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Worksheet through Problem Based Learning Approach as a Learning Media

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Abstract*—This paper was aimed at gaining a worksheet learning media with the steps of Problem Based Learning approaches for the learning of Medical Electronics Practice. This research adapted the development model of Alessi and Trollip consisting three steps, namely planning, design, and development. Product test design used was alpha testing. The data collection technique used was interview, documentation, observation, and questionnaires. Qualitative descriptive analysis was used as technique of data analysis. The results of this research showed that, in general, the worksheet of Medical Electronics Practice developed in this research got the average score 2.97 which was in the feasible category. This worksheet assessment was identified from five assessment indicators, namely graphics, material presentation, Problem Based Learning characteristics, suitability, and usage. Thus, the worksheet of feasible category was able to be applied in the learning of Medical Electronics Practice. The steps of the Problem Based Learning approach written on the worksheet could facilitate the lecturer to apply it into the teaching process.

***Keywords*—worksheet, problem based learning, learning media, medical electronics practice**

I. INTRODUCTION

Medical Electronics Practice is one of the compulsory courses in the Electronics Engineering Study Program of Diploma 3 at the Yogyakarta State University. This course is included in one of the technological engineering fields that has 2 credits (SKS) and must be attended by students in semester 5. This scientific field is a multidisciplinary science consisting of electronics and health sciences. Based on the curriculum, this course studies the design of medical instrumentation and the measurement of electrical signals originating from within the human body such as Electrocardiography (ECG), Electromyography (EMG) and Electroencephalography (EEG). By researching this subject, students are expected to become professional technicians, especially in the field of medical electronics.

The status of Medical Electronics Practice course in Yogyakarta State University officially became the compulsory courses in the academic year of 2016/2017, which was previously an optional course. Considering the importance of this course as one of the branches of electronics and many industries require the skilled technicians in the field of medical instrumentation as well, and because, in every academic year, there are no students who chose this course, and thus the status of this subject becomes a compulsory one. Change in the status of this course has not been matched by the readiness of learning tools that will be used to teach students.

The needs of learning media and teaching methods in the Medical Electronics Practice course are very important in supporting the learning process. But, the facts, it showed that there is still no worksheet learning media available for Medical Electronics Practice courses. Until now, the learning process still uses laptop learning media to find and analyze journals relating to the project to be made. The use of laptop as learning media in the Medical Electronics Practice course causes the students' learning activities become less active because they only sit in front of the laptop screen during the learning process. Yet, most of them are more likely to explore other things outside the learning content. Student learning activities can be a determinant in the success of learning [1].

Each course has certainly a competency standard that has to be achieved, and so the Medical Electronics Practice course does. The fact shows that during the course of Medical Electronics Practice there is only one competency standard achieved in the learning process, while the other one competency standard has not been achieved yet. The standard of competence that has not been achieved is measuring electrical signals originating in the human body. These achievements on the integration of ICT into the organizational work structure are not yet established on a strong foundations [2]. The learning process in this competence is abstract, therefore students are required to think logically so that the learning process needs to be applied in the real world. The real life learning approach is expected to be able to solve abstract learning problems into real ones. The steps of this learning approach need to be implemented into practical activities both practically and writing.

Besides that, an appropriate learning approach that relates to the characteristics of this course is needed in order the students to able to achieve all competencies in the Medical Electronics Practice course. But the facts shows that the learning approach used in the Medical Electronics Practice course is still not able to encourage students to actively participate in the practical learning process. Having been analyzed through brainstorming with the lecturer in Medical Electronics Practice course, it turns out that the learning approach used is not appropriate because it needs a long time to achieve competence like this. Based on the results of the analysis, it is necessary to implement a new learning approach for Medical Electronics Practice courses, namely

Problem Based Learning approach. This learning approach is suitable to be applied to Medical Electronics Practice courses because of providing problems to practical learning can not only train students' skills, but also shape the students' mindset to be critical and logical in finding solutions to problems, so that students can be actively involved in the learning process and make practicum learning more qualified. In addition, the learning approach of Problem Based Learning is considered to be able to improve the students' performance in developing their professional competencies [3].

