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Portable Automotive Starting and Charging System (PASCS) for Industrial Technology and Engineering Students

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Abstract. This research developed a Portable Automotive Starting and Charging System (PASCS) 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 Automotive Starting and Charging System (PASCS) was planned based on the needs of teachers and students as outlined in the automotive/electrical curriculum; 2. the researchers designed the PASCS's automotive and electrical plan, including the materials used; 3. in the development, the researchers built a mobile trainer called PASCS 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 PASCS. 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 PASCS 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,

1. 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

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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

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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 Automotive Starting and Charging System (PASCS) instructional material in teaching Automotive Technology. The PASCS 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 PASCS 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

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automotive to advanced installation. The trainer is appropriate for all levels of general and advanced automotive courses.

2. Methodology

This research utilized a developmental research design. "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 Automotive Starting and Charging System named PASCS.

The evaluation of the PASCS 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 PASCS as to its competence and acceptability, design, functionality, learner engagement and usability. The first part of the instrument was adopted from the thesis "Portable Auto- Electricity Trainer" (Lacanilao, 2022).

This study was conducted at the College of Industrial Technology of Nueva Ecija University of Science and Technology during the first semester of academic year 2023 – 2024.

3. Results and Discussion

This study followed the ADDIE Model in developing the PASCS

3.1. Analysis

In this phase of the development, the researchers gathered needed data to create and formulate concepts for the Portable Automotive Charging and Starting System. 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

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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.

3.2. Design

In this phase of the development, several diagrams were constructed to visualize the logical designs and conceptual frameworks of the Portable Automotive Charging and Starting System. 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, Alternator, Starter Motor, Wire American Wire Gauge (AWG) 18, S, ammeter, fuse, and fuse Box, Ignition switch, Dynamotor, Voltage Regulator, Toggle 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.

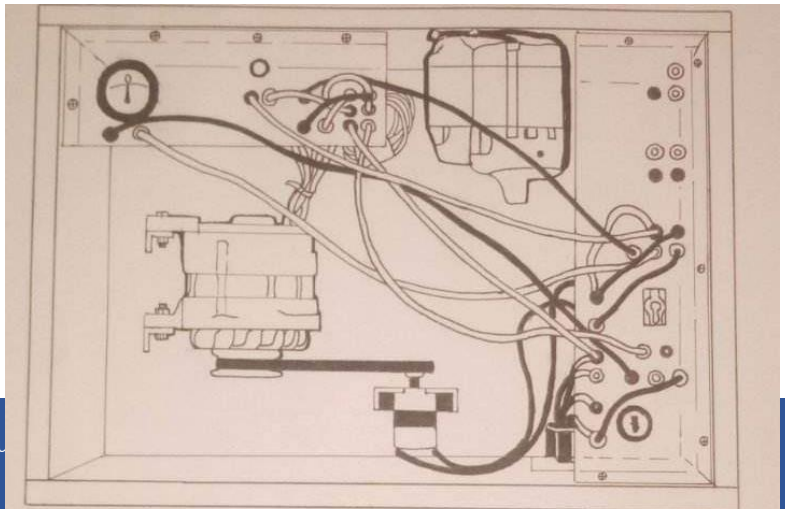

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Figure 1 show the design of Portable Automotive Starting and Charging System

3.3. Development

In the development of Portable Automotive Starting and Charging System, the following were taken into consideration:

1. Prepare necessary materials, tools and equipment.
2. Measure the required dimension (30cm in length and 12 cm in width) and (40cm length and 12cm width) of the panel board.
3. Measure the required dimension of the fiber glass (¼" x 30cm x 12cm) and (1/4" 40cm x 12cm) by using steel tape meter and L-square.
4. Make necessary holes on the fiber glass using portable electric drill.
5. Cut the wood according to the measurement.
6. Apply paint to the frame housing for finishing the frame housing
7. Mount automotive parts and materials to their specified locations and solder through terminals of banana jacks or sockets using soldering iron with rated power of 30 watts and 60/40 solder.
8. Un-tighten banana plugs to expose the solder joint and connect hook-up wire and solder to it. Do the same at the other side.

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Figure 2 show the development of Portable Automotive Charging and Starting System

Figure 3 Developed Improvised PASCS Instrutional Materials

Tools and Materials. This presents the materials, tools and equipment needed in the development of Portable Automotive Charging and Starting System. Table 1 shows the materials needed for the construction of the Portable Automotive Charging and Starting System. These are: fiberglass, panel board, banana plug, alternator, Starter motor, voltage regulator, dynamotor, relay, Wire American Wire Gauge (AWG) 18, ammeter, fuse, and fuse Box, Ignition switch, toggle switch,

Table 1 PASCS Total Costing

Quantity	Unit	Materials	Unit Price	Price
1	Pc	Alternator	2,000	₱2000.00
1	Pc	Starter Motor	1,700	₱1700.00
1	Pc	Dynamotor	350	₱350.00
1	Pc	Ignition Switch	380	₱380.00
1	Pc	Voltage Regulator	750	₱750.00
2	Pcs.	Fuse	40	₱80.00
1	Pc	Starter Relay/Socket	160	₱160.00

