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DEVELOPMENT AND EVALUATION OF A PORTABLE AUTO-ELECTRICITY TRAINER (PAET) FOR INDUSTRIAL TECHNOLOGY AND ENGINEERING STUDENTS

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Abstract

This research developed a Portable Auto-Electricity Trainer (PAET) as improvised instructional material in teaching Automotive Technology. It followed the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model. The following is a summary of the study's findings: 1. the Portable Auto-Electricity Trainer (PAET) was planned based on the needs of teachers and students as outlined in the automotive/electrical curriculum; 2. the researchers designed the PAET's automotive and electrical plan, including the materials used; 3. in the development, the researchers built a mobile trainer called PAET by using auto-electrical parts that were compatible with the design; 4. in terms of implementation and evaluation, the researchers conducted four trials on the operation and use of the PAET. The researchers gathered industry experts, industry teachers, and students to test its competence and acceptability. On design, functionality, learner engagement, and usability, they gave the PAET a very high rating. They were confident that by having this trainer present, the delivery of teaching would be more effective, particularly when it came to completing laboratory activities.

Keywords: Design, Development, Electrical, Portable Auto-Electricity Trainer, Technology,

Introduction

Education is the acquisition of knowledge, skills and attitudes that make men do better. It is not only a preparation for life, but it is life itself (McHale, 2015). Seeking new knowledge and technical know-how is the anticipation of every student for him to be assured of future opportunities for making a living. In order for the school to adequately meet these high expectations of parents and the community, it must provide the best training available, which students deserve. In technological vocational schools, training models in the teaching-learning situations are very much needed in turning out skilled and dependable technicians and teachers in the field of automotive technology. Availability of training models in learning progressions supports curricular training together with instructional materials, instruction, and assessment design. In order to support the development of integrated understanding, relevant instructional materials should be developed to emphasize not only the learning of individual topics but also the connections between ideas and across ideas and disciplines. The Technical Education and Skills Development Authority (TESDA) also proposed that as the Philippines tries to keep up with the technological development among the industrialized nations, the government must provide directions, policies, programs and standards towards quality technical education and skills development. The key factor in meeting the demands of the present-day situation is the resourcefulness and ingenuity of the vocational-technical instructors in resorting to improvisation through the use of cheap, recycled and locally available materials teaching devices (Pascual 2017).

Teaching device is a broadly inclusive term signifying any material or any used by teachers to promote stimulate or motivate learning. According to Nolasco (2001), shop teaching is generally either demonstration of an operation or job, lecture or shop talk concerning related information or both where the shop teacher shows parts of the tools or equipment and give their functions. However, according to him, there is a need for showing these parts so that students can see and have a closer look at them. A cut-away is either a model or real object wherein a portion of which is removable so that it's inside construction as well as how these parts functions can be seen in operation. Learning by doing is the intended precept in any school laboratory setting, one of which is the shop room in an educational setting. However, many studies conducted in the past stated that laboratory/shop rooms were found to be lacking with tools and equipment needed for skills training, as exemplified in the findings of Donato (2012) and Lucas (2014) studies.

Automotive technology, as one of the courses offered in vocational schools, suffers from the lack of inadequate supply of tools and equipment. To answer this problem, Lucas (2014) suggested in his study that innovation be resorted to by teachers by improvising equipment from locally available supplies and materials. Improvised equipment may not be better than its commercial counterpart but what is important is its functionality which could help in the development of necessary skills. It is necessary for the teachers to

full back on a deep reservoir of creativity and resourcefulness to contend with available resources and come up with a device that is functional. A similar study was conducted by Donato (2012). He proposed that one solution for the lack of needed tools and equipment is to invent instructional materials and working models out of locally available supplies and materials to partially substitute for the needed equipment. Improvisation and development of teaching aids and equipment will make students aware of what the theories he learns in the school actually meant through first-hand experiences and hands-on activities. The teacher can demonstrate and perform works test exercises and experiments. Instructional aides can affect students in many ways, by; "motivating students, contributing to the understanding, providing varied learning experiences, reinforcing learning, allowing for different interests, encouraging participation, providing experiences that might not otherwise be bad, and changing attitudes and feelings" (Ornstein, 2020).

