ISBN 978-1-7281-3831-2

isemantic
International Seminar on Application for Technology of Information and Communication
2019

PROCEEDING

INDUSTRY 4.0; RETROSPECT PROSPECT AND CHALLENGES

21—22 September 2019

Universitas Dian Nuswantoro Semarang

Technically Supported by:

IEEE | IEEE Universitas Dian Nuswantoro Student Branch | Listed in ifory

Organized by:

LPPM UDINUS | Computer Science Faculty | Engineering Faculty

PROCEEDINGS

Industry 4.0: Retrospect, Prospect, and Challenges

ISEMANTIC 2019

4th International Seminar on Application for Technology of Information and Communication

September 21st – 22nd, 2019
Universitas Dian Nuswantoro
Semarang, Indonesia

ISBN: 978-1-7281-3831-2
IEEE Catalog Number: CFP19CUE-USB

PROCEEDINGS

2019 International Seminar on Application for Technology of Information and Communication

(iSemantic)

Industry 4.0: Retrospect, Prospect, and Challenges

September 21st – 22nd, 2019
Universitas Dian Nuswantoro
Semarang, Indonesia

ISBN: 978-1-7281-3831-2
IEEE Catalog Number: CFP19CUE-USB

COPYRIGHT

2019 International Seminar on Application for Technology of Information and Communication (iSemantic)

IEEE Catalog Number: CFP19CUE-USB
ISBN: 978-1-7281-3831-2

TABLE OF CONTENT

isemantic

International Seminar on Application for Technology of Information and Communication

PROCEEDINGS

PAPER LIST

Data Acquisition in Determining Lab Work Assesment Ranking Using Fuzzy Analytic Hierarchy Process (FAHP)

Muhamad Haddin, Arief Marwanto, Munaf Ismail,
Electrical Engineering Department
Universitas Islam Sultan Agung
Semarang, Indonesia
haddin@unissula.ac.id

Andi Riansyah, Fahmi Anhar Cholid
Informatic Engineering Department
Universitas Islam Sultan Agung
Semarang, Indonesia

***Abstract*— In the implementation of lab work, there are many assessment criteria which affect the final scoring of a lab work. A university student must go through several stages in carrying out lab work. The problem arising is at the assessment stage, where lab work lecturers find it difficult to determine the ranking of lab work assessment for each student. The more criteria and alternative assessments arise, the more difficult it will be for the lab work lecturers to determine the priority of lab work participants' scores. This study focuses on making a fuzzy-based acquisition system which is the measurement result data in the lab work process. Furthermore, the data which have been determined by fuzzy with the provisions of the specified criteria, the entire criteria in the lab work process were used by analytic hierarchy process (AHP) method which was integrated in the web server application. The hierarchy levels represented the criteria for the lab work process, namely: pretest, lab work implementation, post test and lab work report-making. The implementation of lab work drawn from fuzzy output was one of the highest weight input criteria. The alternative used was a number of students attending the lab work, using AHP stages, including: decomposition, comparative judgment, synthesis of priority and logical consistency. This system was able to show the accuracy level with fuzzy and to select priorities from the assessment criteria and alternative lab work participants. The findings showed that the fuzzy-based data acquisition was able to provide recommendations for measurements on lab work based on the scores of membership degree and fire strength chosen with an error of less than 5%. The use of AHP was able to give the assessment priority to a number of criteria and alternative lab work assessments with the priority score from student 1 was 0.292, student 2 was 0.233, student 3 was 0.214 and student 4 was 0.261.**

Keywords*— *Data Acquisition; F-AHP; Lab work

INTRODUCTION

This The implementation of lab work on measuring electrical quantities in laboratory has a lot of assessment criteria which affect the final scoring of a lab work. A university student must go through several stages in carrying out lab work. The problem arising in the process of lab work implementation is assessment ranking, where lab work lecturers find it difficult to determine the lab work assessment ranking for lab work participants. The more criteria and alternative assessment a rise, the more difficult it will be to determine the ranking of lab work assessment. The problem complexity in determining the lab work assessment ranking does not only lie in the uncertainty or imperfection of the lab work result information, but also relies on the lab work lecturers in objectively assessing the lab work participants. The assessment can show the probability or assessment rankings for each outcome known to decision makers, in this case, the lab work lecturers.

In the lab work process, errors in the measurement and in reading voltage and electric current measurements are often found. These errors cause the data obtained to be deviating the standards. Commonly, if there are incorrect experiment data, they need to be repeated due to the large percentage of measurement error scores. The greater the measurement error score is, the greater the error that occurs, usually due to the errors in series or the use of measuring instruments. One alternative method in determining error scores is to use fuzzy method which is the right way to map an input space into an output space.

