DEVELOPMENT OF AUTOMOTIVE ENGINE ELECTRICAL SYSTEMS TRAINER FOR AUTOMOTIVE TECHNOLOGY STUDENTS

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Abstract

This study aimed to develop an automotive engine electrical systems trainer for automotive technology students with the integrated starting, ignition, and charging systems. It also focused on determining the salient features and the effectiveness of the trainer as an instructional device in introducing basic electrical concepts embedded in Automotive Technology program.

The study employed a quasi-experimental research design. The respondents were chosen using simple random sampling technique. There were 40 students in the control group and 29 in the experimental group. The control group used the traditional method of teaching, while the experimental group used the automotive engine electrical system trainer during instruction. Data were analyzed through the use of the arithmetic mean, standard deviation, regression analysis, K-S test and t-test.

The findings revealed that in the performance ratings in the cognitive and psychomotor domains of the two groups, it indicated that the group in the experimental design performed better than the students in the control group. Moreover, it was concluded that the experts' high approval rating on the evaluation of the trainer as an instructional device confirmed that it was effective in teaching the cognitive and psychomotor skills in shop laboratory. It was recommended that academe with the vigorous and sustaining support of the administration can accelerate technological advances through creative, innovative and scientific production of teaching devices which are feasible, affordable and doable. Also, intensify research in the academe to tap the potentials of Filipino ingenuity.

Keyword: automotive, starting, ignition, charging, cognitive, psychomotor

1.INTRODUCTION

The fast pace of the changing needs of the time is undeniably inevitable. One of the common challenges encountered by both students and teachers is the scarcity of shop laboratory that both students and teachers are the scarcity of shop laboratory equipment or customized instructional tools. Previous studies conducted by experts in the field showed that by the use of trainer in the shop laboratory, student's performance notably improved more than by the conventional approach in teaching automotive engine concepts and practices. The researcher felt the need to improvise alternative models to improve instructional effectiveness with the use of an instructional device inspired by the works of other experts in the same field. As cited by Joordens (2000) stated that with the advent of new technology, educational institutions are espousing the increase in the supply of instructional techniques designed to do everything from maximizing the efficiency of traditional educational procedures to the enhancement of the overall educational experiences in hopes of providing new and efficient means of teaching.

In this study, a new instructional model, "The Automotive Engine Electrical Systems Trainer" (AEEST) was devised and subjected effectiveness. It is conceptualized based on the same need; to provide shop laboratory opportunities and increase cognitive and psychomotor skills of the automotive technology students.

The Automotive Engine Electrical System Trainer as a device is a systematically arranged equipment that includes specific features for the students to learn more efficiently. It consists of the starting system, ignition system and charging system like that of the modern vehicle (Francisco, 2006). In terms of cognitive competence of students, the trainer when used as a teaching aid could contribute to a better impact on to the learning effectiveness of students than that of the conventional chalk and blackboard approach to instruction. With this model, the cognitive and the psychomotor development of the automotive technology students would change positively.

However, the DOST-IPO Administrative Order No. 02-2010 or the implementing rules and regulations of Republic Act No. 10055, otherwise known as the "Philippine Technology Transfer Act of 2009, became effective on May 8, 2010. This act fully recognized that science, technology, and innovation are essential for national development and progress. It shall, therefore, give priority to research and development, invention, innovation, and their utilization. It shall also encourage the most comprehensive and most systematic participation of all stakeholders in policy-making related to science and technology, and in the generation, transfer, and utilization of intellectual property, especially for the benefit of the general public

Furthermore, the researcher is optimistic about the impact of the Automotive Engine Electrical Systems Trainer which is beneficial to both the shop teachers or professors and the automotive technology students.

Finally, the trainer could create windows of opportunities to the institution in research and invention and potential institutional research output. The device is an equipment that can used for instructional aid and potential institutional research output.

