Enhancing Pre-service Vocational Education Teachers' Professional Development: An Examination of Automotive Mechatronic Systems on Crucial Factors

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Abstract

Current studies on higher education have proposed on study to create innovation in student teachers' professional developments. However, in the field of automotive mechatronic systems, there is no a paper of presentation regarding the factors in student vocational education teacher's professional development. The purpose of this study was to examine the influences of the task autonomy (TA), troubleshooting learning environment (TLE), and outcome expectation (OE) on innovation of professional development (IOPD). This study conducted the practical task test on automotive mechatronic systems with 132 Undergraduate Mechanical Technology Education Students at King Mongkut's University of Technology Thonburi. Finding revealed that TA and OE of a Pre-service Vocational Education Teacher's (PVET) professional development showed significant positive relationships with the degree of IOPD into their crucial factors. These predictors were 32.10 percents of IOPD. The predictors equation is stated at .01 level were as follows: 1) The standard scores showed that $IOPD_1 = .871\ TA - .153\ TLE + .591\ OE$; and 2) As well as, the raw scores showed that $IOPD_2 = 6.451 + .383\ TA - .576\ TLE + .422\ OE$.

Keywords: *Task autonomy, Troubleshooting learning environment, Outcome expectation, Innovation of Professional development*

1. Introduction

A country's national competitiveness is contingent upon the quality of its education system. The main issue for learning management system of the Department of Mechanical Technology Education (MTE), Faculty of Industrial Education and Technology (FIET) at King Mongkut's University of Technology Thonburi (KMUTT) is arguably the develop most important factor of students' that affects its education quality. In dealing with national competitiveness, the Ministry of Education of Thailand amended the Thai National Education Act of B.E. 2542 (1999). The declaration of its to promote the combinations of learning innovation, diffusion, and application are critical concepts in the era of knowledge-based economy (Office of the Education Council, 2010).

In contemporary times, current studies on higher education have proposed on study to create innovation in student teachers' professional developments, which summarizes the learning environment of the teachers' workplace experience and the construction of substitute instructional strategies that enhance the students to gain reflective, self-directed learning, and

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critical learning skills. However, in the field of automotive mechatronic systems, there is no a paper of presentation regarding the factors in student vocational education teacher's professional development. A Pre-service Vocational Education Teacher's (PVET) professional development refers to the renewable, improvement, and extension of their knowledge and skills (Association for Career and Technical Education, 2010; Camp & Health-Camp, 2007; Kyriakides, Creemers, & Antoniou, 2009).

In statement of problems, the MTE student teachers' professional developments explores an area of excellence fields in diverse subject areas, which the automotive mechatronic systems is only concerned about these global trends. The several of system is a good example of a mechatronic system and can be noted by the complexity of operation, consisting of a large number of sensors and actuators under computer control (Kiencke & Nielsen, 2004) as shown in Figure 1. Sudsomboon, Wongrod, and Injun (2008) explored that the advances in Automotive Mechatronics System (AMS) increase the need for highly skilled technicians capable of practice these control systems. Then, the FIET at KMUTT converges to establish the highly training instructors that support into the vocational and technical education area and industrial requirements.

