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Development and evaluation of an instructional trainer for 360° dashboard camera system and power window system for automotive vehicle

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Abstract
This study investigated the development of the trainer mock-up innovation, as instructional material for teaching automotive technology students. It sought to answer for the level of acceptability of the Instructional Trainer in terms of functionality, usability, safety, and the level of quality of the Instructional Trainer in terms of content. This research study made use of developmental study mixed Method Design. This involved the mixing of qualitative and quantitative data also called Convergent parallel design as proposed by Creswell & Clark (2011). Convergent parallel design is a collection of data both qualitative and quantitative strands of the research performed independently, and their results are brought together in the overall interpretation of the gathered data.

The Functionality mean rating as perceived by the experts, showed a remarkable accuracy and consistency of the instructional trainer as it met the curriculum alignment of the automotive program having a mean of 4.9 or "extremely agree". The researcher opted to get some feedback from the experts of this field to focus more on the functionality and usability of the prototype. Feedback from the experts about the functionality of the prototype was summarized in Table B below. As reflected in the table, all items obtained 4.9 mean score which is interpreted as "Extremely Agree". The findings connote that the experts discerned the instructional trainer as a valuable instructional material in the teaching-learning process. Such high rating of the trainer could be linked to the completeness of the components where students could also familiarize and enhance their skills in automotive which are practical useful in unravelling practical problems especially in school. It also has a provision for developing students Automotive Servicing National Competency III (NC-III).

The experts' evaluation on the safety features of the instructional trainer revealed as "Extremely safe" to use based on the average mean of 4.9. The findings revealed that the researcher was able to install all the components of the trainer properly and promoted safety for both the instructional material and the user. The results of this study was highly acceptable in terms of functionality, mobility, safety, and maintainability with a general weighted mean of 4.83.

As to evaluation on the level of quality of the instructional trainer module, the content aspect obtained 4.9 average mean which is interpreted as "Extremely Agree". The findings revealed that the module developed could improve the quality of learning of the students, as it supports the teaching strategies as well.

Alpha testing was done to ensure the quality of the instructional trainer before it is ready for the real time end user (Oladimeji, 2007). It is one of the commonly used software development strategies to guide design modification before releasing the product. This serves as a form of internal testing (Lee-Jayaram, *et al*., 2019). To ensure the quality of the prototype, experts in this study were asked regarding the usability, accessibility, and the safety of the trainer. The Alpha testing results involved experts' feedback indicating that the prototype met the standard classroom instruction in the University of Science and Technology of Southern Philippines. This prototype was complete, accurate, and timely in terms of the University curriculum. According to the experts, since the prototype was fabricated well, it could meet the standard classroom instructions since the materials used were standard to the real industry.

Keywords: Development, evaluation, automotive instructional trainer, 360° dashboard camera system, power window system

Introduction

Due to the rapid development of technology, particularly in the industrial revolution 4.0, the manifestations that are integrated in the automobiles have become sophisticated in nature in which without diagnostic computers, technicians are unable to diagnose or repair a vehicle. Accordingly, there was already a wide gap between theory and practice in the teaching and learning automotive technology in tertiary institutions and schools. Automotive technology courses were taught using theory and practical methods in acquiring skills. The mentioned gap is supported by the study of Zhu (2021) [35] which states that colleges cannot provide the students with sufficient practical opportunities and platforms since they lack the construction and expansion of practical teaching bases. On a personal note, one of the common hindrances observed based on experience was the lack of adequate tools and equipment since the automotive technology industries advance daily. Implied in these observations is the fact that modern tools and equipment are needed and, therefore, must be available always for the students to carry out their practical work to hone their knowledge and skills in automotive technology.

The technological changes that are happening in the world forces education to strive for excellence in order to produce graduates who are highly competitive. In today's highly challenging global environment, the students are unable to

meet the needs in the enterprises due to the old curriculum system of the school, one-sided knowledge system, and the insufficient training of the students in terms of comprehensive innovation and practical ability (Pecaso & Pecaso, 2017).

