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Innovated Four-Stroke Gasoline Engine Trainer for Grade 12 Senior HS Students

Jefford Vinson E. Valdehueza[1], Troadio M. Barbosa[2]

[1]Chairperson, USTP
[2]Faculty, USTP

ABSTRACT

Constantly, engine before all ages until today has a piston in it. Reciprocating up and down movement of a piston that converted to rotary motion by crankshaft can never be changed. This study facilitated students in developing their understanding of the operation of four-stroke cycle fundamentals using simulated cut-away parts of an engine. The study used descriptive research design. Descriptive statistics were used to describe the students' survey responses. Inferential statistics (one-tailed t-test) was used to establish the difference between post-test and pre-test results of the written examination, simulation and practical examination. The study was conducted to the 24 senior high automotive Grade-12 students of Lapasan National High School-Gusa Annex during the second semester of School Year 2017-2018. As results, the study found a significant difference in the respondents' pre-test and post-test scores. It helps 100% of the respondents' to pass the national certification level-1. Generally, the students can easily perform simple to complicated tasks, they become self-reliant, confident in handling the actual operation of engine servicing given such advantages. A corollary to this, the said innovation considered and re-assessed toward sustained improvement, the researcher should use the results of the study for deeper analysis of issues and concerns on four-stroke cylinder gasoline engine trainer and as a benchmark measure to increase students' academic performance.

Keywords: Automotive Piston Stroke, Instructional Material, Innovated trainer, Experimental research, descriptive design, Senior High School, Philippines

INTRODUCTION

Expanding public transportation and automotive-related services are important in many ways. It provides mobility, shape land use and development patterns, generates jobs and enables economic growth (Weisbrod and Reno, 2009). Consequently, demand for a skilled automotive technician and automotive trainer to accommodate the prospering automotive business and institutions is increasing, but (Afework & Asfaw, 2014) stated that most of the public schools, instructional materials were unavailable, less in quantity and quality that created challenge on teaching and learning activities, which, in turn, had a negative impact on the improvement of the quality of education.

The Government of Malaysia invested to equip student and teachers with the right attitude to ensure a high acceptance of technology use (Wong, Goh, Hanafi, & Osman, 2010) determinant in the successful integration of technology in teaching and learning always relay in their teaching practices (Teo, 2009, Teo & van Schaik, 2009). Therefore, the teacher should make the necessary innovations to become effective.

The teacher should learn to devise their instructional materials to be consistently effective and efficient in delivering both simple and complicated concepts (Earthman, 2002).

Hands-on learning allows students to responsively perceive and recognize what is happening (Esu, Enukoha, and Umoren 2016). It is often hard to properly understand something you have never directly seen or experienced, this is the reason why hands-on learning has become more prevalent in education (Olawale, 2013).

Despite the fact that instructional materials are essential tools that can make learning practical and knowledge acquisition easily, they are not readily available in most of the Public Senior High School leading to the low performance of learners in government examination (Abdu-Raheem & Oluwagbohunmi, 2015).

OBJECTIVES OF THE STUDY

The study proposed to innovate a single cylinder four-stroke engine trainer. It helps Automotive Students in Lapasan National High School-Gusa Annex in understanding the valve train system that supports the operation of an engine. This learning material increase students' skills in adjusting valves on a gasoline engine, effectively illustrate the basic movement of a valve train and understand the principle of a four-stroke engine thoroughly.

On the other hand, this study developed an engine instructional learning material to assist teachers in teaching the automotive course. The output of the study is a prototype learning material that effectively illustrates the actual movement of the piston that synchronized the engine valve movement.

METHODOLOGY

Research Design

The study used descriptive research as the most applicable method as it determined the effectiveness of the instructional material. This research design helps to describe the data and characteristics of what is being studied. Ethridge (2004) stated that descriptive research is conclusive in nature as opposed to exploratory. In addition, Van Dalen (1967) maintained that descriptive research was used when the objective is to provide a systematic description that is factual and accurate as possible.

The design enables the researcher to collect data to assess current practices for improvement. Also, descriptive research is used to obtain information concerning the current status of phenomena to describe what exists with respect to variables or conditions in a situation (Christensen, & James, 2008). Ethridge (2004) stated that survey studies collect data with the intention of determining the relationships existing between specific events or variables. It provides the number of times something occurs otherwise known as frequency, and it lends itself to statistical calculations such as determining the average number of occurrences or central tendency.