The error levels in lab work assessment are due to many criteria and alternatives, which can be avoided by using Analytic Hierarchy Process (AHP) method, which is integrated in web server application. The lab work stages which become the criteria in the method consist of four processes, namely: pretest, lab work implementation, posttest and lab work report making. The results of the criteria score of each alternative will be obtained weighting which will determine the priority scores of the lab work assessment [1-3]. The alternative used is a number of students who attend the lab work, using AHP stages including: decomposition, comparative judgment, synthesis of priority and logical consistency.

Several studies on AHP implementation have previously been carried out, among others are about the concept of assessment ranking modeling in e-learning class by decision-making using interval score triangular fuzzy number method (IV-TFN) [4]. The FAHP implementation for the quantification of numerical constants on the functions of objective business relationship, using weighted fuzzy goal programming (WFGP) method produced solutions that better represented decision maker preferences. AHP introduced in the chemical engineering for the selection of equipment processes, design and selection of resources [5]. AHP application has also been used: for structured student selection and evaluation [6], to evaluate the ranking of students with weighted criteria including skills, knowledge [7], as a tool in the decision making process about choosing the most appropriate alternative in accordance with the specified criteria [8], used to explore concepts in the learning process [9]. These studies only used multi criteria data and manual alternative input into the FAHP and used a software designed as a quality measuring tool and decision-maker preferences from multi criteria and alternative inputs.

This study focuses on the combination of hardware and software which were integrated in web servers using FAHP. The hardware was designed as a lab work module to measure electrical quantities in the form of voltage and current measurements.

METHODOLOGY

A. Data Acquisition

Data acquisition is a system which has the function to retrieve, collect and prepare data to be processed as desired data can define as data acquisition. During the process of data acquisition, the computer will do a series of the sampling process from physical real-world conditions and convert it into the digital numerical scores. The data acquisition have components such as sensors that can convert the physical parameters into electrical signals. The signal conditioning will convert the sensor signals into the digital scores [10].

The data acquisition process was carried out to measure the voltage and current scores of the lab work module. The module used one of the electrical measurement modules, as shown in Fig. 1.

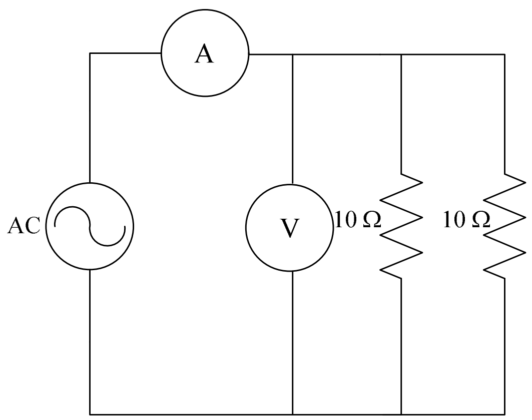


Fig. 1. Experimental circuit module

The instrumentation of voltage and current measurement data recording system is shown in Fig. 2. This system consists of a voltage sensor and current sensor, a keypad which functions to enter student's registration number, alphanumeric LCD 16x2 to show measurement scores, Node MCU whose function is to connect with Wi-Fi hotspots connected to webserver.

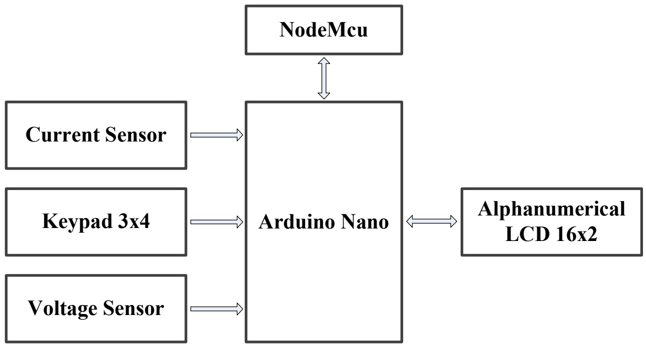


Fig. 2. Block of recording diagram of the voltage and current scores in the 1 phase system.

B. Voltage Sensor

The data acquisition system module analyzes the data using a 220-9 V transformer with current 1 A. The transformer is used to keep the sinusoidal voltage range constant. The sinusoidal waveform at a voltage is needed before connected to the microcontroller. The 9 V voltage is still too large for a microcontroller. Therefore, a series of voltage divider circuit with a maximum output of 5 V are needed. In addition to that, the peak to peak voltage of no more than 5V requires an additional circuit to shift the 0 V point from the sinusoidal wave to the point 2.5 V. The point shift affects the magnitude of the peak voltage to 2.5 V.

