Learning Innovation in Technology: Towards a Training Package for Sustainability Training to Solve the Problems

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บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์ คือ 1) เพื่อหาประสิทธิภาพชุดฝึกอบรมระบบควบคุมการฉีดเชื้อเพลิงดีเซลอิเล็กทรอนิกส์เพื่อส่งเสริมทักษะการแก้ปัญหาของผู้เรียน 2) เพื่อเปรียบเทียบผลสัมฤทธิ์ของผู้เรียนก่อนและหลังการใช้ชุดฝึกอบรม และ 3) เพื่อศึกษาความคิดเห็นของผู้เรียนที่มีต่อชุดฝึกอบรม กลุ่มตัวอย่างที่ใช้ในการวิจัยครั้งนี้ คือ 1) กลุ่มผู้เชี่ยวชาญด้านเนื้อหา และสื่อการเรียนการสอน จำนวน 7 คน และ 2) กลุ่มผู้เรียนซึ่งเป็นนักศึกษาภาควิชาครุศาสตร์เครื่องกล คณะครุศาสตร์อุตสาหกรรมและเทคโนโลยี มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี ชั้นปีที่ 3 ภาคเรียนที่ 1 ปีการศึกษา 2551 โดยการสุ่มอย่างง่าย จำนวน 30 คน ระเบียบวิธีการวิจัยที่ใช้คือ การวิจัยเชิงกึ่งทดลองรูปแบบกลุ่มเดียวทดสอบก่อนหลัง เครื่องมือที่ใช้ในการวิจัยประกอบด้วยชุดฝึกอบรม แบบทดสอบวัดผลสัมฤทธิ์ทางการเรียน และแบบสอบถามความคิดเห็น สถิติที่ใช้ในการวิเคราะห์ข้อมูล ประกอบด้วย ค่าเฉลี่ย ส่วนเบี่ยงเบนมาตรฐาน การแจกแจงที ผลการวิจัยพบว่า 1) ประสิทธิภาพชุดฝึกอบรมระบบควบคุมการฉีดเชื้อเพลิงดีเซลอิเล็กทรอนิกส์ สำหรับโมดูลที่ 1 มีประสิทธิภาพ 91.07/83.69 โมดูลที่ 2 มีประสิทธิภาพ 89.55/85.14 และโมดูลที่ 3 มีประสิทธิภาพ 87.49/80.36 ซึ่งสูงกว่าเกณฑ์ 80/80 ที่กำหนดไว้ 2) ผลสัมฤทธิ์ทางการเรียนของผู้เรียนหลังศึกษาด้วยชุดฝึกอบรมสูงกว่าก่อนศึกษาด้วยชุดฝึกอรมอย่างมีนัยสำคัญทางสถิติที่ระดับ .01 และ 3) ผู้เรียนมีความคิดเห็นต่อชุดฝึกอบรมต่อชุดฝึกอบรมอยู่ในระดับดีมาก

คำสำคัญ: ชุดฝึกอบรม ระบบควบคุมการฉีดเชื้อเพลิงดีเซลอิเล็กทรอนิกส์ นวัตกรรมการเรียนรู้ทางเทคโนโลยี ทักษะการแก้ปัญหา

Abstract

The objectives of this research were: 1) to determine the efficiency of diesel electronic fuel injection control system training package for enhancing students problem-solving skills; 2) to compare the students' learning achievement scores regarding the pre-test and post-test; and 3) to survey the students' opinion towards a training package. This research had been revised by two group experts' who consisted of three experts' in the automotive technology content area, and four experts' in the instructional package design. Sampling group was thirty randomly chose on the third year students of Mechanical Technology Education program at King Mongkut's University of Technology Thonburi, selected by simple random sampling. The experimental was employed in the

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Received 5 June 2009; Accepted 19 August 2009

academic year 1/2008. The quasi-experimental research was employed in this study. The research design was conducted to one group pre-test and post-test design. The instruments were the training package, the students' achievement test and a questionnaire towards a training package. Data were analyzed by means, standard deviation, and t-test dependent. The research results reveal as follows:

1. The efficiency of diesel electronic fuel injection control system training package was 91.07/83.69, 89.55/85.14, and 87.49/80.36, which were higher than the selected efficiency standard criteria 80/80.

2. The students' learning achievement scores of the post-test was higher than the pretest significantly different at .01 level.

