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Effectiveness of a Locally Fabricated Three Speed Permanent-Split Capacitor Run Motor Trainer

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Abstract: ***This research study developed and constructed the Locally Fabricated Three Speed Permanent-Split Capacitor Run Motor Trainer. Its main objective is to have a trainer which will be utilized as an instructional model in performing experiments and other related activities pertaining to variable speed AC motors. This study is a developmental method in nature. It was accomplished through designing, gathering needed materials, testing and validation. Descriptive-evaluative type of research was also used to determine the technical viewpoint of respondents regarding the mean level of acceptability of the developed trainer in terms of its usefulness, effectiveness, functionality and reliability and safety. The results of the study revealed that the developed trainer is applicable in various learning experiences to enhance the knowledge and skills of students in electric motors particularly three speed permanent-split capacitor run motor. On the other hand, the developed trainer was evaluated "Excellent" and would imply that it is very much acceptable as an aid for various variable speed AC motor experiments. However with a grand mean rating of 4.61 further implies that there's more to improve about the trainer.***

Keywords: Technology Education, Locally Fabricated Trainer, Electrical and Electronics Technology, Vigan City, Philippines

1. Introduction

Graduates of the K-12 program is holistically developed Filipinos on the 20^1st^-century skills and are ready for higher education, middle-level skills development employment and entrepreneurship. The curriculum is learner-centered and focuses on the holistic development of the students; the topics are developmentally appropriate or age-appropriate. The curriculum is constructivist which means learner should construct their understanding. The curriculum is also pragmatic because it is a combination of academic and vocational disciplines.

A teacher plays the role of a leader, an enthusiast an entertainer making his lesson very engaging, arousing the interest of the students trying things out, experimenting and exploring so that the students are engaged in lessons that get them transformed as individuals. Teaching electricity and electronics technology may not be an easy task and may cause some difficulties if there is a vast shortage of instructional devices that facilitates acquisition of knowledge and skills development of learners. Many teachers/instructors would have common sentiments which may lead to frustrations as far as teaching objectives are concerned. However, with the demands of giving quality instruction to the learner, the teacher/instructor should make the necessary innovations to become effective. He should learn to create his instructional device/trainer to become effective and efficient in delivering both simple and complex concepts.

Jacks (2004) said that instructional materials used in teaching are necessary for which they are very useful in inspiring our students to learn effectively. Similarly, it is used to enhance the curriculum being taught. That is, the technology changes the way the teacher is delivering or planning information to the students.

Bajet (2013) also emphasized that the National development education post-test effective if it is geared towards preparing and equipping young individuals with the needed knowledge, skills and right attitude embedded in their respective or chosen academic courses. Also, it must be responsive to the technical and technological advantage that would certainly contribute to accelerating productivity and countryside development.

Teachers must not think how to pass the student to his subject but think of how the student may apply what they have learned in real life situations. According to Mendoza as cited by Taupa (2017), instructional materials/device and equipment shortage greatly affects the quality of education in technology. Several schools, colleges, and universities offering technology courses facing problems like lack of tools, equipment, and other facilities required in the teaching-learning process.

As such, both students and instructors may have difficulties to develop desired attitude and skills. With this present concern and challenge, the researcher has come up with the idea of developing and constructing a Locally Fabricated Three Speed Permanent Split Capacitor Run Motor Trainer to accelerate the learning assimilation of knowledge and skills of electrical electronics students.

2. Statement of Objectives

This study aimed to develop and construct a trainer, the Three Speed Permanent-Split Capacitor Run Motor Trainer.

Specifically, it sought to:

1. Identify the different parts and function of an induction motor
2. Identify the different applications/experiments that the trainer can be used
3. Determine the level of acceptability of the trainer in terms of:

a. Usefulness

b. Effectiveness
c. Functionality
d. Reliability and
e. Safety

Significance of the Study

This study may be significant to the following:

Electricity and Electronics Students: The output of the study is intended to reinforce and develop the skills of the students in Electric Motors.

Instructors: This will encourage them to design their teaching devices relevant to their field of specialization.