To address the sustainable development goals of former President Rodrigo Duterte for the year 2030 for quality education, students should be trained to pass the National Competency in TESDA certification body as evidence of their ability and capability in their specialized course. In the area of automotive technology, these competencies require students, among others, to carry out installation testing or repair automotive electrical servicing systems and components. Concerning the attainment of standard competency and lifelong learning skills that will make them competitive, faculty should get ready with instructional materials, teacher-made tools, and gadgets because they are essential for students' learning. One such teacher-made instructional material considered is a dashboard camera that would meet new technology standard in modern automobile. Such a concept would help students get a good grasp of the theory or theories involved in this innovation such that it would be easy for them to move towards practical application.

This concept led to the present study of developing a 360º Dashboard Camera and Power Window System with the aim of enhancing the knowledge and skills of the students in diagnosing new technology that is present in the modern automobile. In a practical dashboard variable of electrical servicing system components, it may include power windows which are controlled by switches or wires and are powered by battery or electricity. This power window will not function if the ignition of the car is not turned on. Unlike the traditional windows, power windows do not have manual handles (Nice, 2021) [26].

There are already lots of modern automobile electrical systems and car alarms with central locking system devices as well as different designs available in the market with different brands and models. Along with these rapidly changing designs, it is more difficult for student learners to interpret its application of theories taught in the school. There are still theories in the field of automotive which many students find it difficult to conceptualize the real world of modern automobile technology. Despite the efforts of the highly capable instructors to explain such theories, there is really a need to use instructional mock-ups or trainers to enhance better understanding and principles presented (Fernandez, 2006).

This study was development in nature which utilized the Analysis-Design-Development-Implementation-Evaluation (ADDIE) framework as a guide. It is an instructional system design (ISD) framework that many instructional designers and training developers use to develop courses.

Generally, in automotive, regardless of the diversity of components, parts, designs, brands, models, and sizes, the same obtain its purpose, principle, and operation (Naelga, *et al*., 2017) [25]. The instructional trainer was intended to cater to the students' needs in classroom instructions which are deemed essential for the automotive instructor to facilitate the teaching-learning process.

Methods

This research study made use of developmental study mixed Method Design. This involved the mixing of qualitative and quantitative data also called Convergent parallel design as proposed by Creswell & Clark (2011). Convergent parallel design is a collection of data both qualitative and quantitative strands of the research performed independently, and their results are brought together in the overall interpretation of the gathered data. Developmental design refers to the conduct of tests in a controlled setting between the relationships of the two variables. The researcher introduced the Instructional Trainer for 360° Dashboard Camera System and Power Window System for Automotive Vehicle to the Academe and Industry Experts. Descriptive approach is an approach which the inquirer often makes knowledge claims based primarily on constructivist perspectives (i.e., the multiple meanings of individual experiences, meanings socially and historically constructed, with an intent of developing a theory or pattern), or advocacy/participatory perspectives (i.e., political, issue-oriented, collaborative, or change oriented), or both McCombes (2022). In addition, descriptive research was used because the objective was to provide a systematic description that was as factual and accurate as possible. This research method provides the number of times something occurs, or frequency, lends itself to statistical calculations such as determining the average number of occurrences or central tendencies. The study employed Branch's (2009) Analysis, Design, Development, Implementation, and Evaluation (ADDIE) Model for instructional design in constructing the experimental treatments and utilized the model's five-procedure such as: The analysis phase, design phase, development phase, mechanical design, supplies and materials, and the implementation phase. The study was conducted in Malaybalay City, Bukidnon. The design and development of the instructional trainer and the external evaluation were done in the locale of the researcher. The evaluation of the Instructional Trainer mock-up and the Instructional Trainer Module was done by 10 Academe and Industry Experts in the field of Automotive Technology. Aside from being experts in this field, they were not connected with Bukidnon State University to avoid bias. Purposive sampling was used in selecting the respondents of the study because it is a non-probability sampling in which the sample was chosen based on the population's characteristics and according to the predetermined criteria related to the study topics.

