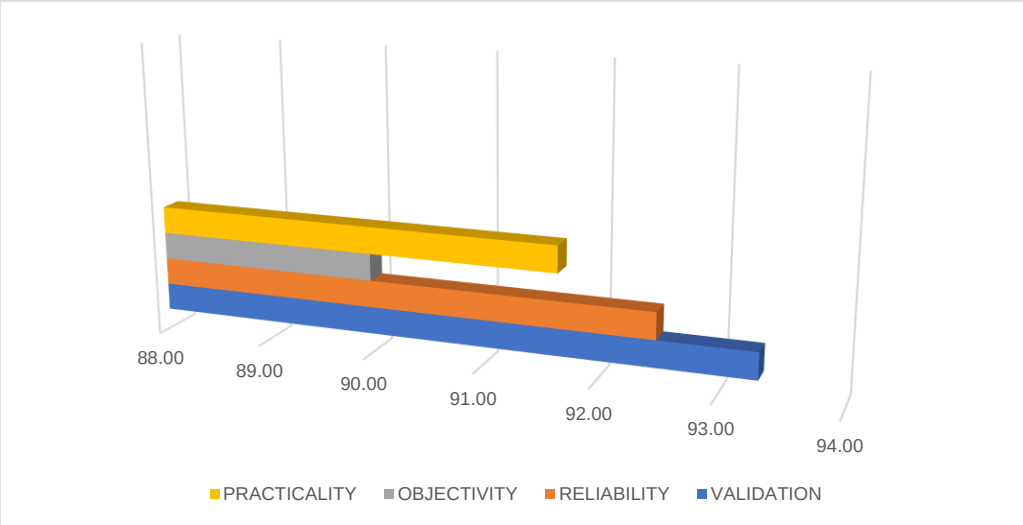

Fig. 3. Histogram diagram of teacher responses to learning

Table 6. Recapitulation of student responses to learning models

Rated aspect	Average	%	Category
Interest in the learning process	3.64	91.04	Very good
Ease of the learning process	3.65	91.25	Very good
Quality of teachers during learning	3.62	90.56	Very good
Lecture activities	3.68	91.88	Very good
Overall Average	3.65	91.18	Very good

Source: Data Processing Results (2023)

Based on the recapitulation of teacher responses to the flipped-blended learning based learning model of computer and network engineering skills concentration on the aspects of validation, reliability, objectivity and practicality, percentages of 93.33%, 92.50%, 90.00% were obtained respectively. and 91.88% where all aspects are in the very good category and the overall average is 91.88% which is in the very good category. It can be concluded that the learning model for concentration of computer and network engineering skills based on flipped-blended learning has high validation, reliability, objectivity and practicality or in the sense of very good.

3.7 Data Analysis of Student Responses to Learning Models

Collecting student response data to collect effectiveness and practicality data. Data was collected from 30 students in class XI in computer and network engineering expertise concentration subjects. The recapitulation of the questionnaire instruments provided can be seen in Table 6.

Based on the recapitulation of student responses to the flipped-blended learning model of concentration of computer and network engineering skills based on the aspects of Interest in the learning process, Ease of the learning process, Quality of teachers during learning and Lecture activities, respectively, the percentages obtained were 91.04%, 91. .25%, 90.56%, and 91.88%, where all aspects are in the very good category and the overall average is 91.18% which is in the very good category. It can be concluded that the learning model for concentration of computer and network engineering skills based on flipped-blended learning has high validation, reliability, objectivity and practicality or in the sense of very good.

4. CONCLUSION AND RECOMMENDA-TIONS

4.1 Conclusion

Based on the results of research and product studies and referring to the research objectives, it can be concluded that:

1. Analyze the need for YPPP Vocational School to have complete facilities such as an LMS platform, computer laboratory and internet access. The needs analysis that supports this model is: (a) learning model books; (b) teaching module; (c)

LMS media; (d) LMS user manual (manual book)

2. The design of a learning model for concentration of computer and network engineering skills based on flipped-blended learning uses a learning model development stage process with model specifications including: (a) Model syntax; (b) Creation of a social system through interaction between students and students and LMS and teachers; (c) Reaction principle; (d) Support systems, including: teaching modules, LMS media, LMS use guidebooks, and research instruments.
3. Flipped-Blended Learning-based Computer and Network Engineering Skills Concentration Learning Model is effective based on observer responses and observations regarding the implementation of the learning model

5. SUGGESTION

The flipped-blended learning based computer and network engineering expertise concentration learning model is effective in learning, therefore it is recommended that teachers at YPPP Wonomulyo Vocational School use this model in the Computer and Network Engineering Skills Concentration Subject.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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