Administrators: The result of this study would be the basis in providing support and assistance to instructors trying to upgrade the quality of teaching and learning.

3. Theoretical Framework

Sometimes, assessing students correctly is a challenge. There are controversies about the effectiveness of exams in determining the ability of students. Instructional materials provide insight into the best methods of creating exams. Teachers create ideas in giving projects and assignments to students through these materials. To provide most accurate form of assessment, it requires several methods. Student's performance is assessed through the creativeness and innovativeness of instructional materials could provide. And, it is difficult to imagine a teacher who is capable of teaching effectively without the accompaniment of instructional materials. In addition to this, any teacher who is deprived of instructional materials is most likely experiencing stress and anxiety on a daily basis Mathew and Crist (2008).

If the rotary switch of the three-speed motor is in a low position, more inductance is supplied in series with the running winding. It would result in the minimal amount of current to flow through the run winding and a reduction in torque. Accordingly, when the torque is minimized, the speed of the motor also decreases. Also, 1625, 1500, and 1350 RPM are the common speeds for a four pole motor of this type. The three-speed motor does not have wide ranges between speeds as would be the case with a consequent-pole motor. If the speed of most induction motors is reduced, it could overheat and damage its winding. Compared to another type of motors, it has much higher impedance winding. Most of the split phase motors have a wire resistance of 1-4 ohms in its run winding. However, in general type, it has 10-15 ohms. The high impedance winding of this type makes it operate without damage. This motor was designed to dramatically slow down when loaded that is why it is not used in high torque teaching-learning. Motors for fans and blowers are some of its common application of this type(Herman 2014).

Recently, Bajet (2014) made an instructional device of Electrical Motor Controller. He emphasized the importance motor controls in the Electrical Technology lessons. According to him most of the electrical technology students are already familiar with the different type of motors wiring diagram, but they have difficulties in installing or connecting the actual wiring circuits of the age-appropriate activities in motor controls; often resulted in damages the motor controller components. Through this, he was motivated to develop the said trainer to enhance the knowledge and skills of the students in the different applications of motor controls.

His Electric Motor Controller Trainer is used in different activities like, Start-Stop Push Button Control; Start-Stop Full- Voltage Starter with Alarm Silencing; Multiple Push Button Stations; Jog Motor Control; Forward Reverse Motor Control (Electrical Interlocking); Automatic Forward and Reverse Motion with Limit Switches; Wye-Delta Reduced Voltage Starter; and Two Stages Sequential Control. The trainer was assessed very much acceptable in terms of usefulness, effectiveness, functionality, reliability, and safety by the different experts in electrical technology from well-known institutions and agencies.
The similar instructional device is developed by Fernandez (2006), an individualized Trainer in Auto Lighting System. The trainer is of great help in providing the students the necessary knowledge in the auto lighting system. The study is done through an actual research in the classroom with the experimental subjects. The quasi-experimental method using the one-group pretest and posttest design is employed given the limitation in the size of the experimental subjects. While the design may not suffice to counter all threats to internal validity, the researcher believed that any significant difference between the pre-test and post-test performance of the experimental subjects was indicative of the effectiveness of the Trainer.

Racoma (2013) also conducted a study entitled Development and Evaluation of Automobile Electrical Wiring Instructional Material. He made use of the experimental method to compare the performance of the new module with the existing module. A validated rating scale was used to evaluate the development of electrical wiring of the automobile along functionality, reliability, usability, and safety to 36 faculties, 30 students, and selected agencies. He also identified the level of effectiveness of the existing mockup for Automobile Electrical Wiring. Moreover, likewise tested the difference between the teaching-learning and new mockup for Automobile Electrical Wiring at 0.05 level of significance. The mean was used to describe the evaluation scores of the evaluators. The researcher used the T-test to test the significant difference between the performances of the new module with that of existing one.

This study revealed that the level of effectiveness of the existing mockup for Automobile Electrical Wiring is very useful (x=4.64). On the other hand, the evaluators gave 4.43 as the mean of the mock-up in terms of its effectiveness. Furthermore, his study also revealed that there is a significant difference between the existing mockup and the new module based from the computed t-value (t=2.79) which is greater than the tabulated t-value of (t=2.04). Based on findings, he recommends the use of the new module in teaching automobile wirings for the CTECH students.

