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: Design Fabrication and Testing of Auto electrical Accessory and Appliances Circuits Trainer

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I Executive Summary

The project aims to design and fabricate a modular automotive electrical mock-up to enhance student understanding of complex auto electrical systems. This mock-up will provide effective instructional materials, focusing on safety, component identification, and troubleshooting various circuits. Additionally, it will assess acceptability and effectiveness as an educational tool, catering to the needs of automotive technology programs in the Philippines.

The project employed a research and development (R&D) method to create and validate a modular automotive electrical system, following a systematic process of planning, construction, testing, and revision. After completing the device, it was assessed for acceptability by automotive technology instructors and students through a checklist questionnaire, and its effectiveness was evaluated using a pre- test and post-test design against existing instructional materials. Statistical analyses, including weighted mean and t-tests, were used to interpret the gathered data and determine the mock-up's impact on learning outcomes.

The modular auto-electrical accessory device effectively integrates three key circuits—car stereo, alarm, and mobile phone charger—using a durable, honeycomb-shaped design with color-coded connectors for easy identification. Constructed through a meticulous research and development process, the device not only serves practical applications but also supports educational purposes, enhanced by a comprehensive instructional manual aligned with NC II standards. Evaluation through pre-test and post- test comparisons showed significant improvements in learner understanding, confirming the device's effectiveness as an instructional tool for automotive servicing.

To enhance the modular auto-electrical accessory device, suggestions include improving the instructional manual with more troubleshooting scenarios, implementing user feedback mechanisms, and broadening testing with diverse sample groups. Proposed utilization activities involve organizing workshops for educators, conducting hands-on demonstrations, and creating online resources to facilitate effective integration into automotive training programs. Additionally, establishing collaborative partnerships and sharing case studies at conferences will promote wider adoption and continuous improvement of the device.

II Abstract

This research focuses on developing a modular automotive electrical mock-up to enhance student understanding of complex auto electrical systems. By integrating functional components and a comprehensive instructional manual, the project aims to facilitate hands-on learning in areas such as circuit identification, safety precautions, and troubleshooting. Grounded in Constructivist Theory and

Gagne's Theory of Instruction, the project emphasizes practical application, allowing students to engage with automotive electrical systems. The study employs a developmental method to create and validate the mock-up as an educational tool. Following a structured research and development process, meticulous planning, construction, and testing were conducted, with evaluations from educators and students assessing its acceptability and effectiveness. Results indicate significant improvements in learning outcomes, as shown by pre-test and post-test comparisons. The mock-up includes three circuits—car stereo, alarm system, and mobile phone charger—integrated through color-coded connectors within a sturdy stainless-steel frame. Evaluation from five automotive instructors and 31 students yielded an average rating of 4.63, reflecting very high acceptability in functionality, mobility, and safety. Additionally, the instructional device demonstrated efficacy in teaching, with notable improvements in the experimental group compared to the control group. The total fabrication cost was Php 10,716.00. This research contributes valuable insights for developing practical instructional materials in automotive education, emphasizing the integration of theory and hands-on experience.

III Introduction

Auto electrical systems are very essential components of a vehicle. Hence, this topic should be backed-up by effective instructional materials. It will surely help the students in familiarizing and understanding the complex and complicated components of automobile. The successful technology-rich school generates impressive results for students including improved achievement; higher test scores; improved student attitude, enthusiasm, and engagement; richer classroom content; and improved student retention and job placement rates. Same as in automotive students; they should be able to understand the lessons clearly with the use of instructional materials.

Unfortunately, while the instruction is going on, several problems came out and hindered the learning of the students. Lacking effective instructional material is the first on the list. Especially on dealing with the automotive electrical systems, the students must identify the parts, service an electrical system properly, discuss its function and familiarize the proper wiring connections.

In this regard, the researchers who are faculty in Automotive Technology Department and at the same time an expert in the field of automotive is challenged to develop an instructional mock-up that will address the mentioned problem in the instruction for automotive technology. The proposed design of the mock-up will use an actual functional electrical component to safely familiarize and perform electrical components connections.

Looking at the economic side, the mockup to be developed will be advantageous in learning the different automotive electrical circuits hence this provide a more focus activity on specific circuit since its design is a modular type which is the different circuits is divided into modules. The learner may opt to use the module without confusing the attention to the other circuits. This mockup is marketable in the Philippines, particularly in the schools like DepEd TESDA, SUCs and private institutions offering automotive Technology or Automotive Electricity. In fact, with the full swing of implementation of Senior High School of the K-12 Program, schools that will offer automotive servicing need to have effective instructional materials and the proposed mock-up will be one of those.

