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Development of Physics Laboratory Utility Program Using Visual Basic for the First Year Students in Rajamangala University of Technology Thanyaburi

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ABSTRACT

The purposes of this research were 1) to develop the Physics Laboratory Utility Program (PLUP) as a tool for calculating and verifying the experiment data, and 2) to study the student satisfactions with the program implement. This computer program, written and developed in Visual Basic version 6.0, consists of 8 experiments as follows : 1) Direct current circuit, 2) Wheatstone's bridge circuit, 3) Capacitor in discharging, 4) Joule's heat equivalent, 5) Magnetic field of earth, 6) Refractive index of liquid, 7) Young's interference and 8) Spectrum of atom through grating.

The efficiencies of the program were examined in 2 ways which were 1) comparing the results of the same experiment data with scientific calculator and Microsoft Excel found that there was no different among them. 2) Evaluating by specialists on the program utilities and the ease of use came out in very good level with average 4.52. The student satisfactions of using this program was at satisfied level with average score of 4.26.

In summary, this Physics Laboratory Utility Program is suitable for teachers and students in Physics Laboratory II as a tool for data evaluation.

1. Introduction

Physics Laboratory I and II are fundamental courses for students in faculty of Science and Technology, Engineering and other faculties such as Agricultural Technology, Technical Education. At least 1400 students registered for Physics Laboratory in each semester. Teaching Physics Laboratory is hard work and time consuming drudgery associated with data verifying, graph examining and enhancing students experiment skills. Data evaluation and curve fitting with scientific calculator take a lot of time and repetition. Spreadsheet program is complicated for some students and spending time to learn.

The development of the Physics Laboratory Utility Program (PLUP) for data evaluation, verifying and graph plotting should save time and reduce repetition in

calculation. Teachers can take care and give more recommendation to students in Physics Laboratory class.

2. Literature Review

Sirichai [1] constructed and investigated the efficiency of the instructional media for circular motion and centripetal force and used this media in physics experiment. The questionnaires about the specialist/instructor opinion were used as a tool for finding efficiency to be collected and analyzed. The results of this research revealed that the testing has reliability 0.85 by Cronback Alpha method. The opinion of specialists/instructors and students in term of teaching/ learning design and experiment is at good level and the efficiency of instructional media is 81/84.

Surapan [2] developed the multimedia package about Teaching on AC Circuit Theory. Research methodology consisted of 3 steps: analysis of content and learning objective, multimedia design, and software and hardware development and quality evaluation. The development shows that the multimedia package consists of the teaching's guide, Power Point presentation, artificial experiment with simulation program which can be demonstrate on AC circuit theory. The average opinion on the quality of the multimedia package of 5 experts who had an AC circuit teaching experience in undergraduate was in a very good level ($x = 4.67$), the average of learning effectiveness of the sampling group was 72.71 %, while the mean of satisfaction was in a high level ($x = 4.16$). Conclusions, the developed multimedia package has a sufficient quality which can be used for learning and teaching on AC circuit theory.

Pipat [3] created the IC 555 Circuit Demonstration for Industrial Electronics Technology Course in Rajabhat Institute Buriram. It consisted of 1) IC 555 circuit and worksheets for experiment, 2) the demonstration evaluation form, and 3) the learning achievement test. The finding in this research were as follows: 1) The quality of the IC 555 Circuit Demonstration as perceived by the experts based on the constructed contents and worksheets was at good level ($x = 4.20$), 2) The quality of the IC 555 Circuit Demonstration as perceived by the experts based on the constructed tools and instruments was at good level ($x = 4.18$), and 3) The evaluation process of the post-test after the experiment was 82.6; whereas, the effectiveness of the post-test after using all 5 worksheets was 83.5 which were agreed and accepted in accordance to the criteria set.

Research purpose

1. To develop the Physics Laboratory Utility Program (PLUP) as a tool for calculating and verifying the experiment data.
2. To study the student satisfactions with the program implement.

