A feasibility study of sensor and transducer trainers as a learning media towards electronics engineering’s students

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Abstract. This research aimed at determining the feasibility of sensor and transducer trainer as a learning media applied for Electronics Engineering students of FT UNM. This study’s feasibility indicators were divided into 3, namely feasible in terms of material, media, and responses from the students as users of these media trainers. The method applied in this research was Research and Development (R&D) by developing a sensor and transducer trainer. The data analysis technique used was descriptive statistical analysis. A questionnaire was used to collect the data by targeting 4 lecturers as media and material experts, while 27 students participated as a respondent. The assessment results from the material expert validator were obtained an average value of the feasibility percentage of 97%, while the assessment of the media expert received an average value of 96%. Based on this assessment, the media trainer was worthy of both the material’s content and its performance. Meanwhile, the value of students’ responses towards the use of trainers after being tested reached 84% with a very good category. The feasibility test results generally showed that the trainer could be used in practical learning of sensor and transducer course. This trainer could be developed with the addition of IoT (Internet of Things) technology to perform remote monitoring and control systems.

1. Introduction

The learning media of trainer is still needed in education, especially in vocational study programs. This need is very clear from the demands that must be mastered by students concerning the mastery of knowledge, skills, attitudes, and values needed by the industry [1]. Therefore, many vocational colleges are developing learning media to accelerate the improvement of student skills in practicum courses.

One of the most effective and widely used media in practicum is the trainer. The application of trainer learning media can improve learning outcomes for both college and secondary students [2][3][4]. Some advantages obtained by using a trainer in practicum are that the students have a lot of experiences during the practicum process, starting from collecting tools and materials, building circuits, measuring components directly, and recording observational data. As a result, the practicum process that directly involves the students using a trainer will contribute a good and positive response from the students [5]. The students are more motivated to learn by using trainers [6].

The current condition in the Department of Electronics Engineering FT-UNM, especially in the course of practicum Sensors and Transducers needs to develop the sensor trainer to follow the
development of electronics technologies. This trainer development is strongly supported by several modules sensor encountered in the market at very affordable prices. The lecturers must utilize this convenience to design and create their sensor trainer model based on a needs analysis and practical learning outcomes. The development of trainer practicum media consists of several phases. The phases can be seen from the performance of a needs analysis of media, design a media, media development both material and technology used, the manufacturing performance of the trainer, perform the validation by expert media and materials, and to conduct a feasibility study on the user [7][8].

A feasibility study is an activity or stage that contributes massive importance to the trainer learning media development. A media’s feasibility is usually determined by the validator, both material, and media experts, through an instrument associated with variables research [9]. According to this phenomenon, this current study adopted and developed several instruments. These instruments were adjusted to this research object, namely adjustments to the type and form of trainers, media needs analysis instruments with observation and questionnaire techniques, and trainer trials on expert validators and conducting trainer’s feasibility studies to the college student.

2. Research Methods

2.1 Development of Research Methods

This study was designed in the form of research and development (R&D). The research development aimed at creating a trainer and testing its feasibility [10], while [11] clarified that the products were produced in accordance with specific areas of expertise and effective in use. The research implemented several stages, namely the needs of the media analysis, manufacturing and development of sensors and transducers trainer, testing the feasibility of media and materials by validator experts, and testing media’s feasibility by students as users. The following figure below presents the research design of this current investigation.

![Figure 1. The Research Development.](image)

2.2 Data Analysis Technique

The questionnaire’s obtained data were analyzed by using descriptive statistical analysis to determine the percentage of learning media’s feasibility from the expert validators and the students [11]. The data were displayed in graphic and bar chart to make the information was clearly understood.

2.3 Research Sample

The sample of this study was Electronics Engineering’s Students who programmed the Sensor and Transducer practicum subject. This research involved 27 students who came from the same class in the third semester. The determination of these samples was based on the semester that had been programmed the previous subject as a requirement to learn it, so they had a basic knowledge of electronics components and sensors.
2.4 Instruments of This Study
This research’s instruments consisted of 2 major instruments, namely media needs analysis and the media feasibility study. Media needs analysis aimed at observing the practical learning conditions performed in the laboratory. There were 2 aspects majorly explored in these instruments, namely learning condition and the needs of media. In general, the desired explored aspect regarding the learning condition was the practicum activities that were mostly done by simulations in the laboratory besides using a trainer. Also, this stage explored the students’ needs in supporting practicum activities, such as the trainers’ availability.