3. The students' opinion towards a training package was at the best level.

Keywords: Training Package, Diesel Electronic Fuel Injection Control System, Learning Innovation in Technology, Problem Solving Skills,

1. Introduction

The automotive industry is experiencing an "electronic revolution." Electrical and electronic devices are now being used in almost every major system of the car. Computers are commonplace and are being used to monitors and control almost all critical assemblies. The computer can be tied to the engine, fuel system, ignition system, emission systems, brakes, suspension, transmission, and many other systems. This can make electrical diagnosis and repair very challenging [1]. The diesel electronic fuel injection control system increases have involved from simple mechanical repairs to high-level technology-related work. The increasing sophistication of automotive engine subject area requires students who can use computerized shop equipment and work with high-end electronic components while servicing their skills with specific tools. Recently, the diesel engine has integrated electronic control systems and complex computer manipulatively and their performance while on the road. Students must have an increasingly broad knowledge of how engine operates' complex components work and interact [2]. Effective education is active and interactive rather than passive and isolating [3]. Its reasonable application can make teaching more diversified, flexible, and effective [4].

The Mechanical Technology Education (MTE) Program at King Mongkut's University of Technology Thonburi continues as a field of theory and practice on automotive technology course. The essential of effective teaching method has emphasized the holistic of learning. In automotive technology course, they have proposed to learning effectively with make them understand the systems, components, and causes. Several cases have demonstrated our effective learning to improve the student's thinking level [5], facilitate problem-solving [6], and offer learning tools which can develop student's competencies. Hence, it is important to study on automotive technology area. On the other hand, the increasing sophistication of automotive subject area requires students who can repair and diagnosis with high performance while servicing their skills common problem-solving skills.

The objectives of this research were: 1) to

determine the efficiency of diesel electronic fuel injection control system training package for enhancing students problem-solving skills; 2) to compare the students' learning achievement scores regarding the pretest and posttest; and 3) to survey the students' opinion towards a training package.

The key questions were raised: How is the effectiveness of a training package affect to learning achievement between formative scores and summative scores? and How do students opinion after learning with a training package? The research hypotheses were as follows: 1) The efficiency of diesel electronic fuel injection control system training package is higher than the selected efficiency standard criterion 80/80; 2) The students' learning achievement scores of the post-test are required to be higher than the pre-test significantly difference at .01 level; and 3) The students' opinion on a training package is at the good level.

2. Theoretical Framework

A study on the effectiveness is the most important for other educators have increasingly been urged to adopt a variety of constructivist approaches in order to facilitate student-centered learning environments [7], [8]. A particular emphasis of this movement has shifted the focus from teacher to learner, inviting learners to take active roles in their learning [9], [10]. Among various constructivist approaches, Problem-based learning (PBL) has been advocated as an exemplar because it promotes students' understanding, integration, and retention of concepts, facts, and skills [11], [12].

A PBL approach is based on the use of ill-structured problem situations that are complex, requiring students to develop expertise in information seeking and making decision to solve the problem. Because the problem situations are messy, confusing, and complex, students need to gather information in order understand, define, and solve the problems. During an authentic problem solving process, students are able to develop their own approaches and set their own goals. Under the guidance and coaching of a skillful teacher, students work collaboratively to inquire, investigate, and plan their activities [13].

According to Margaret [14], the development of practitioner skills in real-world settings is a major issue. In-course projects, however, offer limited exposure to the complex evaluator role and also present logistical problems. After reviewing selected alternative ways to offer real-world experiences, this paper describes the directed evaluation experience, in which students and a professor are involved in short-term contracted evaluations separate from academic course-work. Lewis [15] listed a number of barriers to effective professional development including opportunities to practice, access to outside resources and expertise, and support from the community, and emphasized the importance of having on-site assistance and support while teachers attempt to develop and implement new instructional practices.

Sage [13] contended that a PBL approach was an effective way to integrate technology into the classroom. She defined PBL as "experiential learning, organized around the investigation and resolution of messy, real-world problems" (p.7). Also, Hill [16] suggested that teacher technology development can be based on the same problem-centered methods that are suggested for students in problem-based learning.

3. Conceptual Framework

In cognitivism acquisition of knowledge and internal structured are stressed. Constructivists emphasized the experience for solving the problem. The real-world problem is exclusively referenced to the task perform whereas, in constructivism issue reshapes the real world experiences and create a unique individualized reality.