This Mock-up could be used in developing the following Competencies:

1.Perform safety precautions in working with automotive electricity to avoid accident

2.Identification of Auto electrical components along conventional type electrical system, starting, charging and ignition system, steering wheel combination switches with booster relay, and automotive accessories and appliances circuits.

3.Perform safely and properly on the following circuits along conventional type electrical system, starting, charging and ignition system, steering wheel combination switches with booster relay, and automotive accessories and appliances circuits:

a.Engine electrical circuits
b.Headlight circuit with pass
c.Park light circuit
d.Taillight circuit
e.Signal light circuit with hazard
f.Horn circuit
g.Wiper circuit
h.Accessory circuits

4.Troubleshoot various auto electrical system problems, its causes and perform possible correction.

The learning acquired by the students depends on the effectiveness of the learning materials being used. It helps them to understand the designated competency from complex topic to stress-free and complicated theme to easy. Understanding the operation and circuitry of auto-electrical accessories is a very difficult task for the learner, especially if it is in tock in the vehicle. In order to address this problem, the researchers will find a strategy to isolate the said subcomponents of auto-electrical circuits, in order for the learner to easily understand and acquire the needed competency on auto-electrical accessory servicing. Hence, this Modular mock-up is very necessary for automotive students in acquiring technical know-how, skills and knowledge on auto electrical systems.

Objectives

The aim of this project is to design, and fabricate, a functional modular automotive electrical system and evaluate in terms of acceptability and effectiveness as an instructional material. Specifically, the different study desired it desired to:

1.Design and fabricate the modular auto electrical accesso Circuits with interconnectivity.
2.Write an instructional manual using the mock-up.
3.Assess the acceptability of the mock-up in terms of functionality, mobility and safety.
4.Evaluate its effectiveness as an instructional material.

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5.Determine fabrication cost of the device

Output

1.Fabricated Accessory Circuits
2.Comprehensive Instruction Manual
3.Level of Acceptability of the system
4.Effectiveness of the system as an instructional material
5.Research report

IV Review of Related Studies and Literatures

Modular design is a design principle that subdivides a system into smaller parts called modules (such as modular process skids), which can be independently created, modified, replaced, or exchanged with other modules or between different systems. A modular design can be characterized by functional partitioning into discrete scalable and reusable modules, rigorous use of well-defined modular interfaces, and making use of industry standards for interfaces. In this context modularity is at the component level, and has a single dimension, component slot ability. A modular system with this limited modularity is generally known as a platform system that uses modular components. Examples are car platforms or the USB port in computer platforms. (htps://en.wikipedia.org/wiki/Modulardesign)

Another example of modular type application is the construction industry. There's a strong trend in the real estate industry toward building more things away from the construction site. Modular construction is one approach. Real Projectives® has been involved in multiple modular construction projects throughout the United States, most recently with a new apartment building in downtown Philadelphia. For that construction project, designers and contractors planned to fabricate 75 modules about 100 miles away from the site, truck them into the city, and then stack them on top of each other to complete a six-story apartment building. Applying modular technology to automotive industry, Automobiles are considered one of the significant artworks/ innovations made by man. Through these, transportation was made possible which give ease to humans and the economy as well. Automobiles were composed of several systems which have their own function for the car to be able to move from one place to another. One of which is the Starting System which makes use of the principles of electricity and consist of the storage battery, starting motor, with a solenoid switch, and a starter push button or starter switch. Once the switch is on, electricity turns the starting motor which in turn cranks or turns the engine, through the flywheel that is attached to the engine crankshaft. (https;/www.realprojectives.com)

Electrical energy from the battery was converted to mechanical energy that turns or cranks the engine. After the starting system performs its operation, another system which is the Ignition System will right away perform its function which is to provide high-voltage electricity that produces a spark that will ignite the fuel charge specifically in a gasoline engine. An electric spark is needed in a gasoline engine otherwise known as a spark-ignition engine, to burn the fuel charge which is a mixture of gasoline and air. A typical ignition system consists of a distributor with a rotor, contact points and condenser, ignition coil, and the spark plug together with the connecting wires such as the primary and the high-tension wires, and also the ignition switch which connects and disconnects the flow of current from the battery to the different parts. To sustain the electricity needed by the engine, Charging System is the one responsible for supplying the current to charge the battery and to help supply current to other electrical units of the vehicle. Electric current is considered the lifeblood of gasoline and or spark-ignition engines. Systems consuming electric current bring about a fast discharge of the battery and very soon will put the engine to stop if the battery is not charged. The continuous supply of electric current for as long as the engine is operating is the main function of the charging system. It consists of an alternator, regulator, and storage battery. The alternator converts mechanical energy into electrical energy while the regulator, on the other hand, regulates the output of the alternator to prevent overcharging of the battery and burning of the electrical unit. Automotive institutions offering the automotive course must develop mock-up that are used as instructional material for the teaching-learning process. The use of mock-up as strategic material for learning/discussion will help catches students' full attention, further understand the operation of each system, and develop their skills in performing troubleshooting.