Del Castillo teaching-learning (2013) also conducted a study entitled The Level of Understanding of the Students in Electronics using a Wireless Energy Transfer Model. The researchers used a pretest and posttest to determine the student's level of understanding. Based on their findings the level of understanding of the students was improved after they were exposed to the used of the Wireless Energy Transfer Model in teaching the basic concepts in electronics. The researchers concluded that the one group of the Wireless Energy Transfer Model is an effective instructional tool in improving the level of students understanding the basic concepts in electronics.

The researcher was enlightened with the essential ideas from the studies above and articles served as a guidepost in the conduct of the study. Though, the essence of the study is to develop a trainer which will be used in facilitating teaching-learning process more effective and meaningful and likewise to let the student develop further their comprehension, critical thinking and reasoning about the principles that govern almost all variable speed electric motors.

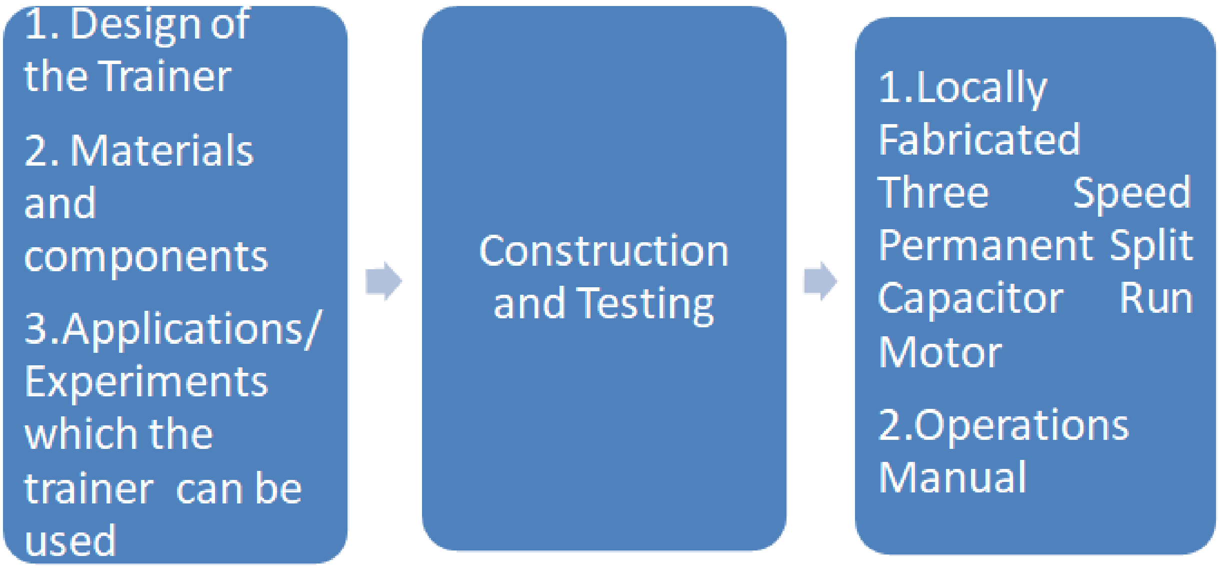


Figure 1: The paradigm

4. Methodology

This study is made use of a developmental method of research. It was accomplished through designing, gathering needed materials, product development, testing, and validation.

The developed trainer can be used by the student in various activities/experiments to apply their prior knowledge and to enhance their knowledge and skills in instrumentation. Descriptive-evaluative type of research knowledge-based in evaluating the mean level of acceptability of the research output regarding its usefulness, effectiveness, functionality and reliability and safety.

A validated rating scale was used to evaluate the developed trainer by 6 electricity and electronics experts at the College of Technology University of Northern Philippines.

The computed mean was used to describe the level of acceptability of the said trainer to be use as an aid in facilitating teaching learning process in variable speed motor lessons.