Every human being must certainly have various problems in their life, both simple and complex problems and so the engineering students who will later become the technicians in a company or industry. They will be faced with various problems in their work. A technician must not only have great competency in knowledge, but also in soft skills that are required by industry [4]. Therefore, students need to be trained through a habitual process of solving problems in their learning. When they are faced with various problems, they have been skilled at solving their problems well.

Based on the problem background described above, worksheet learning media with the steps of Problem Based Learning approach is very important for the students in carrying out Medical Electronics Practice learning. By worksheet learning media in the Medical Electronics Practice course, it is expected that the practical learning process will be more directed so that practical learning can be more effective and efficient. By applying the steps of the Problem Based Learning approach in the Medical Electronics Practice course, it is expected that the practical learning process will be more active so that practical learning becomes more qualified. The results of this brainstorming analysis still need to be proven through a series of stages of research activities. Therefore, the author takes the research title "Worksheet through Problem Based Learning Approach as a Learning Media".

The objective of this research is to produce a worksheet design with the steps of Problem Based Learning approach that has been tested for its feasibility so that it can be used as a learning media in the Medical Electronics Practice course. Theoretically, the benefits of this research are that it can add insight into the use of Medical Electronics Practice learning media and can be used as reference material for relevant future research. Practically, the benefit of this research is that it can produce worksheet designs that have been tested for its feasibility so that they can be used as supporting media in the learning process of Medical Electronics Practice.

II. METHODS

This research belongs to the type of Research and Development. The development model used in this research was adapted from the Alessi and Trollip development model. The development procedure in this research consisted of three stages, namely planning, design, and development as shown in Figure 1.

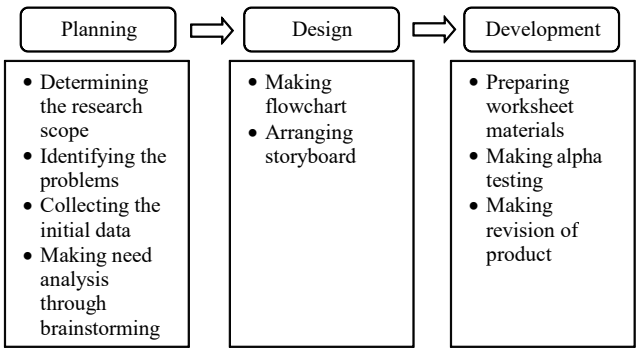

Fig. 1. Research Procedures adapted from Development of Alessi and Trollip [5]

The researcher uses product testing design with alpha testing that involves two Medical Electronics Practice lecturers. Data collection techniques are conducted by interview, documentation, observation and questionnaire. The data analysis technique uses qualitative descriptive analysis techniques.

The worksheet feasibility data obtained from the questionnaire will be used as a combination of quantitative and qualitative data analysis techniques. Data obtained from two lecturers in Medical Electronics Practice as qualitative values will be converted into quantitative values. The rules for granting scores to convert qualitative values into quantitative values are carried out by using a Likert scale with a rating range of 1 to 4 as shown in Table 1.

TABLE I. SCORING RULES

Assesment	Score
Strongly Agree (SA)	4
Agree (A)	3
Disagree (D)	2
Strongly Disagree (SD)	1

Source: [6]

The quantitative data that has been collected will be calculated by the average score using the following formula:

$$\overline{X} = \frac{\Sigma X}{n}$$

Description:

$\overline{X}$ = average score

ΣX = amount of score

n = number of assessors

The data of scoring result is then changed into qualitative values based on 4 categories as shown in Table 2. Rules for converting scores into several categories are used to determine the level of feasibility of developed learning media products.