In design, a problem is any situation where you have an opportunity to make a difference, to make things better. Whenever you are thinking creatively and critically about ways to increase the quality of life (or to avoid a decrease in quality), you are actively involved in problem solving. Although the term "design" is used most often in art (for graphic design) and engineering, the process of design occurs in the diesel electronic fuel injection control system. Researcher creative/critical process is summarized in a brief 5-step with Jonassen model [17]. This concept was conducted into 5 categories:

1. Formulate the problem – define the real problem to be solved;

2. Problem-situation-topic situations – describe the problem in detail. Examine what is known and what is to be achieved;

3. Explore on the appropriate solution – develop a list of alternative;

4. Decide on the appropriate outcomes – evaluate all alternative for best solution;

5. Specify the solution – document the solution.

According to Sudsomboon [18], suggested that the term of in order to gain a better understanding of the learning achievement, the researcher took the opportunity of teaching an automotive scan tools on problem solving at the Department of Mechanical Technology Education, Faculty of Industrial Education and Technology, King Mongkut's University of Technology Thonburi was conducted the present study. They needed to explore the effective automotive technology training material package encourage students to be productive, innovative and enterprising. This involves generating ideas and taking action, as well as developing techniques and problem solving skills that satisfy student needs. Moreover, students must learn about materials, information and systems and the processes by which they are employed. They consider the resources, equipment and techniques that are relevant to the context in which they are working. Students examine the context of a task or activity to determine needs and opportunities and to relate what is known to what might be done.

4. Research Methods

4.1 Research Design

The one group pre-test and post-test design was employed in this experiment show in Figure 1 [19].

The treatment effect also was t-test dependent. This means subject are randomly assigned to a group, which is then given a pre-test, then there is a treatment, then there is a post-test.

4.2 Participants

All participants in this study were undergraduate students from mechanical technology

Group	Pre-test scores	Treatment	Post-test scores
Experiment group	O_1	X	O_2

Figure 1 Research Design.

education program at King Mongkut's University of Technology Thonburi. The 30 participants was the third year students who were have not been studied in the electronic fuel injection control systems. Researcher was conducted during the 1/2008 academic year, and selected by simple random sampling.

4.3 Research Scope

In this research study, a training package consisted of 3 modules as follows: 1) Fuel delivery system; 2) Air induction system; and 3) Electronic control system.

4.4 Training Materials

Training materials have the following: 1) Training manual; 2) the diesel electronic fuel injection control system training package; 3) text book and information sheet; and 4) operation sheet. In term of the demonstratation engine set, researcher was designed and implemented by Toyota diesel engine that had the important specification, such as Engine Model: 1 KZ-TE, Capacity: 4 stroke with in-line, 3.0 Litre, and Water cooling system.

4.5 Instruments

As instruments, the training measurement and evaluation achievement test and a questionnaire were used in the study. The instruments have involved from 3 experts in the field of automotive technology education, 2 experts in the field of instructional technology, and 2 experts in measurement and evaluation were consulted during designing instruments. The unit achievement test was developed by the researcher. The test items were composed of 60 multiple-choice. The learning strategy focused on symptoms diagnosis of diesel electronic fuel injection control system. It can be separated to solve the problems; students' have selected analyze a situation by identifying, testing, inspecting the problem towards well-structured problems or ill-structured problem.

Firstly, a pilot test with 140 items was prepared consulting on the experts. The pilot test was applied to 30 students who had taken this course before. After that, the items were done by the internal consistently method. Then, researchers were identified the difficulty of the test items with 60 items was prepared. It was established that the whole items difficulty level (between 0.36 and 0.74) and discrimination index (between 0.21 and 0.38) were within acceptable range of 0.3-0.7 and 0.2-0.5 respectively [18]. The piloting of these instruments yielded reliability coefficients of 0.66, 0.62, and 0.69 respectively using KR-20 formula. These indicate that the entire dependent was validity and reliability coefficients obtained were higher than the recommended level [20].

Secondly, a Likert's rating scale with 12 items (4 aspects) was developed by the researchers. The items was rated on a five point rating scale from (5) the best to (1) the worst. The pilot form of the attitude scale with 20 items was applied to 30 students, reliability coefficients of 0.92, 0.89, 0.88, and 0.90 respectively using Cronbach's Alpha Coefficient [20]-[22].