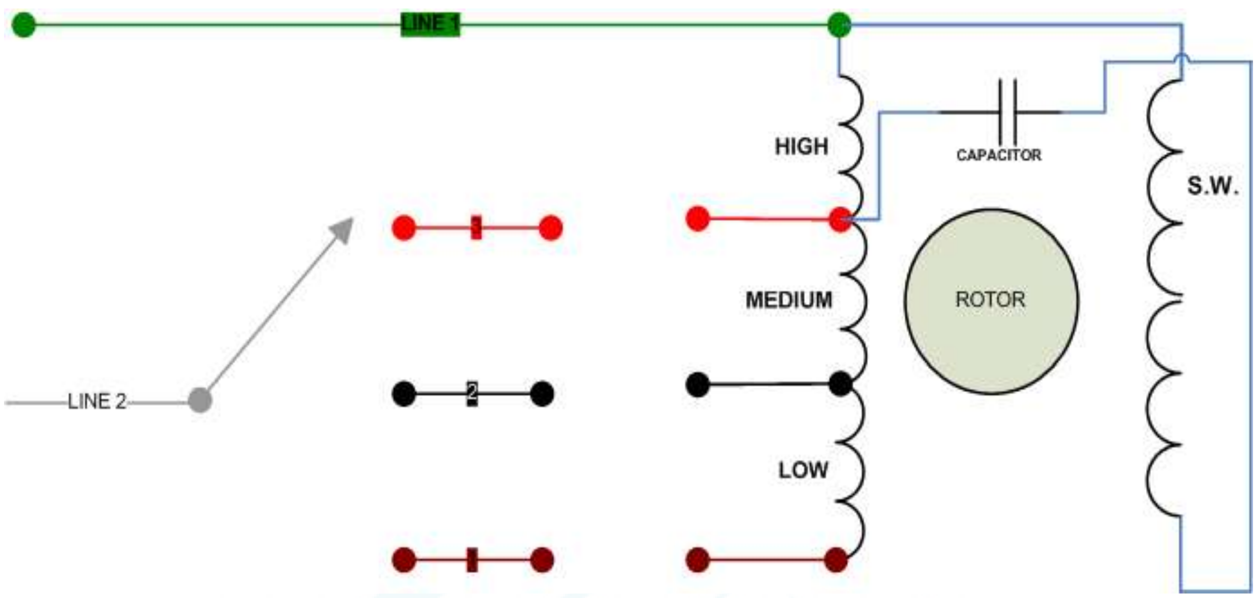
5. Results and Discussion

Technical Description of the Locally Fabricated Three Speed Permanent Split Capacitor Run Motor Trainer

The output of this study was a functional trainer wherein students can conduct experiments by connecting instruments that measure the amount of resistance, current, and voltage and disconnecting and connecting some of its components to observe its effect in the circuit.

The above schematic diagram was adapted from the book of Rosenberg (1995) but was re-layout by the researcher to emphasize the test points/terminal ports of the said developed trainer.

According to Rosenberg (1995) Permanent split capacitor motors are designed in various sizes ranging 1/20 to 35 horsepower. The smaller sizes are used on fans of all types. Because of the low inrush amperes, this motor can tolerate the stress of starting a flywheel type load. The bearings, the winding, the capacitor and fuse are the only components that are subjected to breakdown. Some of the smaller sizes cannot be repaired because of the way how they are constructed. But larger sizes like motors used in refrigeration compressors can be repaired. A permanent split capacitor run motor is a motor having different value of capacitance to its starting and running conditions. As compared to capacitor start motor, this motor has no centrifugal switch, the capacitor and starting and running winding are connected all times and the capacitor is generally of oil impregnated type.



Three Speed Permanent-Split Capacitor Run Motor Trainer Schematic Diagram

The said diagram was re-layout using the Microsoft word Visio 2003. Test points for measuring the stator winding resistance, the amount of current and voltages across each of the speed coil were made accessible for the students who will manipulate the instructional device by using the provided ports guided with labels and layout connections.

The capacitor connection is intentionally detachable for the student to easily disconnect from the circuit to observe its effect.
Each speed coil terminal was terminated with color-coded ports so that the student can easily connect the ammeter in series when measuring current with different level of the motor speed.