3. Methodology

Population and sample

The population of this research was the first year students, taking course in Physics Laboratory II / Physics Laboratory for Engineering II, Division of Physics, Faculty of Science and Technology, Rajamangala University of Technology Thanyaburi, 112 students were sampling by random.

Research tools

Physics Laboratory Utility Program (PLUP)

PLUP was designed for two fundamental Physics Laboratory courses, Physics Laboratory II and Physics Laboratory for Engineering II, it consists of 8 experiments as follows: 1) Direct current circuit, 2) Wheatstone's bridge circuit, 3) Capacitor in discharging, 4) Joule's heat equivalent, 5) Magnetic field of Earth, 6) Refractive index of liquid, 7) Young's interference, and 8) Spectrum of atom through grating. It was created and developed step by step as follows;

Step 1 Search and gather relevant information.

Step 2 Program design

- User Interface.
- Algorithm and program flowchart.
- Function and dynamic linked library for Visual Basic.

Step 3 Program coding.

Step 4 Accuracy inspection of the data analysis.

Testing program and comparing the results of the same experiment data with scientific calculator and Microsoft Excel.

Step 5 Program improvements.

In first trial, 3 students used this program for finding errors and defects.

In second trial, after improving program from the first trial, another 10 students were selected to test this program again.

Step 6 Modified and upgraded and program for the latest version.

Step 7 Evaluate the efficiency of the program.

Step 8 Users' manual document was written.

Satisfaction questionnaires

Performed as follows;

Step 1 Study and collect relevant information.

Step 2 Preparations of satisfaction questionnaires in five rating scale.

Step 3 Evaluated the quality of evaluation form by specialist and testing the questionnaires with 6 students for completeness and clarity of questions.

Data collects.

Step 1 The 112 students were selected by random sampling method.

Step 2 Let sample groups try PLUP

Step 3 Gathering the students opinion after using PLUP.

Step 4 Using statistical analyze with data.

Data analysis

i) The effectiveness of the program was evaluated by specialists. The ranges of average value are [4];

4.51 to 5.00 refer to very good.

3.51 to 4.50 refer to fair good.

2.51 to 3.50 refer to neither good nor bad.

1.51 to 2.50 refer to poor

1.00 to 1.50 refer to not good at all.

ii) Analysis of student satisfactions with the program and the meaning of the average of the evaluation.

4.51 to 5.00 was a very satisfied.

3.51 to 4.50 was a satisfied.

2.51 to 3.50 was a neither satisfied nor dissatisfied.

1.51 to 2.50 was somewhat satisfied.

1.00 to 1.50 was not at all satisfied.

The standard deviation was defined as follows:

SD = 0 was all opinions were exactly the same.

0 < SD < 1 was the most of opinions were in the same direction.

SD > 1 was most opinions were distinct from each other.

4. Results and Discussion

Effectiveness of Physic Laboratory Utility Program (PLUP)

Effectiveness of this program was examined in 2 ways. Firstly, we investigated an accuracy and precision of the program by comparing the results of the same experiment data with the results from scientific calculator and Microsoft Excel (version 2010). We found that there was no different among them.

For Example, these follows data take from "Direct current circuit" experiment.

Experiment 1: Direct current circuit

Circuit no. 1 $R_1 = 2.7 \text{ Ohm}$ (small resistance)