If V_p is the peak voltage, where the peak voltage is a maximum of 2.5 V, the maximum output voltage is $V_{out} = V_m \times 0.7071$ or $V_{out}= 1.767$ V as the readable average voltage on the microcontroller. From this formula, the score of the resistor which will be used can be found out. To determine the value of resistor R_2, the resistance value R_1 must be determined using Eq. (1). The R_1 specified is 10 kΩ, then:

$$1.767\ \mathrm{V} = 9\ \mathrm{V}\ \frac{10000\ \Omega}{10000\ \Omega + R_2} \qquad (1)$$

$$17670\ \mathrm{V\Omega} + 1.767\ \mathrm{V}\ R_2 = 90000\ \mathrm{V\Omega}$$

$$R_2 = \frac{90000\ \mathrm{V\Omega} - 17670\ \mathrm{V\Omega}}{1.767\ \mathrm{V}}$$

$$R_2 = 40.933\ \mathrm{k\Omega}$$

From the calculation of the resistor values in Eq. (1), the value of R_2 = 40.933 kΩ, is obtained, to get a resistor on the market with this value is very difficult. Therefore, the resistor value R_2 is changed to R_2 = 100 k Ω From this score, it affects the magnitude of the output voltage to V_{out} = 0.818 V and the peak voltage V_p=1.28 V. The result is still below the maximum peak voltage and the maximum output voltage, therefore, the resistor can be used. The following is the scheme of the transformer circuit as a reverse voltage sensor as shown in Fig. 3.

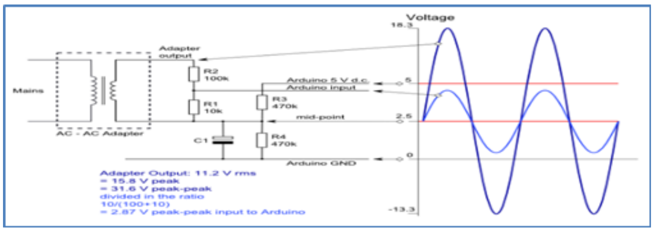


Fig. 3. Voltage sensor circuit with sinusoidal voltage waves leading to the microcontroller

C. Current Sensor

ZMCT103C sensor is a transformer with a ring-core ratio of 1000: 1 and a maximum output current of 5 mA. The current sensor circuit is the same as the voltage sensor circuit, required voltage divider circuit as well as 0V to 2.5 V point shifters in order to be read on the microcontroller as shown in Fig. 4. To maintain the maximum peak voltage in the measurement below 2.5 V, a voltage divider circuit and a resistor are needed as a burden resistor. Through using the Kirchoff Law equation, the score of the burden resistor according to Eq. (2) can be determined.

$$2.5\,V = 5\,mA \times R_{burden} \quad (2)$$

$$R_{burden} = \frac{2.5\,V}{5\,mA}$$

$$R_{burden} = 500\,\Omega$$

The maximum resistor score is at burden of 500 Ω, in order that the voltage output score remains below 2.5 V with a maximum sensor output current score of 5 mA, the resistance score installed should be less than 500 Ω shown in Fig. 4.

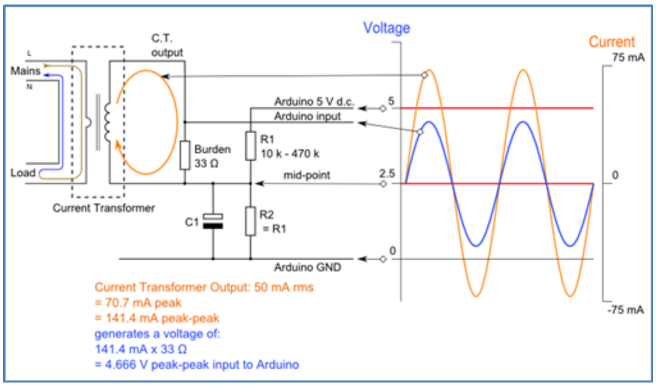


Fig. 4. Current sensor circuit with sinusoidal voltage waves leading to the microcontroller

To get resistor score of 500 Ω is very difficult, consequently the resistor used is 330 Ω and 22 Ω which are connected in series so that the total resistance score is 352 Ω. The resistance score is still within safe limits. If the score of R_{burden}=352 Ω, the score of V_{out} is 1.76 V at maximum.