Palaleo's (2018) study proposed that one solution to the lack of needed tools and equipment is to invent instructional materials and working models out of locally available supplies and materials to partially substitute for the needed equipment. A similar study was conducted by Java, S., Rao, T., and Rao, G. (1985), they found that while some classroom experiments need complex equipment, sometimes, well-designed, simple or improvised apparatus of good quality will help the students understand the idea behind the experiment more easily.

Along this line of concern, educational institutions need to be aware of this technological gap specifically in developing programs in Automotive Technology to ensure an effective teaching-learning situation. To realize the objectives, the researchers planned a device that would enable learners to learn easily in the practical application of the auto-electricity circuit using a complete trainer board with less cost and which is more convenient to use than the commercial one. The device was called Portable Auto-electricity Trainer (PAET), instructional material in teaching Automotive Technology. The PAET is intended to carry out a variety of motorcycle and different types of car vehicles' electrical circuit experiments. This teaching set uses a competency-based approach to instruction, with circuit-building tasks used to reinforce theory learning. The PAET has electrical components onboard that can be linked to carrying out the various experiments. The teaching material covers all aspects of auto-electricity, from the fundamentals to the more complex topics. This teaching aid unit's goal is to give students a thorough overview of the issue, from fundamental automotive to advanced installation. The trainer is appropriate for all levels of general and advanced automotive courses.

Methodology

This research utilized a developmental research design. "A developmental research involves situations in which the product-development process is analyzed and described, and the final product is evaluated" (Angeles, 2013) as cited in Subia (2020). In this study, the developed product is the Portable Auto-Electricity Trainer named PAET.

The evaluation of the PAET was done by 35 Industrial Technology teachers and students and Industrial Technology Experts. The distribution was as follows: 12 Industrial Technology teachers, 10 Industrial Technology students from selected institutions that are offering automotive technology courses, and 13 Automotive Industry experts in Cabanatuan City.

The questionnaire was used to evaluate the PAET as to its competence and acceptability, design, functionality, learner engagement and usability. The first part of the instrument was adopted from the thesis "Low Voltage Power Supply Trainer" (Macaso, 2017). The second part was researchers-made. The reliability of the instrument was calculated using Cronbach's alpha. The Cronbach's value is 0.896 which indicates the instrument is very reliable.

Results and Discussion

This study followed the ADDIE Model in developing the PAET

1.1. Analysis

In this phase of the development, the researchers gathered needed data to create and formulate concepts for the Portable Auto-Electricity Trainer. The researcher analyzed the syllabi of instruction in Automotive, the existing instructional materials and devices and the teaching methodology of the teachers (Ancheta & Subia, 2020). The results were the basis for the next stage of development so that the device being developed can meet the students' and teachers' needs. The researcher based the development of this study on the reviewed syllabi of instruction. Lack of supporting instructional materials to enhance the skills of the students in the teaching-learning process paved the way for the researcher to develop this device to help students in understanding theory and skills in teaching auto-electricity in the automotive technology area.

1.2. Design

In this phase of the development, several diagrams were constructed to visualize the logical designs and conceptual frameworks of the Portable Auto-Electricity Trainer. In this stage of development, the researcher made a mobile trainer that could suit the needs of the students. The design was constructed by using auto-electrical parts such as a banana plug, Head Lights, Stop Lights, Brake Lights, Horn, Plate Lights, Park Lights, Signal Lights, Wiper Motor, Back Light, relay, Flasher relay, Wire American Wire Gauge (AWG) 18, Stop light switch, ammeter, fuse, and fuse Box, Ignition switch, toggle switch, Stop light switch. All auto-electrical parts were mounted and labelled on a panel board and then mounted in a wooden enclosure. All parts were supported by banana plugs which were soldered to the auto-electrical components to serve as the terminals in a variety of auto-electrical installations. The design was made easy in terms of installation by plugging in and plugging out the banana plug connectors based on the activities that will be given to students during the laboratory classes.

1.3. Development

In this phase of the development, several materials were prepared and assembled according to the design.