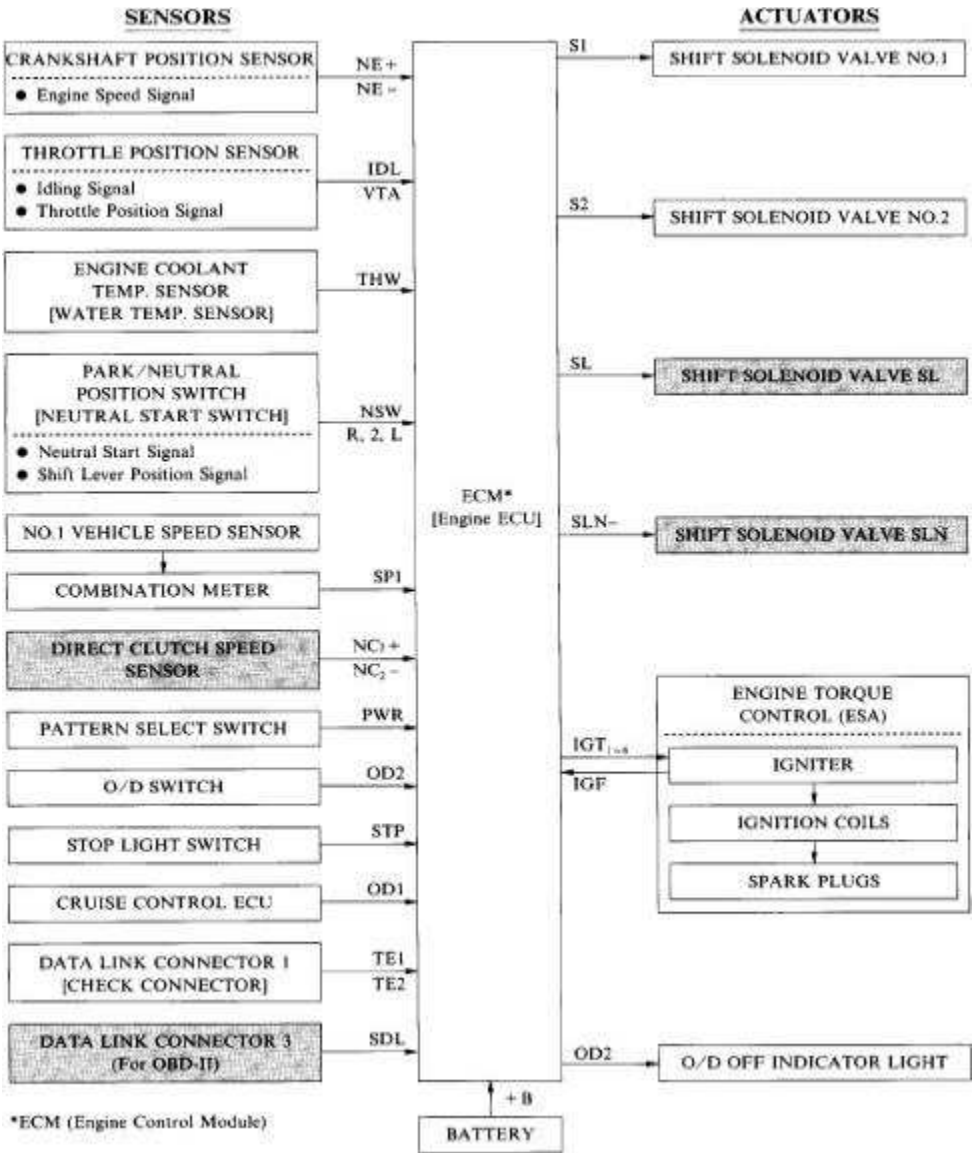

Figure 1 The components of sensors, engine control module, and actuators in the AMS
According to pass studies, Sudsomboon and Hemwat (2011) tested knowledge states and procedural demonstration effects of self-efficacy beliefs and metacognitive prompting on solving electronic fuel injection control system problems while controlling for problem-solving activity involved with ill-structured problems. They found that self-efficacy and metacognitive prompting increased problem-solving performance and efficiency separately through professional practice and strategic knowledge. Its challenges to develop the PVET professional development to search somewhat based on the PVET demands group behaviour task autonomy (TA), troubleshooting learning environment (TLE), and outcome expectation (OE) on innovation of professional development (IOPD).

This study probes into the relationships between innovation and professional development, in order to determine if these factors can enhance both innovation and the theoretical base of key factors. Recently, the study on TA is positively related to the perceived contribution of ability to emerge innovation (Molleman &Van den Beukel, 2007). TLE capability is supported conceptual development of device knowledge and support the construction of a mental space (Jonassen & Hung, 2006). OE capability is considered an essential issue of an organization's effectiveness, and its potential renovate and grow (Chiva & Alegre, 2009).

Additionally, will these factors strengthen the PVET for professional development confirm IOPD? This is a new paradigm of presentation regarding the factors in student vocational education teacher’s professional development. Moreover, students' gain insight the area of excellence can be used as motivation to foster competence in the learning competency of the FIET, KMUTT. The well-qualified PVET should be continuously developed technical and professional updates through the workplace learning environment (Camp & Health-Camp, 2007). The outcome is a suggestion regarding the factors that enhance innovation in the PVET professional developments.

2. Purpose

The purpose of this study was to examine the influences of the task autonomy (TA), troubleshooting learning environment (TLE), and outcome expectation (OE) on innovation of professional development (IOPD).

3. Background

Based on the purpose above, this study covers into literatures related to the IOPD in order to test concepts as the criteria for instrument development and data analysis have the following:

3.1 Relationship between TA and IOPD

TA have demonstrated, using a creativity theory, the main finding of TA was generating incremental innovations and radical innovations (Beugelsdijk, 2008), as well as in the relationship between worker flexibility in team-based work and its perceived contribution to innovation, and the moderating role of TA. It demonstrated a certain between TA and innovation.

Hypothesis 1: The task autonomy can be positively predicted their innovation of professional development.

3.2 Relationship between TLE and IOPD

TLE described the necessary competences of competency-based learning and performance support systems for learning to troubleshoot. TLE model assumes that the most effective way to learn to troubleshoot is by solving troubleshooting problems. Learning-to-troubleshoot problems present learners with the symptoms and state of novel problems and require learners to solve them using a simulator. However, successful troubleshooting cannot be learned without adequate system knowledge (Jonassen & Hung, 2006). A multi-layers conceptual model of the AMS was tied to the simulator that any typographic, functional, procedural, or strategic-based diagnosis was available immediately while using the simulator. Therefore, TLE should be the base of the PVET, which a hypothesis is generated as follows:

Hypothesis 2: The troubleshooting learning environment can be positively predicted their innovation of professional development.