Line 1 and Line 2 ports are in parallel connection which will be use in measuring the drawn of voltage in different speed level. The said terminated speed coil terminals must be connected using terminal connectors during the drawn voltage measurement.

The trainer is also designed to be loaded or unloaded to its fan for the student to observe the change in drawn voltage and current during experiments.

Parts and Functions of the Trainer

Rotor – the rotating part of the motor made up of cast aluminum winding.

Stator– which composed of a laminated steel core with semi-closed slots, a heavy cast-iron or steel frame into which the core is attached, and two windings of insulated wire that are wound into said slots.

End Plates – these are fastened to the stator frame by means of thru bolts and serve mainly to keep the rotor in position. The bore of the end plates, in which the rotor shafts rest, is fitted either ball bearings or sleeve bearings. These sustain the weight of the rotor to keep it precisely centered within the stator and permit rotation without allowing the rotor to rub on the stator.

Stator Windings - consist of (1) a winding of heavy copper wire, which is generally located at the bottom of the said stator slots and is called the run, or main winding and (2) a winding of smaller insulated wire which is usually located on top of the run winding and is called the start or phase winding.

Capacitor- the name capacitor describes the device's operation as it acts as a temporary storage unit of charge for electrical energy; that is, it can store electricity and provide a leading current to the motor's start winding.

Panel – it is made up of insulated flat surface wherein ports and controls are fastened to access testing points.

Ports-it is fastened in the said panel to receive the terminal connectors and instruments for testing.

Stand – it holds the entire trainer wherein all the components and materials are disposed of color-coded.

Connectors- refers to the pairs of insulated wire used to connect terminal ports and instruments.

The researcher developed the trainer functional, interactive and might engage the students in several experiments in which they may acquire the desired knowledge and skills about the principle operation of variable speed motors. The following are the different experiments that the developed trainer could provide to the students:

Applications/Experiment using the trainer

a. The stator winding resistance measurement in different speed level (low, medium, and high).

b. semi-closed
c. Starting current measurement with a load in different speed level (low, medium, and high).
d. Running current measurement without a load in different speed level (low, medium, and high).
e. post-test
f. Starting drawn voltage measurement without a load in different speed level (low, medium, and high).
g. Starting drawn voltage measurement with a load in different speed level (low, medium, and high).
h. Running voltage measurement without a load in different speed level (low, medium, and high).
i. Running voltage measurement with a load in teaching-learning speed level (low, medium, and high).
j. Running current by detaching the capacitor from the circuit in teaching-learning speed level (low, medium, and high).
k. Running voltage by detaching the capacitor from the circuit in different speed level (low, medium, and high).

Supplies and Materials

Table 1: The supplies and materials used in constructing the trainer

Qty.	Unit	Name & Description	Unit Cost	Total Cost
1	pc	Three Speed Split Phase Capacitor Run Motor	450.00	450.00
1	pc	Film type Capacitor 1.5 of	60.00	60.00
1	pc	Insulated panel 6x8 inch	50.00	50.00
1	pc	Plywood ¾, 2x2 ft.	100.00	100.00
1	pc	Variable switch	100.00	100.00
8	pcs	Assorted terminal ports	20.00	160.00
16	pcs	Terminal jack	15.00	240.00
5	m	Terminal wire	15.00	75.00
1	pc	AC Plug w/ Cord	65.00	65.00
Total				**1,250.00**

The trainer is not only meant for equipping students about the theory of operation of the three-speed motor but also in identifying what are the common troubles, strategies on how to diagnose, what causes the trouble, and remedies to post-test in troubleshooting.

Operations Manual of the Trainer

1. Resistance Measurement

- Use an ohmmeter in this experiment

NOTE: In this experiment the trainer must be in off condition/unplugged. Using the common terminal as the reference, each of the different speed coils has a different amount of resistance.

- Set the analog Volt Ohmmeter into RX10 range setting.
- Connect one of the test prod to line one.
- Measure the resistance of low speed coil/no. 1
- Measure the resistance of medium speed coil/ no. 2
- Measure the resistance of high speed coil/no. 3

2. Starting Current Measurement with load/the fan

- Use an analog/digital ammeter in this experiment.