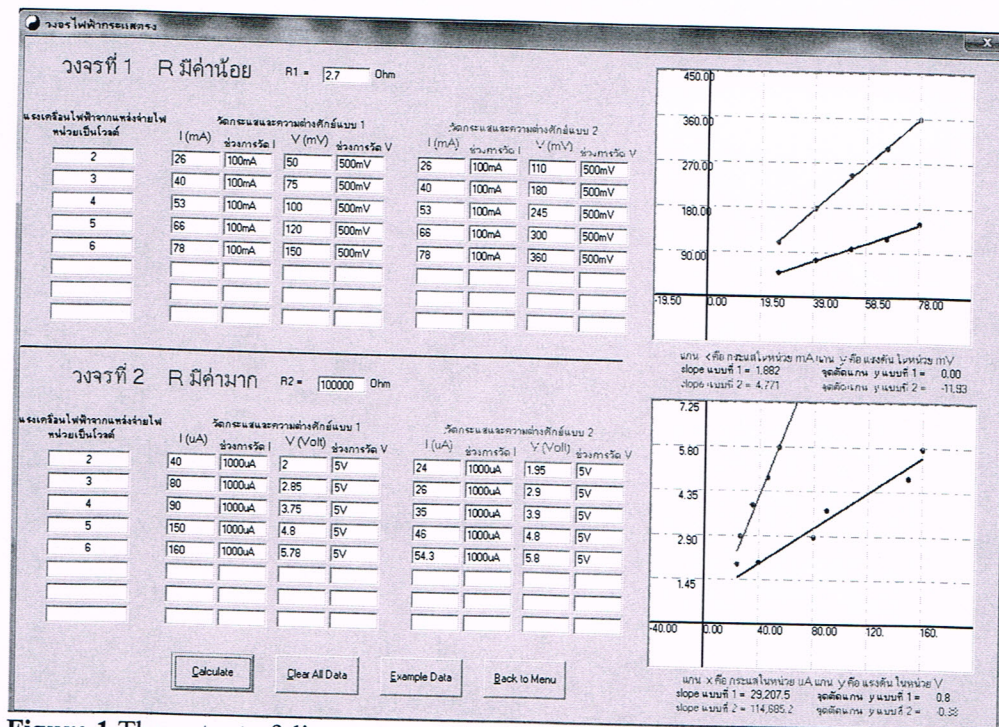
Table 1 Data which gathered from direct circuit experiment

Voltage of power supply (V)	Current and voltage measurement type 1				Current and voltage measurement type 2			
	I (mA)	Meter range of I	V (mV)	Meter range of V	I (mA)	Meter range of I	V (mV)	Meter range of V
2	36	100mA	50	500mV	36	100mA	110	500mV
3	40	100mA	75	500mV	40	100mA	180	500mV
4	53	100mA	100	500mV	53	100mA	245	500mV
5	66	100mA	120	500mV	66	100mA	300	500mV
6	78	100mA	150	500mV	78	100mA	360	500mV

Circuit no. 2 $R_2 = 100,000 \text{ Ohm}$ (large resistance)

Voltage of power supply (V)	Current and voltage measurement type 1				Current and voltage measurement type 2			
	I (uA)	Meter range of I	V (V)	Meter range of V	I (uA)	Meter range of V	V (V)	Meter range of V
2	40	100uA	2.0	5 V	24	100uA	1.95	5 V
3	80	100uA	2.85	5 V	26	100uA	2.9	5 V
4	90	100uA	3.75	5 V	35	100uA	3.9	5 V
5	150	100uA	4.8	5 V	46	100uA	4.8	5 V
6	160	100uA	5.78	5 V	54.3	100uA	5.8	5 V

The results from PLUP appear in following pictures.



Circuit no 1: the small value resistor (2.7 Ohm)

Voltage and current from type 1 measurement

The slope of voltage and current: 1.9 Ohm

Y-interception : 0.0 V

Voltage and current from type 2 measurement

The Slope of voltage and current : 4.8 Ohm

Y-interception : -11.9 V

Circuit no 2: the large value resistor (100 kOhm)

Voltage and current from type 1 measurement

The slope of voltage and current: 29,207.5 Ohm

Y-interception : 0.8 V

Voltage and current from type 2 measurement.

The Slope of voltage and current : 114,685.2 Ohm

Y- interception : -0.4 V

The output from Microsoft Excel 2010 in follow picture using the same input data has the same results as we have got from PLUP.