D. Node MCU Microcontroller Module

Connection on the internet network can be done using LAN cable or Wi-Fi connection. To connect the device to the internet network, a module is needed to manage the connection. In this study, the Node MCU module is used to control this. Node MCU is an open-source firmware and development kit which can help to make prototypes of IoT, Node MCU can be programmed using the Arduino IDE.

Node MCU is communicated on the Arduino Nano using serial communication via Rx and Tx pins. In this communication, Arduino Nano sends data which have been processed to Node MCU to be uploaded to the website. In Node MCU, the data sent to Arduino Nano are in the form of control data retrieved from the website. The following is the wiring Node MCU scheme connected to Arduino Nano as shown in Fig. 5.

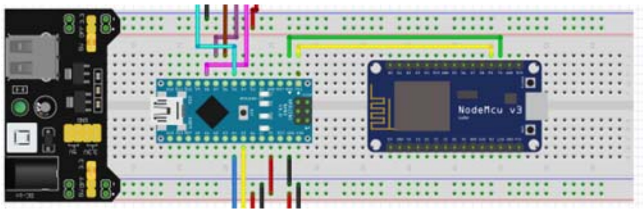


Fig. 5. Node MCU which is connected to Arduino Nano

1) Arduino Nano Microcontroller Module

Arduino Nano is used as the main microcontroller that processes LCD displays, processes sensor input scores, processes input information from RTC, processes control information sent via Node MCU and controls relays as switches.

TABLE I. DISTRIBUTION OF FUNCTIONS ARDUINO NANO PIN

No.	Pins	Functions
1	PIN A0	Current sensor score of ADC input
2	PIN A1	Voltage sensor score of ADC input
5	PIN A4	Pin I2C LCD
6	PIN A5	Pin I2C LCD
9	PIN D2	Keypad 3 x 4 input
10	PIN D3	Keypad 3 x 4 input
11	PIN D4	Keypad 3 x 4 input
12	PIN D5	Keypad 3 x 4 input
13	PIN D6	Keypad 3 x 4 input
14	PIN D7	Keypad 3 x 4 input
15	PIN D8	Keypad 3 x 4 input
21	PIN RX0	Serial communication access
22	PIN TX0	Serial communication access

Arduino Nano is a small, and complete microcontroller which is suitable for pairing on *breadboard*. Table I shows the distribution of functions for each Arduino Nano pin.

2) Fuzzy Logic

A measurement that related to subjective human assessment by using language or linguistic is helped by a fuzzy set theory TFN (Triangular Fuzzy Number). The core of fuzzy is located in pairwise comparisons and it is represented by the ratio scale associated with the fuzzy scale. The flexibility of fuzzy logic makes it applicable to describe the input field into an output field. The modern concept [11] has been introduced with a theory which has objects from fuzzy compilation sets with unprecise limitation and membership in the fuzzy set, and not in the form of true or false logic but expressed in degrees. The triangle curve is basically a combination of 2 lines (linear) as shown in Fig. 6.

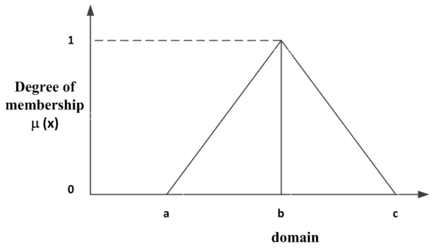


Fig. 6. Triangle Curve

The function of membership is :

$$\mu[x] = \begin{cases} 0; & x \leq a \ \ or\ x \geq c \\ \frac{(x-a)}{(b-a)}; & a \leq x \leq b \\ \frac{c-x}{c-b}; & b \leq x \leq c \end{cases} \quad (3)$$

Where, a is smallest domain score which has zero membership degree, b is domain score which has one membership degree, c is largest domain score which has zero membership degrees.

Furthermore, fuzzy triangular numbers are symbolized and the followings are the membership function provisions for 5 linguistic variable scales. The flowchart of lab work measurement module using fuzzy is shown in Fig. 7. AHP is made to rank alternative weighting on decisions and to choose one of the best criteria for multi-criteria cases by considering qualitative and quantitative factors in overall evaluation of existing alternatives [12].

On the curve shows that membership of function is mapping the input points of the data into membership values or membership degree, the interval of membership degree is between 0 up to 1. The membership value can be found by using the function approach.