TABLE II. SCORING CONVERSION RULES OF FEASIBILITY CATEGORY

Interval Score	Category
$X \geq \overline{X} + 1.SBx$	Strongly Feasible
$\overline{X} + 1.SBx > X \geq \overline{X}$	Feasible
$\overline{X} > X \geq \overline{X} - 1.SBx$	Unfeasible
$X < \overline{X} - 1.SBx$	Strongly Unfeasible

Source: [6]

Description:

X = obtained score

$\overline{X}$ = whole average score calculated by formula $\frac{1}{2}$ (maximal score + minimal score)

SBx = deviation standard of whole score calculated by the formula $\frac{1}{6}$ (maximal score – minimal score)

III. Results and Discussion

A. Planning

Planning is the first stage carried out in this research. At this stage the scope of the research was determined about the learning of Medical Electronics Practice. This course was chosen to be studied because it had several problems in teaching the students. Having been identified, it was found that the problem was the unavailability of worksheet learning media for learning Medical Electronics Practice and the lack of effective learning approach used in the Medical Electronics Practice course.

To support the problem identification process, the initial data collection was then carried out relating to the learning of Medical Electronics Practice. Data collection was done by interviewing lecturers in Medical Electronics Practice courses. The results indicated that there were differences both in learning theory and practical learning. This could be seen from the learning material that was not practiced and practice the learning material that had not been taught. Besides that, the learning approach used in the Medical Electronics Practice course also encountered several obstacles such as the length of time needed to achieve learning competencies.

Documentation was conducted to get more complete preliminary data. The documentation results showed that there was a change in the status of Medical Electronics Practice courses curriculum, namely from elective courses to compulsory subjects. In this case, there was no balance between the readiness of learning devices that would be used to teach students such as the unavailability of syllabus which was used as a reference in the learning process of the Medical Electronics practice and the unavailability of written assessment instruments to measure student competency.

To clarify the initial data, an observation was then made. The results of the observation showed that the learning process of Medical Electronics Practice was carried out by project-based without using worksheet as a guideline for students in conducting practical learning. During this time, the practical learning process often only used laptops connected to the internet network to find out the knowledge and trained student skills in making a project. The practical learning process like this seems to be passive because it only sat in front of the laptop screen and tended to explore other things out of the learning content.

Based on the initial data collected, a needs analysis was conducted through brainstorming with the lecturer in the Medical Electronics Practice course. The results of the brainstorming showed that the development of learning media was needed in the form of worksheets with the steps of the Problem Based Learning approach as a guideline for students in carrying out Medical Electronics Practice learning. The availability of worksheet learning media using the steps of Problem Based Learning approach, the process of practical learning was expected to be more directed and active so that the practical learning was to be more effective, efficient and qualified.

B. Design

Design is the second stage carried out in this research. At this stage, a design concept for the product of Medical Electronics Practice learning media was made by creating a flowchart about the arrangement of the worksheet as shown in Figure 2.

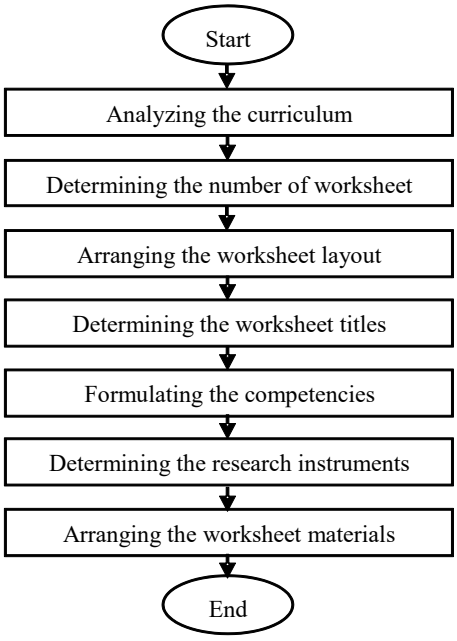

Fig. 2. Flowchart of Worksheet Arrangement Adapted from Education Agency in Prastowo [7]

In this stage, storyboard of worksheet layout is made as seen in the Figure 3.