2. OBJECTIVES

This study generally attempted to develop the automotive engine electrical systems trainer for automotive technology students with the integrated starting, ignition, and charging systems.

Specifically, it sought to answer the following questions:

1. Evaluate the salient features and functionality of the Automotive Engine Electrical Systems Trainer in terms of design construction, component parts, and functionality.
2. Determine the extent of influence of the training device to the achievement performance of the Automotive Technology students in terms of cognitive Competence and psychomotor Skills
3. Determine the significant difference in the achievement performance between the controlled group and the experimental group in the following learning behaviors cognitive competence and psychomotor skills.

3.METHODOLOGY

The study on the development of automotive engine electrical system trainer for automotive technology students at the Zamboanga City State Polytechnic College, is a quasi-experiment design. It utilized the two group pre-test and post-test design. In this research design, the participants grouped into two. All were from the Department of Automotive Technology. They were assigned randomly for the experimental group and the control group. The experimental group (0_1 and 0_2) was taught with the use of the trainer device, while the control group (0_3 and 0_4) taught with the traditional method.

The instrument used in this study was the self-administered questionnaires and check -list type questionnaire. The set of questions was formulated based on the essential features of the trainer that included design construction, component parts, and functionality. The second instrument was the pre-test and post-test, designed to test the cognitive skills of the students with the used of the trainer. The third instrument was designed to test the effectiveness of the trainer as an instructional device for psychomotor skills or hands-on performance

The statistical tools were utilized for analysis and interpretation of data used were, arithmetic mean, and the standard deviation,regression analysis, K-S test and t-test.

4. RESULTS AND DISCUSSIONS

1. Evaluate the salient features and functionality of the Automotive Engine Electrical Systems Trainer in terms of design construction, component parts, and functionality.

5.SALIENT FEATURES

The trainer is composed of heavy-duty structural frame which is made up of angular and flat steel bars. The total height was 74 inches tall, squared table type measured 26 inches in its width and length. The white board frame measured 42 inches. The height from the table measured 32 inches. It was painted with primer and anzhal paint. With regards to the construction process, a time frame for work activities and schedule which included different stages such as planning, estimating , lay-outing , cutting, welding /fabricating , painting, installing and testing/evaluating the component parts of the Automotive Engine Electrical Systems Trainer of the starting systems include battery, battery cables, ignition switch, fuse, starter motor, starter relay, and fusible link. The components of the ignition system, battery, and ignition switch, ignition coil, distributor assembly, condenser, and spark plugs. The charging systems: alternator, voltage regulator, ammeter, and warning light.

Functionality

Table I

Experts' Evaluation on the Design Construction of the Automotive Engine Electrical System Trainer

Design Construction Statements	Mean	Description
1. The Automotive Engine Electrical Systems Trainer is properly mounted and installed.	5.0	Strongly Agree
2. The Automotive Engine Electrical Systems Trainer is easy and safe to operate.	5.0	Strongly Agree
3. It is portable and can be easily moved from one place to another.	4.96	Strongly Agree
4. It uses quality materials for durability and to make it appear neat and presentable.	4.96	Strongly Agree
5. The construction of the Automotive Engine Electrical System Trainer based on automotive electricity.	5.0	Strongly Agree

Table I shows the experts' evaluation of the design construction of the Automotive Engine Electrical Systems Trainer (AEEST). Particularly on the proper mounting and installation; easy and safe to operate; portable and can be easily moved from one place to another; the quality of materials for durability and make it appear neat and presentable. The construction of the AEEST based on automotive activity, which the experts strongly agreed. This indicated that the Design Construction of the AEEST passed the criteria.