Research Site

The study was conducted in Lapasan National High School – Gusa Annex, Cagayan de Oro City, Misamis Oriental. LNHS-Gusa Annex offers Automotive Servicing NC-1, Electrical Installation NC-2 and General Academic Strand (GAS). The school has its own building for the senior high school. Profiling, pretest, activities, simulations, and external evaluation were done in the school.

Participants

The respondents of the study were the 24 grade-12 students enrolled in automotive servicing at LNHS-Gusa Annex during the second semester of School Year 2017-2018. These students voluntarily opted to

choose automotive as their specialization during their first year in senior high.

Instrumentation

A survey questionnaire was administered to the trainees to gather data on their profile, including academic status, program status, and a number of unit loads, family income, and family size.

A researcher-made instrument in written examination format on the test and adjust engine intake and exhaust valve, service crank mechanism, and service engine mechanical valve train had been prepared. The researcher also made activities and simulation assessment. Also, a practical examination that serves as pre-test and post-test was conducted of which results were used by the researcher during the data analysis.

As for the external evaluator, an evaluation sheet was used. Here, the evaluators were required to respond to the 30 items evaluator evaluation sheet. They were asked to indicate the students' performance with yes or no answer.

Data-Gathering Procedure

The data gathering was conducted in the following phases: A letter to the School Head of LNHS – Gusa Annex was sent requesting the school and the grade-12 students to participate in the study. A written letter of consent was requested from the respondents to participate in the study actively. The researcher then conducted the pre-test to determine the skill level of each participant on the test and adjust engine intake and exhaust valve, service crank mechanism, and service engine mechanical valve train. After analyzing their scores, this selected topic has been discussed in simulation using the project; Classroom instruction was integrated with the innovation. After then, they took the post-test and final actual evaluation with the external evaluator. The data were collated, tabulated and analyzed.

Statistical Treatment

Descriptive statistical tools such as frequency, percentages, weighted mean and standard deviation were used to describe the respondents' scores and responses. An inferential statistical tool, the multiple linear regressions, was also used to measure the effectiveness of using the simulator as a pedagogical tool in automotive technology using the pre-test and post-test scores of the respondents. An actual simulation with the trainer accompanied it.

RESULTS AND DISCUSSION

Existing Product Design

This four Stroke single Cylinder gasoline Engine - Section Model displays internal combustion (IC) engine in which the piston completes four separate strokes while turning the crankshaft. The section model is specially designed to demonstrate the actual working of all the components and parts of the engine. Students can see and understand the entire operation of the gasoline engine with this model. The model is specially sectioned in halves for demonstrating the working of a gasoline engine and its components and parts. It is wisely designed in accordance with the original engine so that students can understand and learn the entire operation easily with detailed knowledge.

Innovated Product Design

The study involves the design and development of Four-Stroke Single-Cylinder engine trainer. It is a cutaway model that is carefully sectioned for training purposes, carefully painted with different colors to differentiate the various parts, cross-sections, lubricating circuits, fuel system, and cooling system, among others. Many parts have been lubricated for longer life. It is driven by the functional single cylinder engine to simulate the four-stroke principle in actual original moving parts.

The succeeding table below shows the frequency and percentage distribution, mean, the percentage of correct responses and standard deviation on the respondents' pre-test and post-test written scores in test and adjust engine intake and exhaust valve, service crank mechanism, service engine mechanical valve train.

Table 1.

QUESTION/INDICATOR	Pre-Test		Post-Test	
	mean	S.D	mean	S.D
Test and adjust engine intake and exhaust valve	6.29	1.65	9.83	0.48
Service crank mechanism	5.96	2.96	9.71	0.55
Service engine mechanical valve train	6.13	2.44	9.25	.074

In the pre-test, data shows that the majority (75%) of the respondents' overall written pretest scores range from fair to good. The overall rating is fair (mean=18.38). The standard deviation of 4.93 indicates that the respondents' overall written pre-test scores varied greatly from each other.

These conform clearly to the claim of O'Neill and Oates (2001) in his article, "The Effect of the Pre-Testing on Post-Test Performance", that there is evidence that pre-test can have orienting, motivational and teaching function. There is also evidence that these additional function can be either general or specific among students.

In post-test, data show that 100% of the respondents' overall posttest score was "very good". The overall rating was "very good" (mean=28.79). The standard deviation of 1.02 indicates that the respondents' overall post-test scores still varied from each other.