Storyboard of Worksheet Layout

Cover
Introduction
Table of Contents
General Rules of Practice

Worksheet 1, 2, and 3
A. Learning Competencies
B. Learning Objectives
C. Learning Problems
D. Basic of Theory
E. Tools and Materials
F. Work Safety
G. Work Steps
H. Discussion Materials
I. Assessment
J. Bibliography

Appendix

Fig. 3. Storyboard of Worksheet Layout adapted from Prastow [7]

C. Development

Development is the last stage carried out in this research. At this stage, the product of Medical Electronics Practice learning media was made in the form of worksheets based on the design concepts that had been made. Making product was begun with analyzing the curriculum for Medical Electronics Practice courses. Based on the curriculum, there were generally three topics discussion in this course, namely the design and measurement of the heart's electrical signals, the design and measurement of muscle electrical signals, and the design and measurement of brain electrical signals. However, this paper would only develop worksheet learning media for one subject only, namely the design and measurement of heart electrical signals. This subject was chosen because it was more general and had widely been applied in daily life.

Based on the results of curriculum analysis, worksheets on the design and measurement of heart electrical signals would be developed based on the measurement method that was usually carried out by medical experts. This measurement method was Palpation, Photoplethysmography (PPG) and Electrocardiography (ECG) which were performed using medical instrumentation. Based on this measurement method, it could be determined that the numbers of worksheets to be developed for Medical Electronics Practice courses were three worksheets.

The worksheet layout was made based on the storyboard that had been compiled before. "Medical Electronics Practice Worksheet Measuring Heart Electrical Signal" was chosen as the main title of the worksheet in which there were three subtitles for each practical meeting as shown in Table 3.

TABLE III. SUB TITLE OF MEDICAL ELECTRONICS PRACTICE WORKSHEET

Meeting	Worksheet Sub Title	Description
1	Measuring Heart Electrical Signal with Palpation Method	In this practicum, students will design medical instrumentation, which is then carried out to measure the heart's electrical signal by feeling the arterial pulse.
2	Measuring Heart Electrical Signal with Photoplethysmography (PPG) Method	In this practicum, students will design medical instrumentation, which is then carried out to measure the heart's electrical signals using optical technology as a sensor.
3	Measuring Heart Electrical Signal with Electrocardiography (ECG) Method	In this practicum, students will design medical instrumentation, which is then carried out to measure the heart's electrical signals using electrodes as sensors.

Learning competencies presented in this worksheet were designing medical instrumentation and measuring the electrical signals of the heart coming from the human body. With this competency, students were trained to be skilled in designing medical instrumentation which its design was then carried out to measure heart electrical signals with various measurement methods commonly carried out by medical experts such as the Palpation method, Photoplethysmography (PPG), and Electrocardiography (ECG).

Assessment instruments were used to assess the learning process and student learning outcomes in practical activities. Test instruments and non-test instruments were used to assess the students' learning process in learning Medical Electronics Practice. The test instruments evaluated the cognitive aspects of students using several types of questions and essays as discussion material on the worksheet. Non-test instruments was used to evaluate the students' affective and psychomotor aspects during the practical learning process using the observation sheet. In the assessment process, portfolio through a practicum report was used to assess students' learning outcomes.

The Medical Electronics material contained in this worksheet was related to the measurement of heart electrical signals by the Palpation method, Photoplethysmography (PPG), and Electrocardiography (ECG). The material on this worksheet was taken from several reference sources as shown in Table 4.