Technology advances nowadays as fast as a flip without noticing it. Just like how automobiles release new car models having advanced features which either attract and or answer the passenger's needs. But even though these features provide greater ease for its users, still safety and security should be considered. Vehicles today are more sophisticated than before, and technicians are faced with new challenges in learning new systems and methods of testing and diagnosing. Even in the early days of the vehicle repair industry, guessing as to the cause of a problem is a very inefficient and expensive strategy to use, since new technology is equipped with a computer system that is more sensitive to electrical sparks. That's why it is very important that future technicians trained in school should understand the principles and laws governing complicated auto-electrical circuits. Automotive institutions developed mock-up that are used as instructional material for the teaching-learning process. With the use of mock-up as strategic material for learning/discussion, it catches students' full attention, especially those whose heart is on car repairs. It gives them extra excitement on how to troubleshoot on their own. This will provide students to learn the fundamentals of diagnostics skills, it is also designed as a teaching tool for Automotive Instructors to help their students learn the proper auto-electrical diagnosis on a conventional electrical system which is considered basic electrical system troubleshooting. In the early years after the invention of the automobile, most of the cars didn't use electricity. Lights were powered by gas or oil, bells instead of horn, and engine were started by manually cranking. However, in the early 19th century batteries were developed and they try to put it on cars to provide convenience in starting the engine and provide power to lightings and other automobile components that can be powered by electricity. This brings the birth of the automotive electrical system in the automobile Modern auto-electrical system uses booster relays. Relays is an electromechanical controlled switches that is designed for DC voltage as they allow a low current flow to control a high current flow circuit like headlights and other electrical systems. Relays have two circuits, the energizing circuit and the contact circuit to switch high current circuit with low current circuit. The importance on the usage of the relay is to protect low current switches on a high current circuit, thus relay prolong low current switches life.

Vehicles today are more sophisticated than before; technicians are faced with new challenges in learning new system and methods of testing and diagnosing. Even for early days, the vehicle repair industry, guessing as to the cause of a problem is a very inefficient and expensive strategy to use specially that new technology is equip with computer system which is more sensitive to electrical spark and surges. That's why, it is very important that future technicians trained in school should understand the principles and laws governing complicated auto-electrical circuits. In automotive institutions, mock-up are used as an instructional material for teaching-learning process. With the use of mock-up as a strategic material for This will provide students to learn the fundamentals of diagnostics skills, it is also designed for teaching tool for Automotive Instructors to help their students learn the proper auto-electrical diagnosis on electrical systems equip with booster relays.

The invention of Wu Jianying titled "Automobile electronic modular practical training table", is the closest literature to the present undertaking, this utility model discloses an automobile electronic modular practical training table, belongs to the field of automobile teaching equipment and relates to an improved structure of a practical training table for teaching demonstration aiming at the whole automobile electric appliance system of an automobile. The automobile electronic modular practical training table comprises a power supply module, wherein the power supply module is respectively connected with a windscreen wiper module, a lamp light illumination module, an automobile door control module, a rearview mirror module, a sound system module, an instrument signal module, a starter module and an engine module one by one through switches, the starter module is connected with the engine module through the switch, and the engine module is connected with the generator module through the switch and is then connected with the power supply module through the switch.

. The automobile electronic modular practical training table is applicable to practical operation training and theoretical teaching of the whole automobile electric appliances of the automobile, the dynamic simulation and demonstration, the fault setting, the fault diagnosis, the fault elimination and the like on the whole automobile electric appliances of the automobile can be carried out through practical operation, and the automobile electronic modular practical training table can be used as auto electric appliance teaching and checking.(https://patents.google.com/patent/CN202306942U/en)

However, the present undertaking is modularized or assembled by means of electrical circuits for easy understanding of the learners. These are the Main Frame with Modular Connectivity, Conventional type Auto Electrical System, Starting, Charging and Ignitions System, Steering Wheel Combination Switches with Booster Relay Type Auto Electrical System and the Auto electrical Accessory or appliance Circuits.