NOTE: In this experiment, the Trainer must be energized. To avoid electrical shock, the trainer user should be familiar with, and exercise, all possible high voltage safety practices.

- Set the AC analog/digital ammeter into the desired setting and connection. And the ammeter must also be connected in series each of the speed coil terminals to be measured
- Connect the AC analog/digital ammeter to low speed coil terminal/No. 1.
- Connect the AC analog/digital ammeter to medium speed coil terminal/No. 2.
- Connect the AC analog/digital ammeter to high speed coil terminal/No. 3.

3. Starting Current Measurement without a load/fan

- Use an analog/digital ammeter in this experiment.

NOTE: In this experiment, the Trainer must be energized. To avoid electrical shock, the trainer user should be familiar with, and exercise all possible high voltage safety practices.

- Set the analog/digital ammeter into the desired setting and connection. And the ammeter must also be connected in series each of the speed coil terminals to be measured.
- Connect the analog/digital ammeter to low speed coil terminal/No. 1.
- Connect the analog/digital ammeter to medium speed coil terminal/No. 2.
- Connect the analog/digital ammeter to high speed coil terminal/No. 3.

4. Running Current Measurement with load

- Use an AC digital clamp ammeter in this experiment.
- NOTE: In this experiment, the Trainer must be energized. To avoid electrical shock, the trainer user should be familiar with, and exercise, all possible high voltage safety practices.
- Set the analog/digital ammeter into the desired setting and connection.
- Connect the analog/digital ammeter to low speed coil terminal/No. 1.
- Connect the analog/digital ammeter to medium speed coil terminal/No. 2.
- Connect the analog/digital ammeter to high speed coil terminal/No. 3.

5. Running Current Measurement without a load

- Use an AC digital clamp ammeter in this experiment.
- NOTE: In this experiment, the Trainer must be energized. To avoid electrical shock, the trainer user should be familiar with, and exercise, all possible high voltage safety practices.
- Set the analog/digital ammeter into the desired setting and connection.
- Connect the analog/digital ammeter to low speed coil terminal/No. 1.
- Connect the analog/digital ammeter to medium speed coil terminal/No. 2.
- Connect the analog/digital ammeter to high speed coil terminal/No. 3.

6. Starting Voltage Measurement without a load

- Use an AC Voltmeter in this experiment.
- NOTE: In this experiment, the Trainer must be energized. To avoid electrical shock, the trainer user should be familiar with, and exercise, all possible high voltage safety practices.
- Set the AC Voltmeter into 1000V
- Connect the two test prod in parallel to line 1 and line 2.
- Press/Switch speed number 1 and observe the changes in the original voltage
- Press/Switch speed number 2 and observe the changes in the original voltage
- Press/Switch speed number 3 and observe the changes in the original voltage

7. Starting Voltage Measurement with load

- Use an AC Voltmeter in this experiment.
- NOTE: In this experiment, the Trainer must be energized. To avoid electrical shock, the trainer user should be familiar with, and exercise, all possible high voltage safety practices.
- Set the AC Voltmeter into 1000V
- Connect the two test prod in parallel to line 1 and line 2.
- Press/Switch speed number 1 and observe the changes in the original voltage
- Press/Switch speed number 2 and observe the changes in the original voltage
- Press/Switch speed number 3 and observe the changes in the original voltage

8. Running Voltage Measurement without load

- Use an AC Voltmeter in this experiment.
- NOTE: In this experiment, the Trainer must be energized. To avoid electrical shock, the trainer user should be familiar with, and exercise, all possible high voltage safety practices.
- Set the AC Voltmeter into 1000V
- Connect the two test probe in parallel to line 1 and line 2.
- Press/Switch speed number 1 and observe the changes in the original voltage
- Press/Switch speed number 2 and observe the changes in the original voltage
- Press/Switch speed number 3 and observe the changes in the original voltage

9. Running Voltage Measurement with load

- Use an AC Voltmeter in this experiment.
- NOTE: In this experiment, the Trainer must be energized. To avoid electrical shock, the trainer user should be familiar with, and exercise, all possible high voltage safety practices.
- Set the AC Voltmeter into 1000V
- Connect the two test probe in parallel to line 1 and line 2.
- Press/Switch speed number 1 and observe the changes in the original voltage
- Press/Switch speed number 2 and observe the changes in the original voltage
- Press/Switch speed number 3 and observe the changes in the original voltage

10. Running Voltage Measurement with load

- Use an AC Voltmeter in this experiment.