Table II

Experts' Evaluation on the Component Parts of the Automotive Engine Electrical System Trainer

Component Parts Statements	Mean	Description
1. The Automotive Engine Electrical System Trainer provides the theoretical and hands-on activities on the automotive electricity.	5.0	Strongly Agree
2. The Automotive Engine Electrical System Trainer shows the different stages of the starting, ignition, and charging system.	5.0	Strongly Agree
3. The Automotive Engine Electrical Systems Trainer can be used for demonstration, checking and testing the starting, ignition, and charging systems.	5.0	Strongly Agree
	4.92	Strongly Agree

4. The Automotive Engine Electrical Systems is properly labeled.	5.0	Strongly Agree
5. The Automotive Engine Electrical Systems Trainer provides the schematic diagram to link the actual component parts in the starting, ignition and charging systems.		

In Table II, the experts' evaluation on the component parts of Automotive Engine Electrical Systems Trainer (AEEST) is reflected. The experts evaluated whether the AEEST provides theoretical and hands-on activities on the automotive electricity; show the different stages of starting, ignition, and charging system; its utility for demonstration, checking and testing in the starting, ignition, and charging system; the AEEST is properly labeled; and, whether it provides the schematic link to actual component parts in the starting, ignition, and charging system. The experts strongly agreed that the component parts of the AEEST serve the purpose for which these are used.

Table III

Experts' Evaluation on the Functionality of the Automotive Engine Electrical System Trainer

Functionality Statements	**Mean**	**Description**
1. The Automotive Engine Electrical System Trainer is functional.	5.0	Strongly Agree
2. The Automotive Engine Electrical System Trainer gives an accurate result.	5.0	Strongly Agree
3. The Automotive Engine Electrical System Trainer demonstrates the concepts and principles of starting, ignition, and charging systems.	5.0	Strongly Agree
4. The Automotive Engine Electrical System Trainer illustrates and demonstrates clearly the functions of actual parts.	4.96	Strongly Agree
5. The Automotive Engine Electrical System Trainer provides the schematic diagram to link the actual component parts in the starting, ignition, and charging systems.	5.0	Strongly Agree

Table III shows the experts evaluation on the functionality of the Automotive Engine Electrical Systems (AEEST). The experts evaluated whether the Trainer (AEEST) is entirely functional; produces accurate result; demonstrates the concepts and principles of starting, ignition, and charging systems; illustrates and demonstrates clearly the functions of actual parts; and provides the diagram to link the real component parts in the starting, ignition, and charging system. The evaluation of the experts expressed in their strong agreement that the AEEST is functional.

To carry out the most accurate statistical procedure to answer the remaining research problems, the researcher checked on several assumptions of parametric data. Since the analysis would involve comparing groups, it was important to look into the distribution in each group. Kolmogorov-Smirnov test was performed to check the normality on the data in the pre-test, post-test and psychomotor test results of the control and experimental groups. All of the data were found to be normally distributed, hence, assumption of parametric data has been met. Thus, independent t-test, a parametric test, was utilized in comparing the differences between the control and experimental groups in each of the test. The degrees of freedom and test statistics are reported in Table IV.

Table IV
Kolmogorov-Smirnov Test for Normality

Variables	Control Group		Experimental Group	
	Df	Test Statistic	Df	Test Statistic
Pre-test	29	.156[ns]	36	.110[ns]
Post-test (Cognitive)	29	.126[ns]	36	.122[ns]
Psychomotor test	29	.123[ns]	36	.128[ns]

ns p > .05; The data is normally distributed.

Table IV shows in this study was experimental in nature, in which the relative effects of two treatments were being compared on the basis of two groups, equated in all relevant aspects. There was a need for the researcher to secure equivalent groups or statistical equivalence before applying the experimental factor to control the varying degrees inherited and acquired characteristics in the members of the two groups. In this experiment, the two groups being compared were equated in terms of pre-test score before the experiment was conducted. The researcher did randomization of subjects to achieve the desired statistical equivalence. After several randomization procedures, the researcher was able to obtain the statistical equivalence through independent t-test. The participants assigned in the experimental group obtained a better mean score ($\bar{x} = 19.14, SD = 4.26$) than the participants assigned in the control group ($\bar{x} = 18.86, SD = 3.22$). However, this difference was not significant, t (63) = - 0.29, p > .05. Hence, the two groups were equivalent prior to the conduct of the experiment.