Based on the data, it is evident that there has been an improvement in their scores from pretest to the training assessment process. Furthermore, the variation of the overall written post-test performance can be attributed to the factors that have affected the respondents' performance while this study was underway. The results have been supported by the study of Fernandez (2010). The construction of the trainer for the lighting system and other related training aid revealed that students could understand and apply their topics and concepts pertinent to the subject area.

The succeeding table below shows the distribution of frequency, percentage, mean, the percentage of correct responses and standard deviation on the respondents' pre-test conducted by the researcher and post-test conducted by external evaluator activities and simulation scores in test and adjust engine intake and exhaust valve, service crank mechanism, service engine mechanical valve train.

Table 2.

QUESTION/INDICATOR	Pre-test		Post-test	
	%	SD	%	SD
Test and adjust engine intake and exhaust valve	9.46	1.44	9.88	0.26
Service crank mechanism	9.00	1.22	9.65	0.59
Service engine mechanical valve train	8.96	1.23	9.61	0.45

In Pre-test, data show that majority (87%) of the respondents' overall activities and simulation score was "very good". The overall rating was "very good" (mean=27.42). The standard deviation of 3.12 indicated that the respondents' overall activities and simulation scores varied greatly from each other.

The overall mean of 27.42 reveals that the average scores of the respondents in the overall activities and simulation score in test and adjust engine intake and exhaust valve, service crank mechanism, service engine mechanical valve train was “very good”. The standard deviation of 3.12 implied that their level of significance varied greatly from each other. This means that though the mean is good, that the responses or scores are not entirely very good.

It was noted that most of the respondents obtained "good" to "very good" rating in test and adjust engine intake and exhaust valve, service crank mechanism, and service engine mechanical valve train. The result shows that there were respondents that were rated "very good". This may be due to some unexplained factors: the respondents have been exposed to before taking the simulation or one particular student was challenged to make improvements to his performance. The significant count of one respondent rated as "fair" may be due to some undefined factors that the students possessed.

Such a result conforms to the claims of Ogbondah (2010) that the use of the different instructional materials designed within the mock-up models is most effective in enhancing students learning. Competencies were all exhibited in the trainer model because the students were able to apply the themes and principle into their hands-on that the different systems of an engine could be simulated smoothly.

In post-test, data show that 100% of the respondents’ overall practical post-test scores were “very good’ as evaluated by the three experts. The overall rating was “very good” (mean=28.14). The standard deviation of 1.03 indicated that the respondents’ overall practical post-test scores as evaluated by the three experts varied from each other.

Additionally, after being exposed to the four-stroke gasoline engine trainer during the processes of this study. The variation of the respondents’ performance implied that majority of them were already skillful; they employed varied techniques in test and adjust engine intake and exhaust valve, service crank mechanism, and service engine mechanical valve train.

The training has been very successful. It resulted to increasing of mean scores, positive increase in terms of frequency. These results conform to the assertion of Olumorin, Yosuf, Ajidagba, and Jekayinfa (2010) that the training simulator was acceptable to enhance the learning process of the students in terms of their capability to perform different critical tasks with the help of an instructional trainer.

Since all the sub-assemblies of the engine were exposed and the interrelation of all the parts was easily seen, The results have been supported by the study of Stephen (2015) the use of the trainer model is recommended to enhance the learning process of the students in terms of their capability to perform test and adjust engine intake and exhaust valve, service crank mechanism, and service engine mechanical valve train.

Table 3. Distribution of the respondents’ written performances in testing and adjusting engine intake and exhaust valve, servicing crank mechanism and servicing engine mechanical valve train.

Category	Written Pre-test	written Post-test	P-value	One tail critical	T-value
Test and adjust engine intake and exhaust valve	6.29	9.83	6.12×10^{-11}	1.703	10.069**
Service crank mechanism	5.96	9.71	2.43×10^{-9}	1.706	8.561**
Test and adjust engine intake and exhaust valve	6.13	9.25	1.02×10^{-6}	1.703	6.012**

The table shows the distribution of the respondents' written performances in test and adjusts engine intake and exhaust valve, service crank mechanism, and service engine mechanical valve train. There were two sets of results have been compared: pre-test and post-test.

The results indicate that the written post-test score is greater than pre-test score (T=10.069**) in test and adjust engine intake and exhaust valve, (T=8.561**) service crank mechanism and (T=6.012**) test and adjust engine intake and exhaust valve. The degree is highly significant; hence, the null hypothesis is rejected.