NOTE: In this experiment, the Trainer must be energized. To avoid electrical shock, the trainer user should be familiar with, and exercise, all possible high voltage safety practices.

- Set the AC Voltmeter into 1000V
- Connect the two test probe in parallel to line 1 and line 2.
- Press/Switch speed number 1 and observe the changes in the original voltage
- Press/Switch speed number 2 and observe the changes in the original voltage
- Press/Switch speed number 3 and observe the changes in the original voltage

Table 2: Validation of experts on the level of Acceptability of the Locally Assembled Three Speed Permanent-Split Capacitor Run Motor Trainer

Indicator	Mean	
A. Indicators Along Usefulness		
1. It is useful in the field Electrical Technology specifically in Three Speed Permanent Split Capacitor Run Motor.	4.6	VMA
2. It can be used for both lecture and laboratory.	4.6	VMA
3. It can also be used as an instructional device in another related type of motors.	4.7	VMA
4. It can save time and effort, on the part of instructor and students to fully understand the lesson presented.	4.5	VMA
5. It is simple and easy to transfer to another place or room.	4.5	VMA
AVERAGE	**4.58**	VMA
B. Indicators of Effectiveness		
1. It encourages active participation in the teaching-learning process.	4.6	VMA
2. It is simple and appealing to the students.	4.5	VMA
3. It engages student into an actual/experiential learning.	4.6	VMA
4. It can make the class interactive, especially during experiments.	4.6	VMA
5. It provides convenience to the instructor who will use it for teaching.	4.5	VMA
AVERAGE	**4.58**	VMA
C. Indicators along Functionality		
1. It is easy to operate and understand	4.7	VMA
2. Control switches are properly responding.	4.7	VMA
3. Allow the learners to work at their own pace.	4.7	VMA
4. Hands-on activities can be carried out individually or by groups within the trainer.	4.7	VMA
5. The internal connection layout of the trainer is simple and easy to understand.	4.6	VMA
6. The trainer provides simple but interesting for learning experiences.	4.6	VMA
7. All parts/components of the trainer are functional.	4.8	VMA
8. The learners can manipulate the trainer in performing the following exercises. a. The stator winding resistance measurement in different speed level. b. Starting current measurement without a load in different speed level. c. Starting current measurement with a load in different speed level. d. Running current measurement without a load in different speed level. e. Running current measurement with a load in different speed level. f. Starting drawn voltage measurement without a load in different speed level. g. Starting drawn voltage measurement with a load in different speed level. h. Running voltage measurement without a load in different speed level. i. Running voltage measurement with a load in different speed level. j. Running current by detaching the capacitor from the circuit in different speed level. k. Running voltage by detaching the capacitor from the circuit in different speed level.	4.8	VMA
AVERAGE	**4.7**	VMA
D. Indicators of Reliability		
1. It can operate for a long	4.7	VMA
2. It contains the standard electrical wiring system components/part.	4.6	VMA
3. There's no observed failure during operation.	4.7	VMA
4. Parts are logically arranged.	4.6	VMA
5. It can be used for multiple experiments.	4.7	VMA
AVERAGE	**4.66**	VMA
E. Indicators along Safety		
1. Its components, ports, and connections are properly labeled.	4.5	VMA
2. It has safety precautions provided.	4.6	VMA
3. Its design and construction promote safety.	4.5	VMA
4. Connectors are properly insulated and prevent electrical hazards.	4.7	VMA
AVERAGE	**4.57**	VMA
OVERALL AVERAGE	**4.61**	**VMA**

Legend:

4.50-5.00 Very Much Acceptable (VMA)
3.50-4.49 Much Acceptable (MA)

2.50-3.49 Acceptable (A)
1.00-1.49 Not Acceptable (NA)

Based on the above table, the device is very much acceptable according to the group of respondents having a mean of 4.58. This implies that the electricity and electronics experts find the device to be useful as an instructional device in teaching. However, with the rating 4.58 tends imply that there is a need to improve the device to its portability as indicated from the table.