Therefore, the indicator aspects of a media feasibility study from the questionnaires were the trainer’s useful aspect, the easy use of a trainer, the construction of materials and components, the relevance of materials, and the renewable of materials.

3. Results and Discussion

3.1 Results of the Media Needs Analysis
Based on the observation results and questionnaires towards the student regarding the condition of the learning process in the laboratory, it was revealed 60% of students were satisfied enough with the conditions of the practicum with simulations by using the software. Meanwhile, 92% of students need an additional facility in the laboratory to support the sensor and transducer practices.

![Graph of Media Requirements Analysis](image)

Figure 2. Graph of Media Requirements Analysis.

In general, the need for practicum media such as trainers is really needed by the students, and they support the course to provide the complementary facilities for the laboratory practicum. Based on these results, it indirectly reinforced the making of Sensor and Transducer trainers as a learning media to be applied in practicum learning conditions.

3.2 The Making of Sensors and Transducers Trainer as a Learning Media
The manufacture of the sensor and transducer trainer as a learning media was divided into 2 parts: box trainers and trainer modules. The raw material to make this box was a multiplex with a thickness of 9mm. The surface of the multiplex board was coated with HPL paper which was the brown wood pattern. The HPL paper layer was served to protect the board from splashing water and beautify the trainer box’s surface appearance.
The inside of the trainer consisted of 10 modules. Each module contained several sensor components. The following is an example of the components contained in each module.

- Module 1 consists of a vibration sensor, a tilt sensor, a reed switch, a hall magnetic sensor, a humidity sensor, an infrared receiver, a touch sensor, and a rain sensor.
- Module 2 consists of several RGB sensor modules and a gesture sensor.
- Module 3 consists of an accelerometer sensor, sharp SP2YOA21, limit switch, vibration sensor, ambient light, and voice programmable.
- Module 4 consists of RTC, Driver Relay, 433MHz RF module, and NRF 24L01
- Module 5 consists of a 16x2 character LCD module and a flame sensor
- Module 6 consists of SIM 808 GSM and GPS, a water turbidity sensor, and a dust sensor
- Module 7 consists of a sound sensor, gas sensor, encoder, PIR, and ultrasonic sensors
- Module 8 consists of several temperature sensor modules, including SHTC3, DHT22, NTC, DS18b20, MAX6675, and LM35 Sensor
- Module 9 consists of several light sensor modules such as LDR, Photodiode, infrared flame detector, infrared speed counter, and infrared line tracking sensor module.
- Arduino Mega2560 module is the center of process control.

3.3 Trainer Testing

The media trainer was first tested to assure the modules’ well performances before conducting the validation. The test was done in 2 stages, namely tested by providing the working voltage of each module and tested using a program to determine the sensor performance.

The first test was carried out by providing a voltage supply to the trainer module. Power supply testing was done by measuring the output voltage of 5V using an analog multimeter. The voltage was then connected to each module through the socket provided. This test can be done by measuring the voltage on each socket in the module which is 5V. This voltage source is safe and in accordance with the supply needs of all sensors.
The second test was to create a basic program to read the sensor value and display it in the LCD. This testing phase took several enhancements, including the computer or laptop, Arduino, module 5 (for LCD), and other modules that would be tested. The program was created by using the Arduino IDE software. The compilation results were entered into Arduino and then installed the cable according to the program’s pins. The results of the testing on module 9 using an LDR light sensor, Photodiode, and Infrared Line tracking sensor are presented as follows:

Table 1. The Results of Test towards LDR and Photodiode Sensors.

| Sensor Output | Light Allocation to the Sensor | LCD |
|---------------|--------------------------------|-----|
|               | The Exposed Sensor Surface     |     |
| LDR           | 1                              |     |
| Photodiode    | 1                              |     |
|               | Closed Sensor Surface          |     |
| LDR           | 0                              |     |
| Photodiode    | 0                              |     |

Table 1 shows the result of the test conducted towards LDR and Photodiode Sensors in which it reveals that the score of the digital output of LDR sensor and Photodiode exposed by the sensor surface is is 1 (HIGH). Meanwhile, when the light is blocked from the sensor’s surface, the sensor’s score turns into 0 (LOW). Based on these results, the two sensors had a proper function.