1.3.1. Materials, Tools and Equipment

This presents the materials, tools and equipment needed in the development of Portable Auto-Electricity Trainer. Table 1 shows the materials needed for the construction of the Portable Auto-Electricity Trainer. These are: fibreglass, panel board, banana plug, Head Lights, Stop Lights, Brake Lights, Horn, Plate Lights, Park Lights, Signal Lights, Wiper Motor, Back Light, relay, Flasher relay, Wire American Wire Gauge (AWG) 18, Stop light switch, ammeter, fuse, and fuse Box, Ignition switch, toggle switch, Stoplight switch

Table 1. List of Materials in the Construction of Portable Auto-Electricity Trainer

Unit	Qty	Parts	Amount	Total Amount
2	pieces	Fibre Glass Panel Board 21"x 38"x ¼"	P 600	P1200
2	pieces	Head Lights	P250	P500
130	pieces	Banana Plug	P8	P1040
2	pieces	Stop Lights	P100	P200
2	pieces	Brake Lights	P75	P150
2	pieces	Horn	P75	P150
1	piece	Plate Lights	P90	P90
2	pieces	Park Lights	P100	P200
4	Piece	Signal Lights	P60	P240
1	Unit	Wiper Motor	P 550	P550
2	Set	Back Light	P100	P200
7	Set	Relay	P90	P630
1	Set	Steering Control switch	P1500	P1500
8	Piece	Fuse	P25	P200
1	Set	Fuse box	P150	P150
1	Unit	Ammeter	P 170	P170
1	Set	Ignition switch	P350	P350
2	Set	Stoplight switch	P100	P200
1	pc.	Toggle switch	P45	P45
1	Unit	Flasher relay	P150	P150
¼	kls.	Common Nail # 1”	P25	P25
2	pcs.	Cabinet Handle	P90	P180
1	pcs.	Drawer Lock	P180	P180
8	pcs.	Edge Rubber Support	P8	P64
50	pcs.	Metal Screw	P1	P50
1	pc.	Sticker Paper	P150	P150
1	pc.	Chain	P45	P90
1	ltr.	Lacquer Paint	P180	P180
1	pc.	Plywood 22”x36”x ¼”	P480	P480
15	meters	Soldering lead	P20	P300
2	pc.	Good Lumber, ½’x3.5’x10’	P180	P260
40	meters	Automotive Wires, American Wire Gauge 18	P5	P200
		GRAND TOTAL		**P10,074.00**

Table 2 shows the tools and equipment needed for the construction of the Portable Auto-Electricity Trainer.

Table 2. List of Tools and Equipment in the Construction of Portable Auto-Electricity Trainer

Unit	Qty	Specification of Materials, Tools and Equipment
1	piece	Steel tape measure
1	piece	L-square
1	unit	Portable electric drill
1	unit	Drill press
1	unit	Soldering iron, 36 watts
1	piece	Longnose pliers
1	piece	Philip screwdriver
1	Piece	Hammer
1	Piece	Hacksaw
1	set	Box wrench

1.3.2 Development of Portable Auto-Electricity Trainer

In the development of the Portable Auto-Electricity Trainer, the following were taken into consideration:

1. Prepare necessary materials, tools and equipment.
2. Measure the required dimension (21 inches in length and 18 inches in width) of the panel board.
3. Measure the required dimension of the fibreglass (¼" x 21" x 18") by using a steel tape meter and L-square.
4. Make necessary holes on the fibre glass using a portable electric drill.
5. Prepare the working drawing for the frame housing that will serve as a guide for its construction.
6. Measure the desired length and width of the frame housing.
7. Cut the wood according to the measurement.
8. Assemble the parts of the frame housing with a common nail.
9. Apply paint to the frame housing for finishing the frame housing.
10. Mount automotive parts and materials to their specified locations and solder through terminals of banana jacks or sockets using a soldering iron with a rated power of 30 watts and 60/40 solder.
11. Un-tighten banana plugs to expose the solder joint and connect hook-up wire and solder to it. Do the same on the other side.

Fig.1. Developed Improvised PAET Instructional Material

1.3. Implementation

Testing is one of the most important phases of product development, where the developed product could be tested by Industrial Technology Teachers, Students and Industrial Technology Experts so that possible errors could be corrected immediately. The product went through three (3) trials for every Automotive Electricity part tested, and for every trial of each part implemented, different errors and problems were encountered and corrected. Table 3 presents the circuit implemented, the number of trials, errors found and corrections made in PAET testing.