The researcher utilized an adopted questionnaire in the evaluation of the instructional trainer mock-up and instructional trainer module. Part I of the study was on the functionality of the Power Window System and the 360º Dashboard Camera System for automotive vehicle. The questionnaire was adopted from the study of Omar D. Ramdi entitled, "Development of Automotive Engine Electrical System Trainer for Automotive Technology Students." The questionnaire for usability was adopted from the Technology Acceptance Model (TAM) by Fred David (1986) to evaluate the Instructional Trainer for 360° Dashboard Camera System and Power Window System for Automotive Vehicle. The Technology Acceptance Model was purposely designed to address the factors of the user's system technology acceptance (Chau & Hu, 2002).

Furthermore, the TAM was confirmed to be an easily applied model across different research settings.

The adopted questionnaire for safety came from the study of Victor Rosales entitled, "Acceptability of electrical Installation and Maintenance Instructional Trainer." The adopted questionnaire utilized in the Instructional Trainer Module was from the study of Cris Norman P. Olipas entitled "Student's Evaluation of the Instructional Learning Modules for Application Development and Emerging Technological Courses." The survey questionnaire answered the content and teaching and learning of the Instructional Trainer Module. The survey questionnaire was validated by the Academe and Industrial Experts. These contained items/statements which were scored following the five-point Likert scale. The experts simply checked the numbers with their corresponding description on the questionnaire. The choices given were: *5-Extremely Agree; 4- Slightly Agree; 3- Neither; 2-Slightly Disagree; and 1- Extremely Disagree.*

Results & Discussion

Problem 1. What is the level of acceptability of the Instructional Trainer in terms of

1.1 functionality,

1.2 usability, and

1.3 Safety?

Evaluate the features, functionality, usability, and safety of the instructional trainer.

Table A: Functionality Mean rating as perceived by the experts.

Functionality Statements		1 Extremely Disagree	2 Slightly Disagree	3 Neither	4 Slightly Agree	5 Extremely Agree	Mean	Interpretation
1	The automotive power window and 360° Dashboard Camera System are functional.	0	0	0	1	9	4.9	Extremely agree
2	The power window and 360° Dashboard Camera System gives an accurate result	0	0	0	1	9	4.9	Extremely agree
3	The power window and 360° Dashboard Camera System demonstrate the concepts and principles of advance automotive electrical system	0	0	0	1	9	4.9	Extremely agree
4	The power window and 360° Dashboard Camera System illustrates and demonstrates clearly the functions of actual parts.	0	0	0	1	9	4.9	Extremely agree
5	The power window and 360° Dashboard Camera System provides schematic diagram to link the actual components parts in the power window and 360° Dashboard Camera	0	0	0	1	9	4.9	Extremely agree

Table A, displayed the functionality mean as perceived by the experts. After getting the feedback from the Alpha testing, a Technology Acceptance Model questionnaire was carried out to secure the accuracy and consistency of the instructional trainer. Several questions had been asked to the experts to ensure that the prototype developed was fully functional and the user expectations were met in line with the curriculum. According to Larusdottir, *et al*., (2010), to determine whether the component of the prototype satisfies the users' need, they must involve the participation of the users. However, in this case, the researcher opted to get some feedback from the experts of this field to focus more on the functionality and usability of the prototype. Feedback from the experts about the functionality of the prototype was summarized in Table B above. As reflected in the table, all items obtained 4.9 mean score which is interpreted as "Extremely Agree". The findings connote that the experts discerned the instructional trainer as a valuable instructional material in the teaching-learning process. Such high rating of the trainer could be linked to the completeness of the components where students could also familiarize and enhance their skills in automotive. This is also in line with the study conducted by Pecaso, *et al*., (2018) [28] which indicates that aside from being functional, a trainer is very useful in unravelling practical problems especially in school. It also has a provision for developing students Automotive Servicing National Competency III (NC-III)

Table B: Usability Mean rating as perceived by the experts.