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33	Pcs.	Male Jack	250	₱250.00
33	Pcs.	Female Jack	250	₱250.00
8	m	Wires American Gauge # 14	6	₱48.00
1	Pc	Pulley Belt	100	₱100.00
1/2	Pc	Ply Board Wood	400	₱400.00
10	m	Soldering Lead	10	₱100.00
1	Pc	Dark Gray	100	₱100.00
1	Pc	Putty for Wood	170	₱170.00
1	Pc	Toggle Switch	75	₱75.00
1	Pc	Drawer Lock	80	₱80.00
1	Pc	Cabinet handle	100	₱100.00
1	Pc	Sticker Paper	20	₱20.00
1/4	Kl	Common Nails #1	25	₱25.00
7	m	Wires American Gauge # 10	12	₱84.00
2	Pcs.	Fiber Glass	250	₱250.00
		Total		₱7,472.00

Table 1 shows the tools the materials of the Portable Starting and Charging System

Table 2

List of Tools and Equipment used in the Construction

Unit	Qty.	Specification of Materials, Tools and Equipment
1	Pc	Welding Machine
1	Pc	Grinder
1	Pc	Electric Drill
2	Pcs.	Cutting Disk
4	Pcs.	Welding Rods
1	Pc	Drill Bullet
1	Pc	Jigsaw

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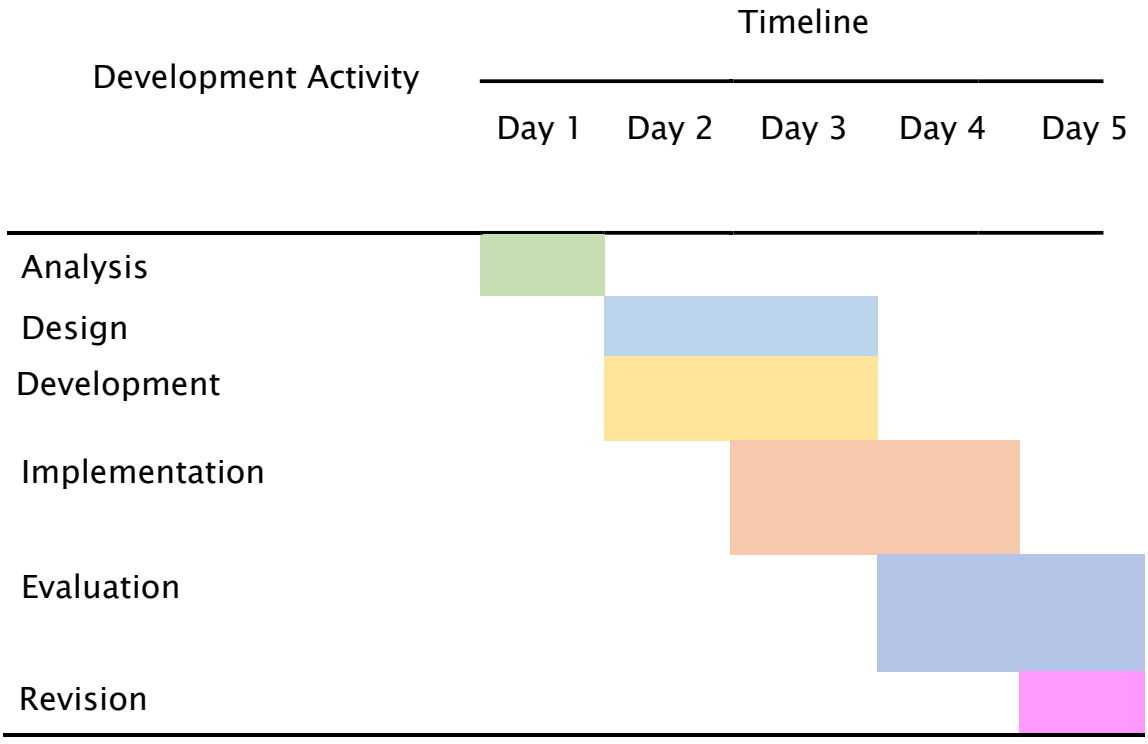
1	Pc	Soldering Iron ,45 watts
1	Pc	Hammer
1	Pc	Philip Screw Driver
1	Pc	L Square

Table 2 shows the tools needed to construction of Portable Starting and Charging System

Table 3 Gantt Chart of PASCS's Development



Testing is one of the most important phases of product development, where the developed product could be tested by Industrial Technology Teachers, Students and

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Industrial technology Expert 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. The Portable Automotive Starting and Charging System implemented were the following: Alternator, Starter and 12 volts motor. Table 7 presents the circuit implemented, number of trials, error found and correction made in PASCS testing.

Table 4 show testing of PASCS

Circuit Implemented	No. of Trial	Error/s	Correction/s
Alternator	1	Lose connection to female banana plug	Re soldered the lose contact
	2	Terminal switch factory defect	Replace the terminal switch
	3	Bulb basted	Replace bulb
Starter	1	Lose connection to female banana plug	Re soldered the lose contact
	2	Terminal switch lose contact	Re soldered the lose contact
	3	Bulb lose contact to holder	Fixing the bulb to the holder

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12 volts motor	1	Lose connection to female banana plug	Re soldered the lose contact
	2	Terminal switch lose contact	Re soldered the lose contact
		Bulb lose contact to holder	Fixing the bulb to the holder

Table 4 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 Automotive Starting and Charging System implemented were the following: Alternator, Starter and 12 volts Motor. The PASCS was successfully tested according to activities as posted in the operating manual.

4. 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.

Figure 4 Evaluation of PASC

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.

Conclusion

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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 Automotive Starting and Charging System (PASCS) 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 PASCS in Automotive/Electrical classes.

3. Having been assessed with convincing and positive results, the PASCS 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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