Table 3. Testing of PAET

Circuit Implemented	No. of Trial	Error/s	Correction/s
Head Lights	1	Lost connection to female banana plug	Re soldered the loose contact
	2	Terminal switch factory defect	Replace the terminal switch
	3	Bulb basted	Replace bulb
Stop Lights	1	Lost connection to female banana plug	Re soldered the loose contact
	2	Terminal switch lost contact	Re soldered the loose contact
	3	Bulb lost contact with the holder	Fixing the bulb to the holder
Back Lights	1	Lost connection to female banana plug	Re soldered the loose contact
	2	Terminal switch lost contact	Re soldered the loose contact
	3	Bulb lost contact with the holder	Fixing the bulb to the holder
Horn	1	Lost connection to banana plug	Re soldered the loose contact
	2	Terminal switch lost contact	Re soldered the loose contact
	3	Distorted sound of the horn	Align and adjust
Plate Lights	1	Lost connection to female banana plug	Re soldered the loose contact
	2	Terminal switch lost contact	Re soldered the loose contact
	3	Male banana plug lost contact	Re soldered the loose contact
Park Lights	1	Lost connection to female banana plug	Re soldered the loose contact
	2	Terminal switch factory defect	Replace the terminal switch
	3	Not function	Fixing wirings
Signal Lights	1	Lost connection to female banana plug	Re soldered the loose contact
	2	Terminal switch factory defect	Replace the terminal switch
	3	Only right-side function	Fixing wirings
Hazard Lights	1	Lost connection to female banana plug	Re soldered the loose contact
	2	Terminal switch factory defect	Replace the terminal switch
	3	Only left side function	Fixing wirings
Wiper Motor	1	Lost connection to female banana plug	Re soldered the loose contact
	2	Terminal switch factory defect	Replace the terminal switch
	3	Not function the motor	Fixing wirings
Tail Lights	1	Lost connection to female banana plug	Re soldered the loose contact
	2	Terminal switch lost contact	Re soldered the loose contact

	3	Not function	Fixing wirings
By Pass	1	Lost connection to female banana plug	Re soldered the loose contact
	2	Terminal switch factory defect	Replace the terminal switch
	3	Not function	Fixing wirings
Power supply	1	Lost connection to female banana plug	Re soldered the loose contact
	2	Terminal lost connection	Re soldered the loose contact
	3	Underrate/ rectifier diode	Replace diode on prescribe rating

This shows the trials for every Automotive Electricity part tested, and for every trial of each part implemented, different errors and problems were encountered and corrected. The portable Auto Electricity Trainer implemented were the following: Headlights, stop lights, Backlights, Horn, Plate lights, Park lights, Signal lights, Hazard lights, Wiper motor, Taillights and bypass. The PAET was successfully tested according to activities as posted in the operating manual. To test the capability and acceptance of the trainer, the researchers invited experts' automotive technicians from Isuzu, from TESDA Palayan City, and from Provincial Manpower and Training Center (PMTC), Palayan City and from Honda, Sta Rosa to demonstrate the device. These personnel went through all the activities the usability and functionality of the PAET following the operational manual made by the researcher. They gave the rating **Very Highly Functional** since the device was very useful and functional and even enthused that the students can use the device with minimal supervision.

1.5. Evaluation

The figure shows the evaluation done by the researcher in cooperation with the industrial technology teachers and industrial technology experts from distinguished institutions and industries.

Fig. 2. Evaluation of the PAET

The technicians commented that the device would greatly help the students to understand the installation of auto-electrical parts. Industry experts, industry teachers and students gave a rating very high on the design, functionality, learning engagement and usability of the Portable Auto-Electricity Trainer. They were convinced that with the presence of this trainer, the delivery of instruction will become more effective especially in accomplishing laboratory activities.

Conclusions

Based on the results of the study, the following conclusions were drawn:

1. The innovation that has been developed (Maungmeesri, Kantananon, Maungmeesri, & Maneetham, 2022) named Portable Auto-Electricity Trainer (PAET) meets the approval of automotive/electrical Information Technology teachers, students and experts.

2. The overwhelmingly positive comments given by the respondents have rewarded the researcher's efforts in using PAET in Automotive/Electrical classes.

3. Having been assessed with convincing and positive results, the PAET can be of great help in carrying out the teaching-learning process insofar as the Automotive Technology Area of the College of Industrial Technology is concerned.

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