Usability Statements		1 Extremely Disagree	2 Slightly Disagree	3 Neither	4 Slightly Agree	5 Extremely Agree	Mean	Interpretation
1	The instructional trainer enables the students to accomplish the task more quickly.	0	0	0	1	9	4.9	Extremely agree
2	The instructional materials improve the student's performance	0	0	0	1	9	4.9	Extremely agree
3	The instructional materials increase the student's productivity.	0	0	0	1	9	4.9	Extremely agree
4	The instructional materials enhance the effectiveness of teaching advanced automotive electrical systems.	0	0	0	1	9	4.9	Extremely agree
5	The instructional materials make it easier for the students to perform actual tasks.	0	0	0	1	9	4.9	Extremely agree

Table B showed the experts' evaluation on the usability of the instructional trainer. The experts evaluated whether the instructional trainer increased productivity of the students, enhanced the effectiveness of teaching advanced automotive, and produced accurate results. The findings revealed the average mean rating is 4.9 which mean "Extremely Agree". The trainer provided ease of use which may lead to facilitation of the learning process. The result of this study is consistent with the study of Ramdi (2020) which indicates that teaching the students with a trainer as an instructional device is more effective than without. It also taught the students to learn more concepts about automotive engine electrical systems trainer and perform better tasks in automotive. The works of Andabon (2015) on his device "Automotive Engine Ignition System Circuit Trainer," also claimed that by using a trainer in aid of instruction allows the learner to acquire higher cognitive and manipulative skills.

Table C: Safety Mean rating as perceived by the experts.

Safety Statements		1 Extremely Disagree	2 Slightly Disagree	3 Neither	4 Slightly Agree	5 Extremely Agree	Mean	Interpretation
1	The instructional trainer has safety features and protection.	0	0	0	0	10	5	Extremely agree
2	The instructional trainer connections are correctly connected and insulated.	0	0	0	0	10	5	Extremely agree
3	The instructional trainer shows the appropriate labels and symbols for electrical circuits and devices.	0	0	0	0	10	5	Extremely agree
4	The instructional trainer connection of devices is made in a safe manner and condition to eliminate electrical shocks and hazards.	0	0	0	1	9	4.9	Extremely agree
5	The instructional trainer does not pose a serious risk of injuries to the user.	0	0	0	2	8	4.8	Extremely agree

In Table C, revealed the experts' evaluation on the safety features of the instructional trainer is reflected. In terms of safety, the tables manifest that experts evaluated the trainer as "Extremely safe" to use based on the average mean. The findings revealed that the researcher was able to install all the components of the trainer properly and promoted safety for both the instructional material and the user. The results of this study are in line with the study conducted by Bernaldez (2015) where he developed an instructional trainer that was acceptable to the respondents. Such similarities in results could be associated with the study conducted by Manzillo, *et al*., (2019) in which the instructional trainer developed was highly acceptable in terms of functionality, mobility, safety, and maintainability with a general weighted mean of 4.83.

Problem 2. What is the level of quality of the Instructional Trainer in terms of content?

Table D: Evaluation level of quality of the instructional Trainer module.

	Contents	1 Extremely Disagree	2 Slightly Disagree	3 Neither	4 Slightly Agree	5 Extremely Agree	Mean	Interpretation
1	At the start of the module, there is a clear information and guidance on what the module covered and on assessment details	0	0.	0	1	9	4.9	Extremely agree
2	The module allowed to gain skills that will aid in the employability or career advancement.	0	0	0	1	9	4.9	Extremely agree
3	The Module contents are up to date.	0	0	0	1	9	4.9	Extremely agree
4	The module was relevant to the course	0	0	0	1	9	4.9	Extremely agree

Table D, emphasized that this instructional trainer included a module that contained materials descriptions that were systematically arranged and had been selected based on certain objectives. The table above shows the results of assessment of experts of the module in terms of its content. The content aspect of the module obtains 4.9 average mean which is interpreted as "Extremely Agree". The findings revealed that the module developed could improve the quality of learning of the students. According to Pecaso, *et al*., (2018) [28], a module can further support strategies in teaching while using an instructional trainer.

Thematic Analysis of the Expert's Feedback

Alpha testing must be done to ensure the quality of the instructional trainer before it is ready for the real time end user (Oladimeji, 2007). It is one of the commonly used software development strategies to guide design modification before releasing the product. This serves as a form of internal testing (Lee-Jayaram, *et al*., 2019). To ensure the quality of the prototype, experts in this study were asked regarding the usability, accessibility, and the safety of the trainer. The feedback is displayed in the table below.