System inputs that work based on the principles of fuzzy logic, only require the addition of a new membership function and rules relating to the assessment of the degree of membership. The fuzzy system while the initializing process can reduce the amount of value from a large number into a membership grade value by using the controller to make a decision. If the input changes just a little, the system will respond quickly and produce another output.

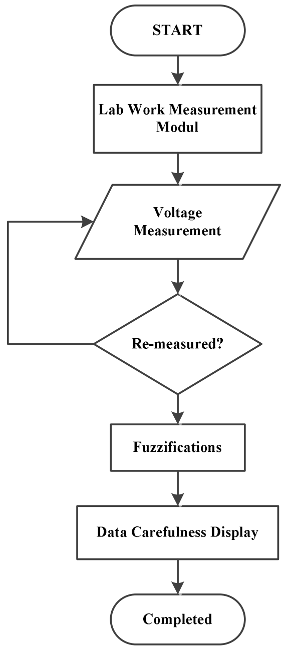


Fig. 7. Flow chart of Fuzzy based lab work measurement module

3) *Analityc Hierarchy Process* (AHP)

The steps used to complete the criteria using AHP are, first is to carefully examine the problem, the next step is to arrange the problem into a hierarchy. AHP accommodates a number of considerations and special scores to its logical scores. Constructing a hierarchy of problems is hinge on experience and knowledge. This logical experience and knowledge can give considerations for weighting and selecting the best criteria [13].

The basic principles of AHP are:

a) The arrangement of hierarchy

Is a step to simplify a problem into a part which becomes the main element. It is then divided into smaller parts and so on in a hierarchical manner to make it clearer, so that it makes it easier for decision makers to analyze and draw conclusions about the problems.

b) Determining priority

AHP conducts pairing comparison between two elements at the same level. The two elements are compared by weighing the preference level of one element against another based on certain criteria.

c) Logical consistency

Logical consistency is a rational principle in AHP. Consistency means two things, namely:

- *Similar thoughts or objects are grouped according to their homogeneity and relevance.*
- *Relations among objects based on certain criteria, logically justifying each other.*

4) *Hierarchy*

Hierarchy is an image of complex problems in many levels of structure in which the top level is the goal and followed by the level of criteria, sub criteria and so on down to the lowest level is the alternative level. In determining the hierarchical framework using criteria, the sub-criteria of some data are obtained using a set of paired comparisons [14]. Pairwise comparison is used to analyse the determination of priority criteria through priority elements. By this method, all of the elements can be fulfilled [15].

The hierarchy graphically illustrates the interdependence of relevant elements, showing the relationship among homogeneous elements and relations with the system so that it becomes a complete unity. The AHP hierarchy structure is shown in Fig. 8.

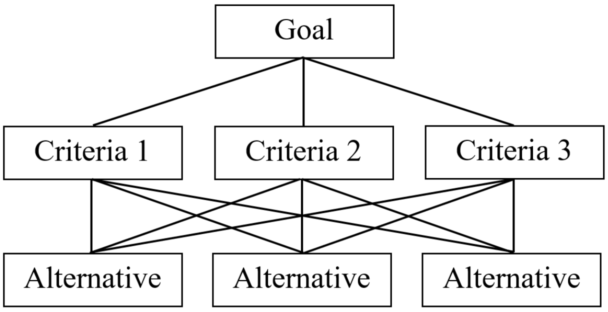


Fig. 8. AHP model hierarchy

Once the criteria are known, forming pairing comparison matrix for each criterion for numerical analysis is done. The numerical scores given to all comparisons are obtained from a predetermined scale of 1 to 9 as shown in Table II.

TABLE II. PAIRWISE COMPARISON ASSESSMENT SCALE

Interest level	Definition
1	As important
3	Little bit important
5	More important
7	Very important
9	More absolute important
2,4,6,8	The score is between two closely related choices
Reciprocal	Reversed

This study measures the university students' learning in lab work with AHP has several stages of the process to get the best alternative recommendations from the lab work participants. The first stage, an asssitant determines the process to be taken into account and later the students' names will be displayed according to the type of process in the lab work stage, then the assistant can fill in the assessment of each criterion namely; pre test, post test, report, and lab work analysis. It is then continued with the calculation system process using Analytical Hierarchy Process method in order to provide outputs in the form of ranking the best lab work participating students. The sequence of flowcharts can be seen in Fig. 9.