Another patent considered as closely related to the present endeavor is the "Modular electrical assembly and removable wedge therefor ", a modular electrical connector assembly for use with the wiring systems of vehicles. The assembly includes a plurality of modular blocks, each having one or more tapering mortises formed on the sides thereof and a plurality of tubular, singled walled, double tenon wedges which are insertable into the mortises to assemble the blocks together. Preferably, wedges are formed with an upwardly tapering ramp disposed on each tenon which terminates in an upwardly depending stop surface for

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engagement with a downwardly depending stop surface formed on the mortises of the modular blocks to prevent relative vertical motion between the blocks and the wedges. In this invention, they claim a modular electrical connector assembly comprising: a plurality of parallel piped modules, each having top and bottom surfaces and two pairs of opposed sides, and each including at least one inwardly tapering mortise formed on one of said sides and extending for a distance on said side toward said top surface and said bottom surface; socket means formed on the top surface of each of said plurality of modules for insertion of an electrical connection element therein; and a plurality of resilient tubular wedges, each configured to include a pair of opposed, outwardly flaring tenons for mating engagement with said at least one mortise to form a dovetail joint therewith. (Rei, VanDerStuyf, Volpe, https://patents.google.com/patent/US5295870A/en)

This technology is used as a component of a vehicle, unlike with the present research developing an instructional material that would help learners easily understood the concept of automotive electrical and electronics components in a modular design. The learners and instructors had an option to focus more on the difficult electrical circuit since the modular electrical system is individually designed for their choice to master the competency in performing the difficult task for them.

A modularization fuel cell engine integrating method for bus, the method is: uses the design of the modularization fuel cell engine, the components, the structure, the manufacture, the design and the assembly of every modularization fuel cell engine are absolutely accordant, the outputting power is about 50 kilowatts, processes the combinative integrative assembly of several modularization fuel cell engine according to the material condition of the bus, which the power accumulation can achieve the request of the capability satisfactorily for buses. . the integrated approach that is used for the modular fuel battery engine of urban bus, it is characterized in that, this method adopts modular fuel battery engine, and at city big bus internal combustion engine, the original installing space of Diesel engine, the combination of carrying out two modular fuel battery engines is integrated; Two complete independent operating of modular fuel battery engine wherein, each engine block comprises independently fuel battery stack module, air supply subsystem, hydrogen supply subsystem, boiler water circulation and heat dissipation subsystem, control and Monitor And Control Subsystem; Two independently the electricity output of modular fuel battery engine adopt and be connected in parallel, be added with diode and contactor separately; During the outside output current of two simultaneous firings, its output voltage is identical, but operating current can be different; One of them modular fuel battery engines breaks down, and can carry out isolated shutdown at any time. (https://patents.google.com/patent/CN1897339B/en)

A connector for structurally and electronically interconnecting modular electronic components which permits as single connection to provide both electrical communication and structural support between the modular components is disclosed. The interconnector may be a separate component from the housing for the electronic components or may be integrated therein. (Schipper, Williams, https://patents.google.com/patent/US5601445,

It is shown in the preceding patents the usability and importance of a modular design in the sophisticated technology. Like with present proposal on presenting a nobel landscape on modular design in an automotive electrical system. Hence it is expected that the modular electrical trainer is attractive, effective and functional as a new model of instructional material in the automotive technology.

Scientific Basis/Theoretical Framework.

The design and development of the Modular- Type Auto-Electrical System will be anchored in three combined theories namely the Constructivist Theory, Gagne's Theory of Instruction and Edgar Dale's theory of Experience Figure 1 shows the Theoretical Paradigm.

According to Bruner, constructivist theory is that learning is an active process in which learners construct new ideas based upon their current/past knowledge. The learner selects and transforms information; construct hypothesis and makes decisions relying on a cognitive structure to do so. The said theory is important for the researcher in considering the translation of the information to be learned by the students.

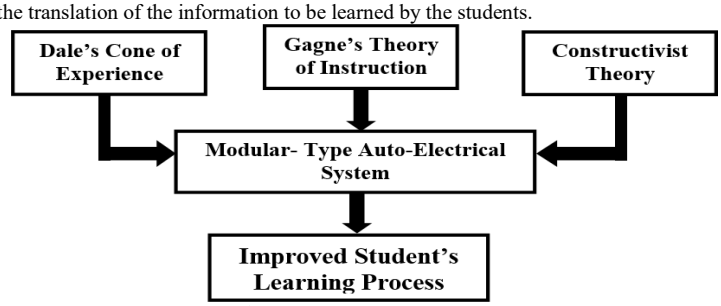

Figure 1. **Research Paradigm**

Another theory that provides help in the realization of the study will be the Gagne's theory of instruction which provide a hands-on and step-by-step instruction in everyday teaching and learning, his taxonomy of learning outcomes, conditions for learning and nine events instruction focus and consider the possible scenario before, during and after the learning process which is seen as a more systematic approach to guide our learners. The instructor in this theory should perform as event arranger and provider of learner situation and condition based on the designated learning objective and the learners' unique characteristics. In this regard, the said theory will help the researcher in developing instructional device that would provide effective learning condition for the students.