4.6 Procedure

Researcher was applied Jonassen model [17] for conducting into 12 procedures as follows:

4.6.1 Students were matched by conducting a pre-test.

4.6.2 A pre-test for each module was structured and administered before training.

4.6.3 Each module was taught through a training package.

4.6.4 Introduction of the problem situation: Ill-structured problems were clarified by training instructors.

4.6.5 Expectation from the group members: students were matched with the group members, and then they were defined to analyze the problem occur as follow as training materials.

4.6.6 Opinions about the problem: Each group member generated their ideas about causes and reflected on their peers' opinions through the training package.

4.6.7 Prior knowledge about the problem: Group members performed and explored their prior knowledge on the problem.

4.6.8 Required information to solve the problem: Group member determined and discussed upon text book and information sheet and operation sheet. There were the type and extend of information necessary to defined the solution to solve the problem.

4.6.9 Determining plans: Each group member determined an individual study plan addressing the problem solution and reflected on their peers' plans.

4.6.10 Solution process: Using their resources and discussing with group members and the training instructors, each member proposed and performed the solution on the training package.

4.6.11 Evaluation: Each group member reflected on their peers' action into operation sheet step by step. Therefore, they needed the collect data and the analyze data to the solution were completely in each module.

4.6.12 A criterion test for the whole content was administered after training.

4.6.13 Suitable statistical techniques were employed to analyze the data collected.

4.7 Evaluation of Problem Solving Skills

The problem solving skills achievement test was developed by the researchers. The achievement test was evaluated by percentage. The learning strategy focused on symptoms diagnosis of diesel electronic fuel injection control system. It can be separated to solve the problems; students' have selected analyze a situation by identifying, testing, inspecting the problem towards well-structured problems or ill-structured problems.

In practical strategies, researcher can be designed by identify the relevant problem-solving environment that would allow situations to be recall in the experiment. Choose from among the following indexes, most of which are suggested by Kolodner [23]:

4.7.1 Analysis of the Problem-situation-topic situations

1) What are the goals-sub goals-intensions to be achieved in solving the problem or explaining the situation?

2) What constraints affect this goal?

3) Which features of the problem situation are the most important and what is the relationship between its parts?

4) What plans are develop for accomplishing the goal?

4.7.2 Explore on the appropriate solution

1) What solution is use?

2) What activities are involved in accomplishing the solution?

3) What is the reasoning steps used to derive the solution?

4) How do you justify the solution?

5) What expectations do you have about results?

6) What acceptable, alternative solutions, is suggest but not choose?

7) What unacceptable, alternative solutions, is not choose?

4.7.3 Decide on the appropriate outcomes

1) Is the outcome fulfilling?

2) Are expectations violating?

3) Is the solution a success or failure?

4) Can you explain why any failures occur?

5) What can you do to avoid the problem?

In practical term, the criteria on evaluation of problem solving skills were separated by pass and not pass. The criteria was passed >70% and <70% not passed [2]. Training materials were used in the assessment tools. The criteria of problem solving skills achievement test conducted the step by step based on operation sheet. Students can be provided in 3 groups for selecting on the individual aptitudes (10 participants per group selected by simple random sampling); furthermore, fuel delivery system, air induction system, and electronic control system. Researcher has assigned the sample of one problem on practical process as active knowledge acquisition. Students actively process analysis of the problem-situation-topic situations, explore on the appropriate solution, and decide on the appropriate outcomes.

4.8 Quality Assessment

The quality assessment in this study was divided into on content analysis consisted of 3 aspects as follows: 1) Content; 2) Items; and 3) training package design. The result of 5 experts' was mean at 4.70 which were at the highest level.

4.9 Data Collection

In this research study, researcher conducted the experiment of the training package as follows: 1) This study involved into 3 modules and post-test; 2) Conducting the experiment was existing problem-solving training program, 3) Find out the efficiency of training package by implementing pre-test and post-test; and 4) students' opinion do collected through a questionnaire. The pre-test and post-test and questionnaire were designed to assess the impact of the training package on diesel electronic fuel injection control system. It also was assumed that integration of modules is crucial to the Mechanical Technology Education Program at King Mongkut's University of Technology Thonburi. The experimental was employed in the academic year 1/2008, which has been undertaken on MTE 373 Automotive Technology III session subject on 6 hours for two days.