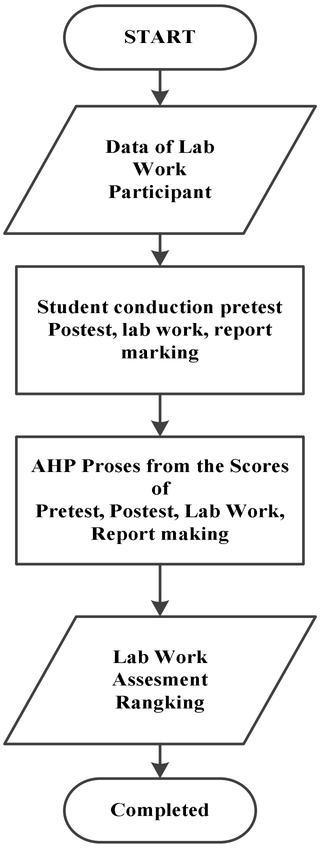


Fig. 9. AHP Flow-chart

RESULT AND DISCUSSION

A. Pretest

Pretest, this assessment is intended to find out whether students know about the material to be taught. The e-lab application calculates the number of text characters described by students, if students describe more and more broadly the indicator the student gets 20 points on each question that must be answered, the total number of pretest questions is 5. Then if the student can describe well to those 5 questions, the assumption is that the value given by the application of e-labs is 100. Interface *Pretest* shown in Fig. 10.

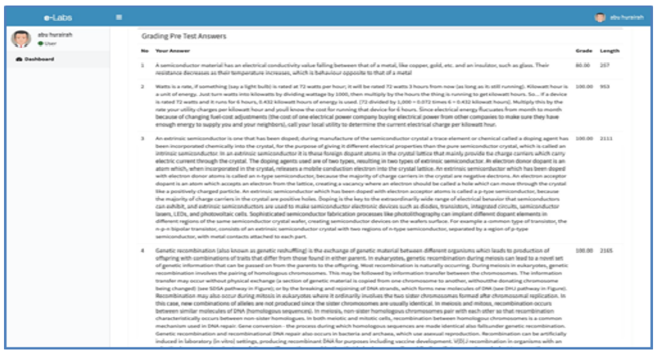


Fig. 10 Interface Pretest

B. Practical

Practical assessment, this study was given to find out whether students correctly mastered the measurement of electrical voltage, this measurement mechanism uses a measurement tool designed for this study shown in Fig.11, a tool that can measure voltage and can send data in realtime to e-labs application, then e application-labs will give an assessment using the following equation (4).

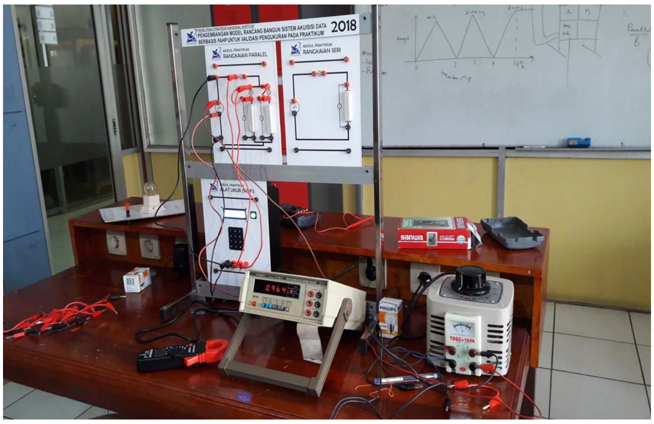


Fig. 11. Practical Measurement

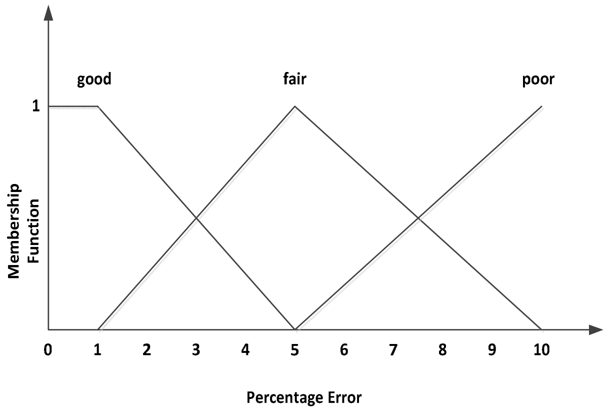


Fig. 12 Membership Fuzzy

$$Percentage\ Error = \left|\frac{values\ shoul\ be - measured\ values}{measured\ values}\right| x100\% \quad (4)$$

The measurement error value sent by the tool to the e-labs application is compared with the reference value which is both medium and bad. Good value predicate on reference is if the measurement has a value of < 5% get 100 points, for the medium rating category < 10% and ≥ 5% get 80 points, then the bad predicate is an assessment that exceeds 10% gets 60 points as shown in Fig. 12 and interface measurement shown in Fig. 13.