2. Determine the extent of influence of the training device to the achievement performance of the Automotive Technology students in terms of cognitive Competence and psychomotor Skills

To answer this research problem, a two regression analyses were carried out. First, a regression analysis was carried out in the Social Science for Statistical Package 13 (SPSS 13) trial version where the respondent's group served as the independent variable and their post-test results as the dependent variable. In the two regression analyses, dummy coding was used as a way of representing groups of people using only zeros and ones. The students of the control group served as the baseline group, thus, coded as 0 and the respondents of the experimental group were coded as 1. Then, these dummy variables were placed into the regression analysis. It revealed in the data analysis that by entering dummy variable (Control Group vs. Experimental Group), it can explain 69% of the variance in the change in post-test scores. In other words, 69% of the variance in post-test can be explained by the group where the respondents belong.

Furthermore, the ANOVA tells us that the model is significantly better at predicting the change in post-test scores than having no model, F (1, 64) = 139.44, p< .05. Thus, the 69% of variance that can be explained is a significant amount. As shown in Table V, the B – values tell the change in the outcome due to a unit change in the predictor. In this case, a unit change in the predictor is the change from 0 to 1. This actually represents the difference in the change in post-test scores if a student belongs to the control group, compared to someone who is in the experimental. This difference is the difference between the two group means.

Thus, the mean score of the experimental group is 11.7 greater than the mean score of the control group and this difference is significant, p < .05. This difference is attributed to the training device, since the participants in the experimental group were taught using the training device.

The results are in consistent in Table V, that, by subtracting the mean scores of the experimental and control group, the difference is 11.7 (36.97 – 25.27 = 11.7). Therefore, teaching the students with the trainer as an instructional device is more effective than without the trainer. Students taught with the trainer were able to learn more concepts than the students taught without the trainer.

Table V

Regression Analysis Summary for Dummy Variables for Predicting Post-test scores

	B	SE B	β
Constant	25.27	0.74	
Control vs. Experimental	11.70	0.99	0.83*

Note: R = 0.83, R^2 = 0.69, * $p < .05$

Table VI

Mean and Standard Deviation of the Control and Experimental Groups in Post-test scores

	Control Group	Experimental Group
Mean	25.27	36.97
SD	3.46	4.33

For the second regression analysis, the performance test of the respondents considered as the dependent variable. In the same manner, the students of the control group served as the baseline group, thus, coded as 0 and the respondents of the experimental group coded as 1. Then, these dummy variables placed into the regression analysis. It revealed in the data analysis that the dummy variable (Control Group vs. Experimental Group) shows a significant difference between the change in performance scores for the control group and the experimental group, $p < .05$. Moreover, 25.8% of the variance in the change in post-test scores can explained by the group where the respondents belong. Based on the B – values, the mean score of the experimental group is more significant than 38.21 than the mean score of the control group. This is also consistent to table VI, that, by subtracting the mean scores of the experimental and control groups, the difference is 38.21 (205.92 – 167.71 = 38.21). Therefore, teaching the students with the trainer as an instructional device is more effective than without the trainer. Students showed with the trainer were able to perform the necessary skills more efficiently than without the trainer.

Table VII

Regression Analysis Summary for Dummy Variables for Predicting Performance Test Scores

	B	SE B	B
Constant	167.71	8.97	
Control vs. Experimental	38.21	13.21	0.508*

Note: R = 0.508, R^2 = 0.258, * $p < 0.05$

Table VIII

Mean and Standard Deviation of the Control and Experimental Groups in the Performance Test Scores

	Control Group	Experimental Group
Mean	167.71	205.92
SD	36.72	29.84

3. Determine the significant difference in the achievement performance between the controlled group and the experimental group in the following

learning behaviors cognitive competence and psychomotor skills.