Lastly is the Dale's Cone of Experience, it is a model that incorporates several theories related to instructional design and learning processes. During the 1960s, Edgar Dale theorized that learners retain more information by what they "do" as opposed to what is "heard", "read" or "observed". His research led to the development of the Cone of Experience. When Dale researched learning and teaching methods, he found that much of what we found to be true of direct and indirect (and of concrete and abstract) experience could be summarized in a pyramid or 'pictorial device'. He stated that the cone was not offered as a perfect or mechanically flawless picture to be taken literally. It was merely designed as a visual aid to help explain the interrelationships of the various types of audio-visual materials, as well as their individual 'positions' in the learning process.

It is important to note that Dale never intended the Cone to depict a value judgment of experiences; in other words, his argument was not that more concrete experiences were better than more abstract ones. Dale believed that all of the approaches could and should be used, depending on the needs of the learner. This Dale's Cone of Experience has significance in this study since it asserts that "learning by doing" transforms the teacher into a facilitator who assists the learners as they apply the theories learned through given hands-on activities. The said theory affirmed the fact that the proposed prototype provided realistic learning tasks to the automotive mechanics.

Materials and Methods

This project used the developmental method of research particularly the research and development (R&D process) considering the nature of the objective of the study which is to develop and validate educational products. According to Luenendonk (2019), the creation of new body of knowledge about existing products or processes, or the creation of an entirely new product is called R&D. This is systematic creative work, and the resulting new knowledge is then used to formulate new materials or entire new products as well as to alter and improve existing ones. Thus, to assure the quality of the modular auto electrical system, step by step procedure such as planning and designing, preparation and purchasing the materials, constructing, testing and revising and evaluating was followed.

In planning and designing, the researchers produced the blueprint of the device for easy identification of the task to be done for the realization of the said instructional materials. Prior to construction of the device, the researchers prepare the materials to be used through following the purchasing guidelines and coordinating with the research center as the authority to perform the task. Upon acquiring the needed materials, the researchers with the help of fabricator started the construction process by following the specified plan to come up with the desired output which is the instructional materials. After the construction, the researchers tested the instructional material to identify the parts which are not fully developed as it should be. The researchers made some revision based on the result of testing.

The finished modular system was submitted to the identified intended users being the respondents such as automotive technology teachers/trainers/instructors or professors and students/trainees to assess its level of acceptability. The respondents are given a checklist questionnaire for them to give rating on the acceptability of

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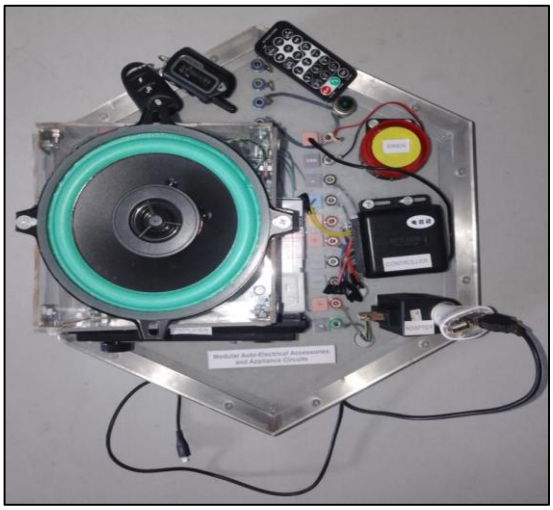

the trainer based on the variable listed. And then, checklist questionnaire has been collected and was subjected for tabulation and interpretation. The data gathered through their responses was tallied and treated statistically using weighted mean on the level of acceptability

In evaluating the effectiveness of the modular system as an instructional device by the intended users, they were subjected to experimental research using a pre-test and post-test design for an experimental group and control groups. The experimental process revolved on comparison between the existing against the present instructional materials. In other words, the advantages of the existing trainers and materials for electrical system has been compared. Criteria were set to easily and accurately compare the performance of the two groups. The data gathered from the experimental process on the level of effectiveness of the system has treated statistically using two-tailed t-test of independent with 0.05 margin of error.