Fig. 13 Interface measurement

C. Post test

Assessment of posttest, this assessment is intended to determine the absorption of material taught to students. The procedure for designation is the same as the pre-test assessment, where students fill 5 questions in the e-labs application, if they can describe the answers well on each question then get 20 points on each question.

With the basis of the designation in each category (pretest, practicum and posttest), the e-labs application can do AHP calculations to find out their consistency. AHP method is used to solve complex problems by constructing and drawing a hierarchy of the criterion, interested parties, results and various consideration to develop weight or priority.

AHP calculation stages in e-labs applications.

The following is how to implement the AHP method on student assessment by comparing the value of pretest, practicum and posttest value, then the e-labs application will determine simple fuzzy categories (low, medium and high) in the grade column.

a). Low < 60
b). Medium > 60 and < 79
c). High > 80

With the basis of the pretest + practicum value + posttest value/3. Interface *Postest* shown in Fig. 14.

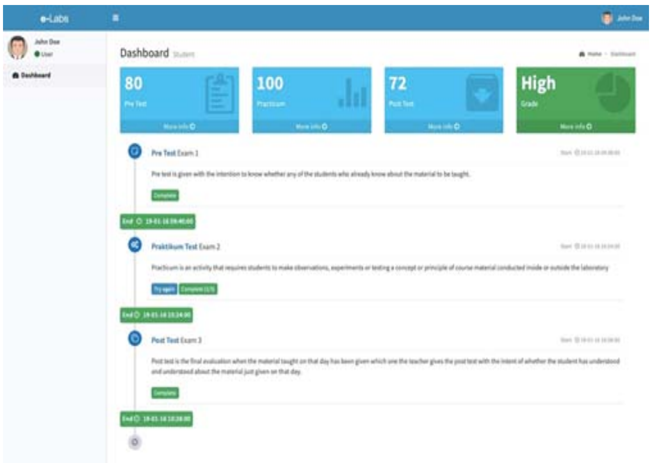


Fig. 14 Interface Postest

1) Comparing 3 assessment categories

- Pretest with Postest = 80 - 72 = 12, the 12 results are rounded down to 10/10. So as to produce a value of 1 for the pretest. Results of the comparison shown in Fig. 15.

Fig. 15. The results of the comparison of the pretest and posttest.

- Postest with Practicum = 72 - 100 = -28, the result of -28 is rounded up because in the case of rounding if ≥ 5 will be rounded up, so that it becomes a value of -30/10 the result is -3 for the lab. Results of the comparison shown in Fig. 16

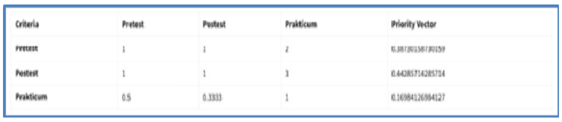
Fig. 16. The results of the post-comparison with practicum.

- Pretest with Practicum = 80 - 100 = -20, the result of -20/10 so as to produce a value of -2 for practicum. Results of the comparison shown in Fig. 17.

Fig. 17. The results of the comparison of the pretest with the lab

2) Data Comparation

The value that will be generated in the comparison of this data is priority vector which is the sum of all cells. The example of data comparison is provided with a matrix form. The results are shown in Fig.18.



Criteria	Pretest	Postest	Prakticum	Priority Vector
Pretest	1	1	2	0.38730158730159
Postest	1	1	3	0.44285714285714
Prakticum	0.5	0.3333	1	0.16984126984127

Fig. 18 Results of the data comparison

3) Calculate Pricipal Eigen Value (lmax)

That is calculating the matrix by adding up between cells in the row number and cell in the priority vector column as follows: 2.5 x 0.38730158730159 + 2.3333 x 0.44285714285714 + 6 x 0.16984126984127 = 3.0206349206349

4) Consistency Index (CI)

The calculating the consistency of index CI = (lmax-n) / (n-1) with n is the number of criteria. In this case CI = (3.0206349206349 - 3) / (3 -1) = 0.01031746031746

5) Random Index (RI)

Table III shows the number of criteria which determine the RI.

TABLE III, RANDOM INDEX

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

So for n = 3 RI can get = 0.58.

6) Consistency Ratio

Consistency Index (CR) obtained by the formula CR = CI / RI, the RI value depends on the number of criteria as shown in Table III. That is the value of Cr is 0.017788724685276, If the result of the calculation of CR is smaller or equal to 10 %, inconsistency can still be accepted, conversely if it is greater than 10 %, it is not acceptable.