วงจรที่ 1 R มีค่าน้อย 2.7 Ohm									
แรงเคลื่อนไฟฟ้า จากแหล่งจ่ายไฟ หน่วยเป็นโวลต์	วัดกระแสและความต่างศักย์แบบ 1				วัดกระแสและความต่างศักย์แบบ 2				
	I (mA)	ช่วงการวัด I	V (mV)	ช่วงการวัด V	I (mA)	ช่วงการวัด I	V (mV)	ช่วงการวัด V	
2	26	100 mA	50	500 mV	26	100 mA	110	500 mV	
3	40	100 mA	75	500 mV	40	100 mA	180	500 mV	
4	53	100 mA	100	500 mV	53	100 mA	245	500 mV	
5	66	100 mA	120	500 mV	66	100 mA	300	500 mV	
6	78	100 mA	150	500 mV	78	100 mA	360	500 mV	
วงจรที่ 2 R มีค่ามาก 100,000 Ohm									
แรงเคลื่อนไฟฟ้า จากแหล่งจ่ายไฟ หน่วยเป็นโวลต์	วัดกระแสและความต่างศักย์แบบ 1				วัดกระแสและความต่างศักย์แบบ 2				
	I (A)	ช่วงการวัด I	V (Volt)	ช่วงการวัด V	I (A)	ช่วงการวัด I	V (Volt)	ช่วงการวัด V	
2	4.00E-05	100 uA	2	5 V	2.40E-05	100 uA	1.95	5 V	
3	8.00E-05	100 uA	2.85	5 V	2.60E-05	100 uA	2.9	5 V	
4	9.00E-05	100 uA	3.75	5 V	3.50E-05	100 uA	3.9	5 V	
5	1.50E-04	100 uA	4.8	5 V	4.60E-05	100 uA	4.8	5 V	
6	1.60E-04	100 uA	5.78	5 V	5.43E-05	100 uA	5.8	5 V	

Figure 2 Data processing in Microsoft Excel 2010.

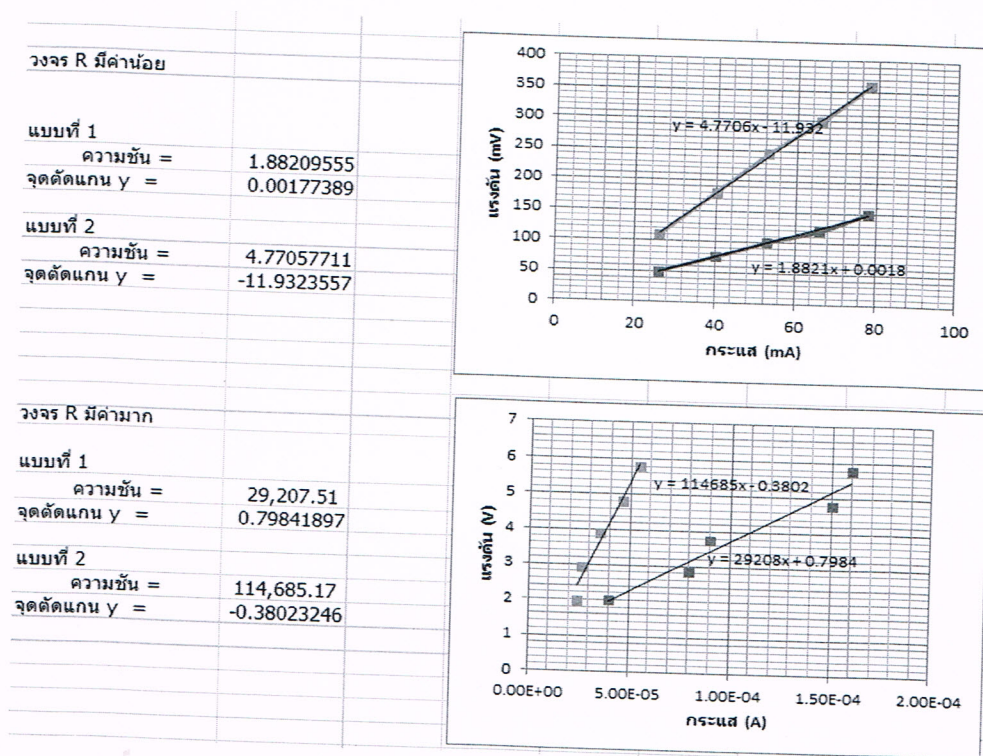


Figure 3 Graph plotting in Microsoft Excel 2010.