TABLE IV. REFERENCE SOURCE USED FOR COMPILING THE WORKSHEET

Reference Source	Title	Author
Books	Anatomi dan Fisiologi untuk Paramedis	Evelyn C. Pearce
	Auskultasi Jantung	Richard W. D. Turner and Ronald G. Gold
	Basic Trauma Cardiac Life Support	Sudiharto and Sartono
	Biomedical Digital Signal Processing	Willis J. Tompkins
	Biomedical Instrumentation	R. S. Khandpur
	Biomedical Signal Analysis	Rangaraj M. Rangayyan
	Biomedical Signal and Image Processing	Kayvan Najarian and Robert Splinter
	BTCLS + AED	Tim GTC
	Ensiklopedia Tubuh Manusia	Steve Parker
	Introduction to Biomedical Engineering	Jhon D. Enderle and Joseph D. Bronzino
	Medical Instrumentation Application and Design	John G. Webster
	Panduan Praktis Mempelajari Aplikasi Mikrokontroler dan Pemrogramannya Menggunakan Arduino	Abdul Kadir
Journal Article	Advances in Photopletysmography Signal Analysis for Biomedical Applications	Jermana L. Moraes, Matheus X. Rocha, Glauber G. Vasconcelos, Jose E. Vasconcelos Filho, Victor Hugo C. de Albuquerque, & Auzuir R. Alexandria
	A Review on Wearable Photoplethysmography Sensors and Their Potential Future Applications in Health Care	Denisse Castaneda, Aibhlin Esparza, Mohammad Ghamari, Cinna Soltanpur, & Homer Nazeran
	Pengembangan Trainer Indikator Denyut Jantung	Pipit Utami & Muklas Fajar
	Rancang Bangun Photoplethysmography (PPG) Tipe Gelang Tangan untuk Menghitung Detak Jantung Berbasis Arduino	Riza Yulian & Bambang Suprianto
	Wearable Photoplethysmographic Sensors - Past and Present	Toshiyo Tamura, Yuka Maeda, Masaki Sekine, & Masaki Yoshida

The worksheet was then tested using alpha-testing to two lecturers in Medical Electronics Practice. The results of the alpha-testing tests for the Medical Electronics Practice worksheet with the Problem Based Learning approach got the score of 3.38 from the first lecturer and 2.56 from the second lecturer with detailed scores as shown in Figure 4. The average score of the two lecturers became 2.97. Based on the conversion rules for the score of the feasibility category as shown in Table 2, the score of 2.97 was included in the feasible category. The results of these tests still required revisions on a small scale so it was necessary to revise the graphics which includes the selection of fonts, adjusting size and image quality, use of watermarks; presentation of material which included the inclusion of sources of quotes and images, use of terms on worksheets; Characteristics of Problem Based Learning which included making special space for learning problems on worksheets; and conformity which included learning objectives with learning evaluation tools.

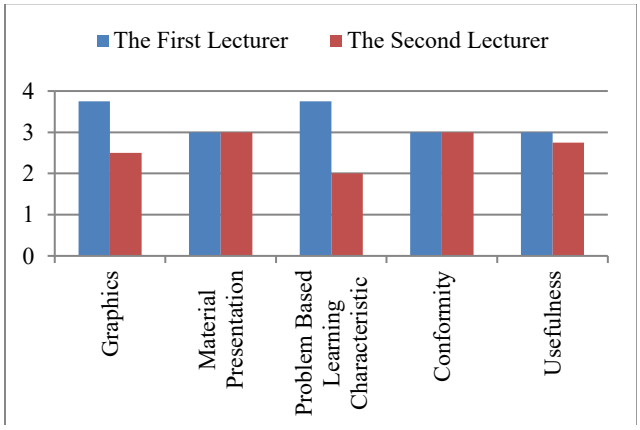

Fig. 4. Result of Alpha-Testing Test

The Medical Electronics Practice Worksheet was developed using the Problem Based Learning approach containing learning problems and solutions that would be sought through practical activities. This worksheet would be used as a learning medium for Diploma 3 Electronics Engineering students who learned Medical Electronics Practice courses.

The Medical Electronics Practice Worksheet was developed with an adaptation method, namely the process of developing worksheets based on existing learning material from various learning sources into an adapted works worksheet. In addition, the contents of the mind from the knowledge that had been obtained by the author as well as the experience that had been done by the author and the Medical Electronics material were also included in this worksheet.

The Medical Electronics Practice Worksheet was made using HVS 80 gram A4 size paper with vertical position (portrait). The type of font used was Arial with a space of 1.5 on each line to make it easier to read by the students. The font size used varies according to needs. The size of 20 points up to 16 points was used for titles and 12-point sizes used for reading texts.