4.10 Data Analysis

The data analysis was scores, percentages, mean standard deviation. The t-test dependent used for calculate the significance of differences between the groups [19]. The effectiveness of a training package presented a p-value of less than .01 was considered statistical significance difference. All the analysis was done by using the Statistical Package for Social Sciences (SPSS) computer program.

5. Results and Discussion

Toward the end of the study, 30 students completed an experimental designed to source data

on students' learning achievement and students' opinion toward a training package on the diesel electronic fuel injection control system. The pre-test and post-test were 30 multiple choices and 4 chosen. A questionnaire comprised two components; the first one focused on the specific aspects of the general issues and the students' overall perceived effectiveness; and the second part focused on the whole of a training package.

The efficiency of diesel electronic fuel injection control system training package was 91.07/83.69, 89.55/85.14, and 87.49/80.36, which were higher than the selected efficiency standard criteria 80/80 as shown in Table 1.

Table 1 The efficiency of diesel electronic fuel injection control system training package of each module

Module	n	E1	E2	E1/E2
1	30	91.07	83.69	91.07/83.69
2	30	89.55	85.14	89.55/85.14
3	30	87.49	80.36	87.49/80.36

Students were passed on the overall of problem solving skills achievement test as shown in Table 2.

Table 2 Evaluation of Problem solving skills

Descriptions	Group 1 Fuel delivery system (n = 10)	Group 2 Air induction system (n = 10)	Group 3 Electronic control system (n = 10)
1. Analysis of the Problem-situation- topic situations	82%	77%	74%
2. Explore on the appropriate solution	79%	83%	72%
3. Decide on the appropriate outcomes	80%	78%	74%

Table 3 Summative scores and the efficiency of each module

Effectiveness	n	Mean	Standard deviation	*t*
Pre-test	30	14.13	5.47	11.603**
Post-test	30	23.56	2.88	

** p<.01

The results in Table 3, reveals that there is significant difference between the scores of the participants in pre-test and post-test. The calculated $t = 11.603$ is more than the critical value, $t = 2.462$. The students' opinion showed that an average value of 4.60 which was at the best level as shown in Table 4.

Table 4 Students' opinion towards a training package

Item	Mean	Standard deviation	Level
1. Applications	4.54	0.66	best
2.Knowledge Acquisition	4.83	0.51	best
3. Simulation	4.37	0.79	good
4. Problem-solving skills	4.65	0.69	best
Average	4.60	0.66	best

6. Conclusion

The study focused on the students' learning achievement upon of the diesel electronic fuel injection control system training package. As a result, this research finding was that the training package contains of three modules. It was divided into three categories: 1) Fuel delivery system; 2) Air induction system; and 3) Electronic control system. The supplementary presentation composed of learning activities, exercises, summary and pre-test and post-test. Students' can be solved the problems by retrieving experiences with a training material

package. In the form, of modules and applying the lessons learned from those procedures that shown in student manual for performing to the new problems. Candidate new problem-solving skills have the following characteristics: they:

6.1 Represent specific knowledge tied to a context.

6.2 May cover small or large chunks of time.

6.3 Record experiences that are different from what was expected.

6.4 Process useful lessons that helped the problem solver achieve some goal or that warn of potential failure.

The effectiveness of diesel electronic fuel injection control system training package can reduce cost and time. Students can solve the problems within self-efficacy and real-time underpin knowledge acquisition. They were finding out any suggestion that affect to engine performance. Moreover, the training material package has retrieved new competencies in the holistic. The researcher satisfaction divided much more factors to promote learning with experiences (real-time, current data, and accuracy). The thinking skills of students were challenging to study, and then attitudes and perceptions are more important than teaching methods. If they can learn with technology, they will succeed on the problem-solving. This research were tried to shift paradigm about learning to change, learning to building capability of them. In achievement testing, which is consisted of pre-test and post-test of each unit before and after learning, there was a sampling test which done according to objective of each learning unit and evaluate learning according to each test item objective. Test score will be notified immediately.

The results of this study is appropriateness and able to offer a training program in diesel electronic fuel injection control system. The characteristics of effective training were mean at high level in each theme. The future research should be integrated multimedia representation and embedded the computer simulation into the training package that had a better approach than do other representations [24]-[26]. Hence, researchers can find a challenge, particularly in the implementation of higher education instructions. This study showed a need for professional development in automotive technology area for adapting in higher education as well.

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