Feedback	THEME
Instructional trainer is effectively useful for the students training.	USABILITY
The instructional trainer is very helpful in terms of standard procedure in teaching the desired topic.	
It does make use of time in providing learners a direct perspective of the components without taking time in disassembly and assembly.	
The instructional trainer is reliable, and efficient in giving instruction.	
As the instruction trainer is completed the effectivity and the efficiency of the student learning will be assured.	
The trainer (instructional) is designed to meet the standard of the industry.	
With proper guidance and provision of laboratory activities, this instructional material will be a great help for learners.	
The instructional trainer is effective if the lacking application will be installed.	
It is more effective in actual hands-on in the laboratory instruction.	
The power window and 360-degree dashboard camera is a good material to use for instruction.	
The instructional material will give convenience to the driver.	
Given the instructions and activities that is bundled with the material, it will totally help learners gain new skills and knowledge.	
The instructional trainer is effective if it does not only include installing and troubleshooting.	
The instructional trainer is effective if it is a complete package.	
The instructional trainer is convenient to bring anywhere.	ACCESSIBILITY
It enables the learner to access the current vehicle in a simulated real time scenario.	
These new technologies will provide learners idea on how these things work.	
The 360 dashboard camera system is easy to understand and the students can also read it in the module.	
The 360 dashboard camera system is easy to operate because of its design.	
The instructional trainer is easy to access because of its simple design.	
The diagram and manual is ready.	
The camera and power window of vehicle is very common for the new model of cars.	
The instructional trainer is easy to understand because the wirings are in place.	
The instructional trainer is convenient when you park your vehicle since it includes a power window and a 360 degree camera.	
Without the process of assembly and disassembly, it takes lesser risk in damaging parts or inflicting physical damages to users.	SAFETY
The instructional trainer is safe to use.	
The instructional trainer is safe in giving instruction.	

Conclusion

Based on the findings of the study the following conclusions are drawn:

The use of the instructional trainer would be beneficial to the students in classroom discussions. Actual laboratory work of the students could be enhanced and made effective due to the use of Instructional Trainer. The results of the experts' feedback stated that the instructional trainer was usable, accessible, and safe in the classroom instruction. The Industry and Academe Experts believed that the 360° Dashboard Camera System and Power Window System for Automotive Vehicle Instructional Trainer was functional and performed better in the teaching-learning process which could contribute to the enhancement of skills in the automotive students. The result of the study based on the evaluation of the Industry and Academe Experts showed that the Instructional Trainer would be useful in increasing the skills and knowledge of the automotive students. The safety features of the Instructional Trainer were evident in the 360° Dashboard Camera System and Power Window System for Automotive Vehicle. In introducing the Instructional Trainer to the automotive students, proper safety precautions should be emphasized to the trainer and user. According to the study of Porter (2018) [36], the complexity was evident in automotive lab activities, where the instructor must balance teaching and demonstrating while also guiding the teaching process for multiple students of varying skill levels, protecting the tools and equipment, and ensuring the students' safety. With proper Instructional Trainer Module that contained activities and assessment, it helped the students in attaining various knowledge which later could be applied in the Instructional Trainer. This finding supported the study of Reddy (2005) which states that course module plays very important role in the busy academic schedule because it saves time and covers all concepts.

Recommendations

From the findings and conclusions of the study, the following recommendations are given to following stakeholders.

Administrators: In order to assess the students in passing the National Certificate 3, they should have had this type of instructional trainer that can help boost the skills development of the students.

Technicians/Teachers: They should be encouraged to utilize this innovation and its different functions, operations and controls in testing and repairing the 360° Dashboard Camera System and Power Window System in the laboratory hands-on activity.

Students: The 360° Dashboard Camera System and Power Window System in the laboratory hands-on activity would greatly help them to relate the theories they learned with their practical application, specifically on how these instructional trainers operate.

Automotive Industry: The development of novel instructional material such as the instructional trainer may provide the right incentive for the industry to support institutions in their effort to come up with new and modernized instructional trainer for its own benefit and for the future automotive graduates who will be equipped with quality technical skills ready to take their place in the industry and related workplace.

Future Researchers: The success of this instructional trainer may encourage future researchers to create, design, innovate, invent and, more importantly, conduct similar studies that could help in the advancement and development of the automotive students, institutions, and industry.

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