VI Results and Discussion of Accomplishments per Objective

Design

The device consists of three circuits namely car stereo circuits, alarm circuits and mobile phone charger. Each circuit are connected through male and female jack connectors. Female jacks are provided with different colors to easily determine the connections. The frame of the device is made-up with stainless steel with permanent magnet forming a honeycomb-like shape which provides ease when connecting to the other auto-electrical system.

Table 1. Parts of the Mock-up

Parts of Car Stereo Circuits	Parts of Car Alarm	Parts of Mobile Phone Charger
Speaker Case	Antenna	USB Port
Amplifier	ST Starter Light Indicator	Charger
Jack Port	Siren	Adapter
Speaker	Alarm Controller	Jack Port
Volume Controller	USB	
	Jack Port	

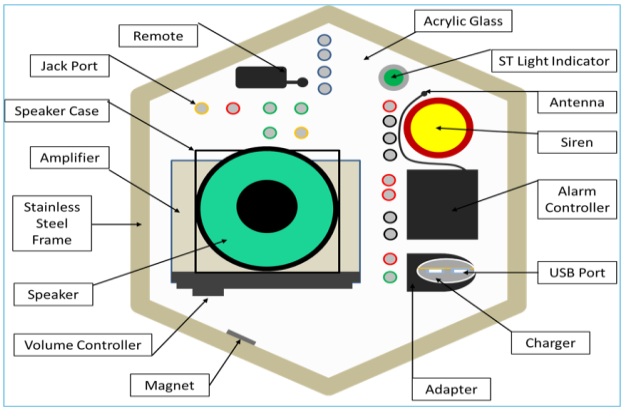

Figure 2. **Design and the Minor Components of Auto-Electrical Accessory**

On fabricating the device, the researcher carefully followed the research and development procedure from planning and designing, preparation and purchasing the materials, constructing, testing and revising and evaluating. The construction procedures are as follows:

1.Cutting the materials on the desired dimensions as stated in the design or blueprint.
2.Forming a honeycomb-like shape stainless steel through welding
3.Providing holes at the top of each hexagon and the fiber glass by drilling
4.Attaching the fiber glass using screws.
5.Assembling the components of radio set, mobile charger, and the car alarm.
6. Testing and Revision

Plate 1. The Finished Product

Content of Instructional Manual

The information contained by the instructional materials developed allows the learners to access data needed in analyzing data and perform basic troubleshooting on the said circuits. The instructional manual of auto-electrical accessory circuits contains information on the following.

1. background of the device
2. target competencies align with automotive servicing NC II

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3. vocabulary of terms
4. warm-up exercises
5. information sheet
6. sets of activities
7. points to ponder
8. drills and practices
9. about the author

Level of Acceptability

Based on the provided data, the mockup under evaluation demonstrates very high acceptability in terms of its functionality, mobility, and safety. The average rating of 4.63, which falls within the "very high acceptability" category, indicates a strong positive overall impression of 5 automotive instructors/trainers and 31 automotive students.

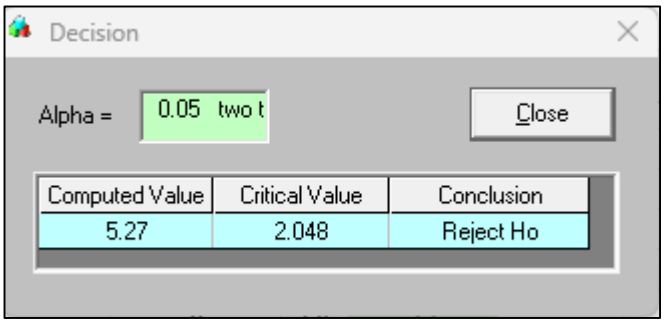
Table 2. The level of acceptability of the mock-up based on respondents' perception.

Parameters	5	4	3	2	1	$\sum fx$		Mean
Functionality								
Ability to operate and function well	21	15	0	0	0	165		4.58
Parts has each significant function	24	12	0	0	0	168		4.67
The device is usable	22	14	0	0	0	166		4.61
							Average	**4.62**
Mobility								
Easy to transfer	22	13	1	0	0	165		4.58
Movable in terms of height	24	12	0	0	0	168		4.67
Movable in terms of weight	23	13	0	0	0	167		4.64
							Average	**4.63**
Safety								
The mock up is safe to use	22	14	0	0	0	166		4.61
The mockup is stable	21	14	1	0	0	164		4.56
Electrical wiring is safely connected	24	12	0	0	0	168		4.67
Movable parts are secured	24	12	0	0	0	168		4.67
							Average	**4.63**
						General Average		**4.65**

Level of Effectiveness

In evaluating the effectiveness of the modular system as an instructional device by the intended users, they were subjected to experimental research using a pre-test and post-test design for an experimental group and control groups. The experimental process revolved on comparison between the existing against the present instructional materials. In other words, the advantages of the existing trainers and materials for electrical system have been compared. Criteria were set to easily and accurately compare the performance of the two groups. The data gathered from the experimental process on the level of effectiveness of the system has been treated statistically using a two-tailed t-test of independent with 0.05 margin of error.