Table 2. The Trial Results Module of Infrared Line Tracking Sensor.

| Sensor Treatment | LCD |
|------------------|-----|
| IR1              |     |
| IR2              |     |
| IR3              |     |
| IR4              |     |
| IR5              |     |

The line tracking sensor’s testing using 5 infrared sensors was done by giving a white paper in front of the sensor surface. From table 2, the treatment column of the white sensor indicates an active sensor.
When the sensor is active, it will display the number 1 (HIGH) on the LCD character, while the passive sensor will display the number 0 (LOW).

3.4 Media Feasibility Testing Results

3.4.1 Material Feasibility Testing. The questionnaire results obtained from 2 material experts showed an average value of 97% with a very good category. The assessment is seen from material relevance, material construction, and material renewal, as presented in the following chart.

![Materials Validation Chart]

**Figure 5.** The Results of the Material Validation.

Figure 5 shows the result of the material validation in which graph number 1 shows the maximum score of each aspect, number 2 shows the average score of each aspect, while number 3 is the percentage of each assessment aspect.

3.4.2 The Fit Test of Trainer Learning Media. The media feasibility was tested by the media expert validator and resulted in a score of 96% with a very good category. This provided evidence that the use of trainers significantly affected the students’ motivation.

![The Learning Media of Trainers Validation Chart]

**Figure 6.** The Results of Media Validation.
3.4.3 Testing the Trainer on Students. The students’ responses after using the trainer as a practical learning media were very good. It can be seen from the results of the students’ instrument data processing related to the increase of understanding and motivation to learn, ease the use of trainers, and clarity of voltage indicators and pin component to be connected to other devices.

Figure 7. Graph of Students’ Responses of the Trainer’s Use.

Based on Figure 7, the students’ responses regarding the trainer learning media’s appropriateness from 3 aspects of the overall assessment obtain an average score of 84% and categorized as a very good category. This score was obtained from the students who have used Sensor and Transducer trainers in the practicum activities.

3.5 Discussion

The students required the condition of Sensor and Transducer practical learning by applying learning media in the form of a complete sensor trainer with various types of sensors. All types of sensors in the trainer could be used easily because several references were available starting from the basic programs, sensor development, and supporting libraries for the Arduino IDE software.

This trainer could reference other lecturers who want to create and develop other types of sensor trainers for practicum needs with relevant subjects. This trainer could also be used as a student’s final project with some technological developments from the previous trainer. The research on the development of learning media would be progressively conducted in line with technological developments, especially in electronics, sensors, and automation. This technological development should encourage the next generation to follow, especially for lecturers who teach in engineering.

The results obtained in this current study seemed to strengthen the development of previous trainers, assessments from media expert validators, material experts, and responses from students with an average percentage value above 80% with a very good categories [3] [12] [13]. These results also illustrated the human potential can be realized in the form of works that were beneficial to students and society in general. The use of practical trainer did not require coming from reputable products which were very expensive. Still, a trainer can also be made from the module development components which were available in common commercially and can be used with the same function, although in a small-scale application and not based on the industry.
4. Conclusion
Based on the results obtained from material experts, media experts, and student responses, the Sensor and Transducer trainer learning media was very suitable for the practicum learning process. This trainer can only be used in the classroom teaching instruction by doing straightly to assembly and program the computer, so it was suitable for the learning instruction conducted in the laboratory. For future works, it is expected that the trainer can be developed with additional technology based on IoT (Internet of Things) to control and monitor the sensor readings using a smartphone distantly. Therefore, the use of this type of controller must be adjusted to the purpose of its trainer development.

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