Steps of program improvement

First testing: Let 10 students testing PLUP after data gathering and evaluating in Physics experiment comparing the results with scientific calculator. These are good and weak points of program form student opinions;

1. PLUP is convenient and easy to use.
2. In case of rounding and truncating number in calculator, sometime we had got different results after 3 decimal place. The tolerance should be updated to 3 decimal place or better.
3. Data processing consumed less time than manual calculation.
4. Units in software and in data sheet should be the same i.e. centimeter in data sheet and meter in program or nanometer in data sheet and micrometer in program.
5. The colors of light in Spectrum of atom through grating experiment should be more convenient if they are selected by combo box (not typing by user).
6. Update user manual more easily understanding.
7. Tab sequence for data input did not place in order that caused the user click mouse every time for typing data.
8. Data error prevention: such as string input instead of numeric value or negative and zero value.

All drawbacks of program had been improved and upgraded already.

Second testing: let another 10 students testing upgraded program in physics laboratory class as in the first test. These are some of their opinions;

1. The results were more accuracy and precision. Linear curve fitting in graph reinforce graphing skill and slope calculation without spending a large amount of time.
 2. Data calculation had the same results as in scientific calculator.
- Third testing:
Using PLUP with sample group

Evaluate the effectiveness of the program by specialists. The effectiveness of the program was evaluated by 5 specialists into two categories, attributes related to program execution and attributes related to program interfaces. Average, standard deviation and the meaning of values were shown in Table 2.

Table 2 Presents the effectiveness of the program evaluated by specialists.

Attributes	average	S.D.	meaning
Related to program execution.			
1. Data input are covered all parameter and quantities in lab.			
2. The accuracy and precision of data analysis.	4.60	0.54	very good
3. The speed of data processing.	4.80	0.44	very good
4. Reliability and consistency of program.	4.60	0.54	very good
5. Prevent errors that may be occurred.	4.40	0.54	fair good
Average	4.20	0.44	fair good
Related to program interfaces.			
1. The interfaces (menu, button etc.) are accustomed standard.			
2. The program connection links to the appropriate page.	4.20	0.44	fair good
3. Easy-to-use.	4.60	0.54	very good
4. Users' manual and instructions are understandable.	4.40	0.54	fair good
5. Enable users to analyze data more efficiency.	4.40	0.70	fair good
6. Enable teacher to check and evaluate student experiment easily.	5.00	0.00	very good
7. The need for this program	4.80	0.44	very good
Average	4.60	0.54	very good
Total average.	4.51	0.46	very good
	4.52	0.48	very good

Program performance which evaluated by specialists as shown in table 2 found that The average of program execution was 4.52 indicated the program was at very good level. The average of user interface of the program was equal to 4.51, very good level. Moreover, the total average for both attributes is 4.52 indicated that the program was very good by specialists.

The analysis of student satisfactions with the program was shown in table 3.

Table 3 Presents the results of student satisfactions with the program.

Attributes	average	S.D.	meaning
The program execution.	4.24	0.65	satisfied
The program user interfaces.	4.38	0.69	satisfied
Total average	4.26	0.67	satisfied

The average of attributes related to program execution as shown in table 3 was 4.24 at satisfied level and the average of attributes related to program user interfaces was 4.38 at satisfied level too. Moreover, the total average value was 4.26 indicated that the students were satisfied with this program.

5. Conclusions

This research, the development of Physics Laboratory Utility Program using Visual Basic for the first year students in Rajamangala University of Technology Thanyaburi, found that:

1. The program accuracy and precision of PLUP were examined by comparing the data processing results with scientific calculator and Microsoft Excel. Researchers found that the output had the same values for all experiments. The effectiveness of the program was evaluated by experts with five-scale questionnaires. The total average was of 4.52 indicated that the performance of the program was very good by experts.
2. Evaluation of student satisfactions using another five-scale questionnaires got average score 4.26 at satisfied level.

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