In the presented data there are 30 samples that have been purposively selected to be the controlled and experimented group. The mean difference in the controlled group was 5.67 while the mean difference on the experimental group got 12.27. It appears that the computed value revealed 5.27 using the SSB Simplified Statistic for Beginners. The critical value also shows 2.048 which, hence it concluded that the null hypothesis should be rejected. This simply means that the experiment that has been conducted has significant difference on the result of the controlled group. This emphasis that the use of the device is effective as an instructional material.



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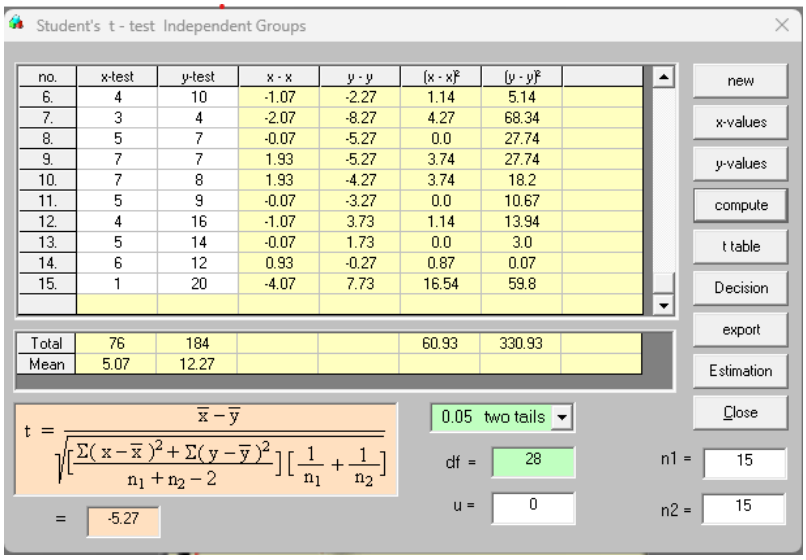

Figure 1. Raw Data of Statistical Analysis Using SSB

Figure 3. Fabrication Cost of the Device

The fabrication cost of this modular device is as follows.

Quantity	Description	Unit Price	Total Price
1 set	12 v Radio Set	1,110.00	1,110.00
1 pc	Voltmeter	250.00	250.00
1 pc	Ammeter	480.00	480.00
1 pc	Ignition switch	500.00	500.00
2 pc	5v charging port	350.00	700.00
6 pcs	Bosch relay	810.00	4,860.00
1 roll	Automotive wire	250.00	250.00
1 set	Car Alarm	1,000.00	1,000.00
Total			**10,716.00**

This table summarizes various automotive components and their respective costs. It includes a range of items such as a wiper motor, horn, 12V radio set, voltmeter, ammeter, ignition switch, charging ports, Bosch relays, automotive wire, and a car alarm. The total cost for all these items comes to Php 10,716.00. Each item is essential for vehicle functionality, safety, or convenience, highlighting a comprehensive approach to automotive repair or enhancement.

VII Conclusions and Recommendation Conclusions

The modular auto-electrical accessory device effectively integrates three essential circuits—car stereo, alarm, and mobile phone charger—through a well-designed framework of color-coded connectors for easy identification. Constructed with stainless steel in a honeycomb-like shape, the device not only enhances connectivity with other auto-electrical systems but also ensures durability. The thoughtful selection of components facilitates efficient operation, making this device a valuable tool for both practical applications and educational purposes in automotive servicing. Overall, the design demonstrates a comprehensive approach to modernizing auto-electrical systems, promoting user convenience and safety.

The fabrication of the modular auto-electrical accessory device was executed with meticulous adherence to a structured research and development process. Key steps included precise cutting of materials, welding to form a robust honeycomb structure, and careful assembly of components, ensuring both functionality and durability. The methodical approach to construction, including drilling and securing components, reflects a commitment to quality and safety. This process not only facilitates effective operation of the device but also highlights its potential as a reliable tool for automotive applications and education. The successful execution of these procedures underscores the viability of the design in meeting user needs.