On the other hand, they also gave 4.58 as the mean of the device regarding to its effectiveness. This would also imply that the group of respondent finds the device to be semi-closed in teaching electricity and electronics student about AC motors. However, having a sub mean of 4.58 tends imply further that there's more to improved for it to be perfectly effective because it does not meet a perfect rating of 5.0

Along with functionality, it was also rated very much acceptable, and this would also denote that the group of evaluator finds the device to be functional as it can be operated easily and it can be used according to its desired function as an instructional device in the teaching-learning process. However, with the rating 4.7 tends to imply that there is a need of improving/simplifying the label of parts and internal connection layout of the device.

The device was also rated very much acceptable along reliability, and this would imply that it is reliable to be use as an instructional device in teaching electricity and electronics about three-speed motors. Hence with the rating of 4.66 would imply that there's a little bit more to improve in its operation though there's no failure during the test of the device during evaluation. Moreover, the researcher might have to strive more to observe the weaknesses of the device and turn them to a possible solution for it to be completely reliable.

Moreover, lastly the device was also rated very much acceptable along safety. It would also imply that the device can be used safely to engage students in a productive learning process. Despite the fact that it is rated very much acceptable, there's more to improve on its construction, or the way it was made and a more precise user manual might be provided for the user. The researcher did not find any risk of using the device as long as the user is familiar with all the safety precautions and the user's manual provided with the device. However, definitely with the rating 4.57 as the mean further implies that there is a need of improving the device regarding safety.

Taken as a whole, the respondent's grand mean of 4.61 implies that the device is very much acceptable to use as an instructional device in teaching electricity and electronics students about electric motors especially three-speed motors though there's more to improve on the device as described in each of the standards that evaluate the device.

6. Summary, Conclusions and Recommendations

This chapter presents the summary of the findings, conclusions formulated and recommendations made regarding the Effectiveness of a Locally Fabricated Three Speed Permanent-Split Capacitor Run Motor Trainer.

It made use of the developmental method of research. It was accomplished through p designing, gathering needed materials, testing, and validation. Descriptive-evaluative type of research was also employed in evaluating the mean level of acceptability of the research output regarding its usefulness, effectiveness, functionality and reliability and safety. A validated rating scale was used to evaluate the developed instructional device by six experts in electricity and electronics from the College of Technology University of Northern Philippines. The computed mean was used to describe the level of acceptability of the said trainer.

7. Findings

1. The developed trainer is applicable in following experiments: a.) The stator winding resistance measurement in different speed level, b.) Starting current knowledge-based without a load in different speed level, c.) Starting current measurement with a load in different speed level, d.) Running current measurement without a load in different speed level, e.) Running current measurement with a load in different speed level, f.) Starting drawn voltage measurement without a load in different speed level, g.) Starting drawn voltage measurement with a load in different speed level, h.) Running voltage measurement without a load in different speed level, i.) Running voltage measurement with a load in different speed level, j.) Running current by detaching the capacitor from the circuit in different speed level, k.) Running voltage by detaching the capacitor from the circuit in different speed level.
2. The grand mean rating of the device was described as very much acceptable (4.61) along Usefulness, Effectiveness, Functionality reliability and safety. This means that the device is made useful, functional, effective, reliable and safe to use as an instructional device in the teaching-learning process.

8. Conclusions

From the findings of this study, the following conclusions are formulated:

1. Parts and components of the trainer are all equally important as a source of learning
2. The developed trainer is applicable in various learning experiences in enhancing the knowledge and skills of students about electric motors especially three-speed motors.

3. The developed trainer is very much acceptable as an instructional device in facilitating teaching learning process in electricity and electronics

9. Recommendations

The researcher recommends the use of the developed trainer in teaching electricity and electronics student about electric motors. Future researchers may also conduct similar studies to develop instructional devices to improve instruction.

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