CONCLUSION

The implementation of lab work with instrumentation using fuzzy method is able to show the CR calculation result is smaller or equal to 10 %. The implementation of lab work becomes one of the input criteria for the Analytical Hierarchy Process (AHP) in determining the lab work score ranking. AHP method is able to determine multi alternative and multi criteria lab work assessment rankings.

ACKNOWLEDGMENTS

Acknowledgments to the Indonesian Ministry of Research, Technology and Higher Education for funding research through the national strategic research competitive grant scheme.

REFERENCES

[1] S. Kundu, D. Khare, and A. Mondal, “PT US CR,” *Ecol. Inform.*, 2017.

[2] K. Phudphad, B. Watanapa, W. Krathu, and S. Funilkul, “Rankings of the security factors of human resources information system (HRIS) influencing the open climate of work: Using analytic hierarchy process (AHP),” *Procedia Comput. Sci.*, vol. 111, no. 2015, pp. 287–293, 2017.

[3] R. Morgan, “An investigation of constraints upon fi sheries diversi fi cation using the Analytic Hierarchy Process (AHP),” *Mar. Policy*, vol. 86, no. February, pp. 24–30, 2017.

[4] M. Harun, K. M. Yusof, M. N. Dimon, P. I. Khalid, S. Zaleha, and A. Hamid, “Significance of Speech Intelligibility Assessors in Medium Classroom Using Analytical Hierarchy Process,” vol. 16, no. 4, pp. 1673–1678, 2018.

[5] M. A. B. Promentilla, K. B. Aviso, R. I. G. Lucas, L. F. Razon, and R. R. Tan, “Teaching Analytic Hierarchy Process (AHP) in undergraduate chemical engineering courses,” *Educ. Chem. Eng.*, vol. 23, pp. 34–41, 2018.

[6] H. A. Setyadi and A. Kristianto, “Implementation Of The AHP Method And Decision Table To Determine The Problem Student,” pp. 110–115, 2015.

[7] S. Pavani and P. Gangadhar, “Evaluating Teachers Ranking Using Fuzzy AHP Technique,” *Int. J. Soft Comput. Eng.*, no. 26, pp. 2231–2307, 2013.

[8] C. Ayca and K. Hasan, "An application of fuzzy analytic hierarchy process (FAHP) for evaluating students project," *Educ. Res. Rev.*, vol. 12, no. 3, pp. 120–132, 2017.

[9] Y. Owusu-Agyeman, O. Larbi-Siaw, B. Brenya, and A. Anyidoho, "An embedded fuzzy analytic hierarchy process for evaluating lecturers' conceptions of teaching and learning," *Stud. Educ. Eval.*, vol. 55, no. December 2016, pp. 46–57, 2017.

[10] H. Austerlich, *Data Acquisition Technique Using PC.* Orlando: Academic Press, 2003.

[11] Zadeh, "Fuzzy Set," *J. Inf. Control*, pp. 338 – 353, 1965.

[12] Saaty, "A Scaling Method For Priorities in Hierarchical Structures," *J. Math*, vol. 15, pp. 234–281, 1977.

[13] A. Calabrese, R. Costa, N. Levialdi, and T. Menichini, "Technological Forecasting & Social Change Integrating sustainability into strategic decision-making : A fuzzy AHP method for the selection of relevant sustainability issues," *Technol. Forecast. Soc. Chang.*, no. September, pp. 1–14, 2018.

[14] I. Komariah and T. Matsumoto, "Application of analytic hierarchy process for selecting river restoration policy," *Pollut. Res.*, vol. 36, no. 3, pp. 504–512, 2017.

[15] Marfuah and S. Widiantoro, "The Implementation of Analytical Hierarchy Process Method for Outstanding Achievement Scholarship Reception Selection at Universal University of Batam," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 97, no. 1, 2017.

isemantic.dinus.ac.id

CERTIFICATE OF PARTICIPATION

MUHAMAD HADDIN

"PRESENTER"

THE INTERNATIONAL SEMINAR ON APPLICATION FOR TECHNOLOGY OF INFORMATION AND COMMUNICATION 2019 RECOGNITION IS CONFERRED TO

(iSemantic 2019)

Institute of Research and Community Service, Dian Nuswantoro University

testimony signature is below

The day of September 21, 2019, Semarang Indonesia

isemantic

International Seminar on Application for Technology of Information and Communication

Dr. Pulung Nurtantio Andono, S.T., M.Kom

Conference Chair