The Medical Electronics Practice Worksheet was divided into three parts, namely the front, the contents and the back. The front part of the worksheet consisted of cover, introduction, table of contents, and general rules of practice. The contents of the worksheet consisted of three practical material presented using the Problem Based Learning approach. The back of the worksheet was also appendix.

On the front part of the worksheet there was a cover made of thick paper that were designed in such a way as to describe the contents of the worksheet with the aim of attracting students' interest in studying this worksheet. In this section there was an introduction containing a general overview of the writing of this worksheet. The table of contents in this section was useful to facilitate the students to find practicum material to be studied. The general rules of practice in this section functions as signs for students in conducting practical activities.

The contents of the worksheet consisted of three practical material, in which each material consisted of learning competencies, learning objectives, learning problems, basic f theory, tools and materials, work safety, work steps, iscussion materials, assessment, and bibliography. The earning competencies in this worksheet was a competence hat would be learned by students on each material. The earning objectives in this worksheet were the aspects that vould be achieved by students after learning the worksheet n each of the material. The learning problems in this vorksheet contained problems that had to be solved by tudents by discussing with the group. The basic of theory in his worksheet contained a brief material that was ndamental from the theories that students had learned as a rovision for practicum activities. The tools and materials in his worksheet were considered as a list of equipment needed carry out practical learning. The work safety in this vorksheet contained signs that had to be adhered by students uring the practical learning process. The work steps in this worksheet contained procedures in conducting practical activities. The discussion materials in this worksheet contained several questions that had to be answered by each group as material for evaluating practical learning to find out the understanding of students. The assessment in this worksheet is the rules to assess the process and results of practical learning. The bibliography in this worksheet was a list of reference sources used in arranging the worksheet. In this section, the worksheet was developed using five stages of the Problem Based Learning approach adapted based on the theory of Professor Richard I Arends as shown in Table 5.

TABLE V. STAGES OF PROBLEM BASED LEARNING APPROACH ON WORKSHEET ADAPTED FROM ARENDS

Stages of Problem Based Learning	Application of Worksheet
Leading the students to the problems	Delivering learning objectives and presenting learning problems in the form of observations through real objects or objects that resemble real objects in the form of images, graphs, and tables that can be observed by students.
Preparing the students to study	Stimulating students to find solutions to learning problems by observing, asking questions, discussing, and exploring their knowledge of the learning problems presented.
Helping the students to do research	Inviting students to conduct experiments through practical activities related to designing medical instrumentation and measurement of heart electrical signals.

Stages of Problem Based Learning	Application of Worksheet
Presenting the display	Presenting the results of the practicum that have been done as a form of report on what they have done and got during the learning process.
Analyzing and evaluating the process of problem solving	Reflecting the process and results of practical learning that have been carried out and assess the process and students' learning outcomes from cognitive, psychomotor, and affective aspects related to the problem solving process of learning presented in practical activities.

Source: [8]

On the back part of the worksheet there were three types of appendices, namely appendix A which showed the Arduino Uno's input output legs, pulse heart rate sensor's input output legs, and AD8232 heart monitor's input output legs; appendix B showed the Arduino's instruction sketch; and appendix C showed the glossary for definitions foreign words or less commonly used terms. Overall, the final product of the Medical Electronics Practice worksheet with the Problem Based Learning approach is shown in Figure 5.

Fig. 5. Final Product of Medical Electronics Practice Worksheet

IV. Conclusion

In general, the Medical Electronics Practice worksheet developed with the Problem Based Learning approach obtained the average score of 2.97 which was included in the feasible category. Worksheet with appropriate categories could be used in learning Medical Electronics Practice. The steps of the Problem Based Learning approach written on the worksheet could facilitate the lecturer to apply it into the teaching process.

The Medical Electronics Practice Worksheet that had been developed and assessed as feasible needed to be implemented on a large scale practical learning activity. Furthermore, it was necessary to analyze the process and student learning outcomes related to the use of the Medical Electronics Practice worksheet in practical learning.

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