To answer this research problem, independent t-test was used to analyze and interpret the achievement performance between the control and the experimental group in terms of their cognitive competence and psychomotor skills. Their cognitive competence measured in terms of the post-test given to them after the experiment. Independent t-test, a parametric test, was believed to be appropriate since data on these two variables normally distributed. It was found out that the experimental group (Mean = 45.97, SD = 2.77) significantly performed better than the control group (Mean = 28.64, SD = 2.2) in terms of their cognitive competence, $t = -11.08$, $p < 0.05$. Likewise, it was found out that the experimental group (Mean = 205.92, SD = 29.84) significantly performed better than the control group (Mean = 167.71, SD = 36.72) in terms of their psychomotor competence, $t = -54.45$, $p < 0.05$.

These findings are consistent in the results of the research problem number 2. The data provided sufficient evidence that the students can learn more concepts about automotive engine electrical systems trainer and perform better tasks in automotive than the students taught without the trainer.

To cite a few, are the works of Andabon (2005) of his device "Automotive Engine Ignition System Circuit Trainer," and that of Lacson (2007) of his equipment "Hydraulic Brake Master Cylinder Tester and Trainer." Both claimed that by using the trainer in aid of instruction allows the learner to acquire higher cognitive and manipulative skills.

6. POLICY AND IMPLICATIONS

Extension refers to the activities/projects/programs conducted by a faculty which includes technology verification, packaging, managing/facilitating non-formal/non-degree trainings, consultancy and speakership in trainings/seminars/ symposia/ convocations, community development activities, people empowerment/capability building, radio programs, development/ publication/ dissemination of manuals, brochures, pamphlets, leaflets, techno-guide and newsletters. Includes extension activities which are community-based, service oriented (without remunerations) voluntary, not part of the faculty's teaching load and/or activities in line with faculty expertise. (QCE OF NBC NO. 461).

The Zamboanga City State Polytechnic College, as an institution of higher learning is mandated to perform extension, in accordance with the vision, mission, goals and core values of the College.

1. Conduct a school based extension program offered during school days and summers.
2. Responds to actual needs of target beneficiaries through the conduct of research.
3. Extension services intervention shall be offered, first and foremost, shall not be limited to nearby barangays , but as well local, regional, and national level.

The Automotive Engine Electrical Systems Trainer used in the classroom instruction in the Automotive Technology and in the extension service program of the College implemented in school-based extension program and in the different Barangay of Zamboanga City, Bureau of Jail Management Penology , victims of the Zamboanga Siege and collaborative effort with the funding agency International Committee Red Cross. This claimed is supported by Paraguya (2014) conducted a study "Level of Awareness and Participation of the Stakeholders in the implementation of ZCSPC Extension Services' reveals that the level of awareness among stakeholders manifest extremely high. This implicates that the barangay officials are supportive of the activity, which resulted to high positive participation of stakeholders, due to house to house campaign and conducted massive information drive among the members and constituent of the community. It only shows that the operations are carefully planned, implanted and monitored, worthy of emulation to be sample for others to follow, which the present study wishes and endeavor.

7.CONCLUSIONS AND RECOMMENDATIONS

Shop work laboratory instruction can be enhanced and made more effective through the Automotive Engine Electrical System Trainer (AEEST). The Trainer is useful as an instructional device in teaching the starting system, ignition system, and the charging system. The students perform better in the cognitive learning domain when trained using the Trainer than those taught with the traditional method. The students taught with the use of the Trainer performed better in the psychomotor learning skills than those students taught without the use of the trainer as an instructional device. The students must always be motivated and inspired with technology so that they can become productive citizens of society and will be able to pursue research and produce the needed teaching devices, production machines and usable practical inventions with the support of the Academe and the Administration.

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D. Legal Basis

[1] Republic Act No. 10055 "Philippine Technology Transfer Act of 2009 ".