In addition, the data implies that the students can greatly manifest and attain specific knowledge when they are exposed to different learning simulations. Significantly, this supports the claim of Riveire (2006) that simulations help to enhance learning, memory, and application of knowledge by helping the learners to build, motivate and promote learner engagement and a deeper level of learning.

Table 4. Distribution of statistic (one-tailed T-test) respondents' practical performance in Testing and adjusting engine intake and exhaust valve, Servicing crank mechanism, Servicing engine mechanical valve train when grouped according to pre-test and post-test.

Category	Pre-test simulation	Post-test practical	P-value	One tail critical	T stat
Test and adjust engine intake and exhaust valve	9.46	9.87	0.0466	1.708	1.745*
Service crank mechanism	9.00	9.65	0.0119	1.692	2.370**
Test and adjust engine intake and exhaust valve	8.96	9.61	0.0105	1.699	2.439**

The table shows the distribution of statistics (one-tailed T-test) respondents' practical performance in Test and adjusts engine intake and exhaust valve, Service crank mechanism, Service engine mechanical valve train when grouped according to pre-test simulation and activities and posttest practical. Two groups were being compared: pre-test simulation and activities and posttest practical.

The null hypothesis, posttest practical is lesser than pre-test simulation and activities are rejected. The results indicated that posttest practical is greater than pre-test simulation and activities (T=1.745*) Test and adjusts engine intake and exhaust valve, (T=2.370**) Service crank mechanism and (T=2.349**) Test and adjust engine intake and exhaust valve. And the degree is highly significant in-service crank mechanism and test and adjust engine intake and exhaust valve. The degree is significant in test and adjust engine intake and exhaust valve.

A teacher should know how to devise their instructional material to become effective and efficient in delivering both simple and complicated concept in teaching automotive technology. Students can be less motivated when teacher don't use instructional devices that can facilitate the acquisition of knowledge and skills development of the learner which very important to the educative process.

These findings surprisingly confirmed the claims made by Olawele (2013) that when experiential precede formal instruction, learners are better prepared for formal learning materials and have higher learning gains

Prototype Trainer Model

Figure 9 Prototype of the front view model.

Four Stroke Gasoline Engine specification:

1. 90% made from scrap and indigenize materials
2. Durable and aesthetics
3. Painted for easier illustration
4. Simulation is driven by a functional engine

CONCLUSIONS

All of the respondents had a regular academic status and regular load for a number of major subjects. The majority (96%) of the respondents chose automotive as their first course. In addition, the majority (54%) of them had a family size of one to four members. The majority (75%) of the respondents' overall pre-test scores ranged from fair to good. The overall rating was fair (mean=18.38). The standard deviation of 4.93 indicated that the respondents' overall pre-test scores varied greatly from each other. The majority (87%) of the respondents' overall activities and simulation score was "very good". The overall rating was "very good" (mean=27.42). The standard deviation of 3.12 indicated that the respondents' overall activities and simulation scores varied greatly from each other. One-hundred percent of the respondents' overall post-test score was "very good". The overall rating was "very good" (mean=28.79). The standard deviation of 1.02 indicated that the respondents' overall post-test scores also varied from each other. One-hundred percent of the Respondents' overall practical post-test scores as evaluated by the three experts was "very good". The overall rating was "very good" (mean=28.14). The standard deviation of 1.03 indicated that the respondents' overall practical post-test score as evaluated by the three experts also varied from each

other. There was a highly significant degree of difference between the respondents' pre-test and post-test scores in all areas, at the one-tailed test with 0.05 level of significance. There was a highly significant degree of difference between the respondents' simulation and practical performances in all areas, at a one-tailed test with 0.05 level of significance.

TRANSLATIONAL RESEARCH

The Automotive teachers should adopt the use of four-stroke cycle gasoline engine trainer as it aids their laboratory and classroom instruction in teaching hands-on activity for gasoline engine tune-up on engine valve train adjustment. The students should use and apply their conceptual understanding in gasoline engine tune-up that focused on engine valve train adjustment. Using this four-stroke cycle gasoline engine trainer makes their learning and hands-on demonstration valuable. The administration should increase students' performance and assure them greater chance to pass the assessment. It should provide assistance to teachers who are willing to develop instructional trainers to enhance the teaching-learning process. The industry should use the four-stroke cycle gasoline engine trainer so that a student in Automotive can develop their competence for quality and globally competitive services in their Automotive Company. Other researchers from the similar field should use the results of the study for deeper analysis of issues and concerns on four- to increase students' academic performance.

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