The instructional manual for the modular auto-electrical accessory device is a comprehensive resource designed to enhance learning and competency in automotive servicing aligned with NC II standards. It includes essential background information, relevant vocabulary, and structured activitiessuch as warm-up exercises and troubleshooting drills. By providing detailed information and practical exercises, the manual equips learners with the necessary skills to analyze and troubleshoot the device's circuits effectively. This resource significantly contributes to the educational experience, ensuring that users can engage meaningfully with the technology and develop essential automotive skills.

The mockup's performance is highly commendable, meeting or exceeding expectations in all key areas. These positive findings suggest that the device is well-suited for its intended purpose and can be considered a viable option for further development or implementation.

The evaluation of the modular auto-electrical accessory device as an instructional tool demonstrated its effectiveness through a rigorous experimental design involving pre-test and post-test comparisons between control and experimental groups. With a sample size of 30, the results indicated a significant improvement in the experimental group, with a mean difference of 12.27 compared to 5.67 in the control group. The statistical analysis, using a two-tailed t-test, confirmed a significant difference, leading to the rejection of the null hypothesis. This underscores the device's efficacy as an instructional material, enhancing learners' understanding and application of automotive electrical systems. The findings support its integration into educational curricula, promoting better learning outcomes in automotive servicing.

The total fabrication cost was Php 10,716.00. This research contributes valuable insights for developing practical instructional materials in automotive education, emphasizing the integration of theory and hands-on experience.

Recommendations

1.Enhance Instructional Manual: Include more troubleshooting scenarios and interactive activities to deepen learner engagement.
2.User Feedback: Implement a feedback mechanism for users to continually improve the device based on practical experiences.
3.Broaden Testing: Conduct further studies with larger and more diverse sample groups to validate findings across various educational settings.
4.Explore Cost Reduction: Investigate alternative materials or sourcing options to lower fabrication costs while maintaining quality.
5.Additional Features: Consider incorporating more advanced technology, such as digital interfaces or connectivity options, to modernize the device further.
6.Training Workshops: Organize workshops for educators on effectively utilizing the device in teaching to maximize its educational impact.

VIII Proposed Utilization/dissemination activities emanating from results

1.Workshops for Educators: Organize training sessions for automotive instructors on how to effectively use the modular auto-electrical accessory device in their curricula, highlighting its functionalities and instructional benefits.

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2.Hands-On Demonstrations: Conduct live demonstrations in automotive training centers to showcase the device's applications, allowing students and instructors to interact with it directly.
3.Webinars and Online Tutorials: Develop a series of online webinars or video tutorials that explain the device's features, troubleshooting techniques, and integration into existing automotive servicing programs.
4.Collaborative Partnerships: Partner with automotive schools and training institutions to pilot the device in their programs, collecting feedback and case studies for further improvement.
5.Publication of Case Studies: Document success stories and case studies from institutions that implement the device, sharing these insights through educational journals or conferences to promote broader adoption.
6.Participation in Educational Conferences: Present findings and experiences related to the device at relevant educational and automotive industry conferences to reach a wider audience.
7.Development of Supplementary Materials: Create additional instructional resources, such as quick reference guides or troubleshooting checklists, to complement the existing manual and enhance user experience.
8.Online Resource Hub: Establish a dedicated website or platform where users can access instructional materials, share experiences, and provide feedback on the device's use in different educational settings.

By implementing these activities, the results of the research can be effectively disseminated, ensuring that the benefits of the modular auto-electrical accessory device reach a broader audience and contribute to the improvement of automotive education.

VII Actual/Perceived Impact of Results

The modular auto-electrical accessory device successfully integrates essential circuits—car stereo, alarm, and mobile phone charger—within a durable, honeycomb-shaped framework, promoting ease of use and safety in automotive applications. Its development followed a meticulous research and development process, ensuring quality construction and functionality. The accompanying instructional manual enhances learning in automotive servicing, providing valuable exercises that facilitate troubleshooting and skill acquisition.

The device's effectiveness was demonstrated through a rigorous evaluation, revealing significant improvements in learners' understanding compared to a control group. Recommendations for enhancing the manual, gathering user feedback, and conducting broader testing will further validate its impact. Proposed dissemination activities, including workshops, webinars, and case studies, aim to share insights and promote its integration into automotive education.

The results suggest that the device significantly enhances learners' competencies in automotive electrical systems, making it a valuable educational tool. Its implementation in curricula is expected to lead to better learning outcomes, equipping future technicians with essential skills for the evolving automotive industry.

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