3.3 Relationship between OE and IOPD

The theories related to the teachers' learning are essential for promoting the teachers' professional development. The innovation is the result of outcome expectation and the information of students knowledge. While innovation may result from alliance learning, it can also be improved by combining the knowledge-based and generating into the learning outcomes (Neilsen & Neilsen, 2009). Thus, the strategic factors will enhance OE and continuously improve students' performance.

Hypothesis 3: The outcome expectation can be positively predicted their innovation of professional development

3.4 IOPD

Based on all above, the IOPD played continuously learn, update, improve, enhance, and develop in the professional transformation, upon knowledge-based and innovations regardless the professional and performance. The determine in effectiveness and efficiency of learning have obtained effects of the students and the university.

4. Methods

4.1 Conceptual framework

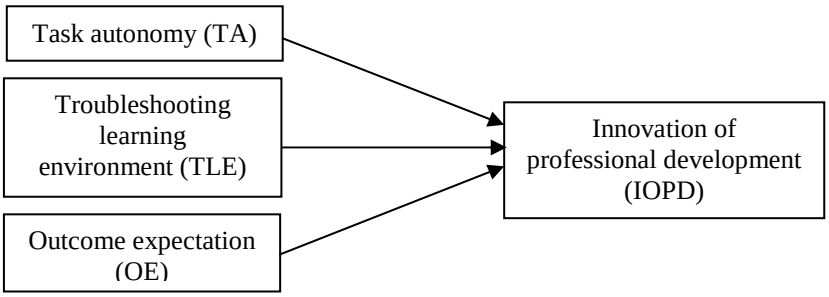

Figure 1 Conceptual Framework

Figure 1 showed that the TA, TLE, and OE are independent variables, and the dependent variable is the IOPD.

4.2 Participants

This study conducted the practical task test on automotive mechatronic systems with 132 Undergraduate MTE Students at KMUTT in the semester 2/2011. The participants were the full-time students attended in IDT 231 Introduction to Automotive Technology, MTE 272 Automotive Technology II, and MTE 373 Automotive Technology III.

4.3 Instruments

The assessment performance skills used a Likert's Rating Scales measurement to evaluate 40 questions on TA, TLE, OE, and IOPD. The scale designed from 5, "Strongly practicum," to 1, "Less practicum." The participants were asked involving learnt in the workshop. The instruments have conducted from the ASE Certification-Type Assessments (National Institute of Automotive Service Excellence, 2011), and then translate in Thai version. It was standardization assessment form, researcher allowed to ensure the form was validity and reliability as shown in Appendix 1. The only 10 questions were included in the final evaluation form. After that three factor analyzes of "TA, TLE, and OE", 30 questions were answered into "Introduction to Automotive Mechatronics System" as shown in Figure 1, which provided namely, location, and simple functional on the AMS in automobile, respectively.

4.4 Data collection

Researchers tested on the current situation while students' practicum, as well as the real-world applications. Somewhat the pilot case took place to check students performance "What if the burnt have effected on the gasoline EFI system?" - *preview the logics - problems - causes - solutions*. They viewed included the test time in the incremental innovations to think aloud, selected topographic, function, strategic, and procedural demonstrations. As a simulator, researchers encouraged the learner to generate hypotheses, reconcile the system mode, test the hypotheses, and interpret the results from the test was based on the training materials.

4.5 Data analysis

Data were analyzed by the descriptive statistics: Pearson Product-Moment Correlation, and Multiple Stepwise Regression Analysis.

5. Results and Discussions

Table 1 Results of the mean of the variables

Variables	Mean	SD	CV
TA	3.683	1.337	27.623
TLE	3.264	3.624	34.891
OE	4.427	1.352	16.953
IOPD	3.512	2.394	20.037

In Table 1, the coefficient of variance found that TLE was highly scores and OE was less scores, respectively.

Table 2 Correlation matrix of the variables

Variables	IOPD	TA	TLE

TA	.325**	1.000	-
TLE	.113**	.403**	1.000
OE	.519**	.390**	.653**

*Note. **p < .01*

The results of the Pearson Product-Moment Correlation showed in Table 2. The reveal found that the all variable were a statistically significant positive correlation with IOPD at .01 level. The variables have determined with Multiple Stepwise Regression Analysis, OE is the most significance predictor of IOPD variable. The results related Henze, Van Dreil, & Verloop, (2009) explored the changed competences are extremely important for the teachers' learning.

Table 3 Prediction analysis of the variables with Multiple Stepwise Regression Analysis

Predictors	**R**	***F* value**
TA	.540	88.366**
TA TLE	.311	105.593**
TA TLE OE	.345	62.760**

*Note. **p < .01*

In Table 3, *F* value was a statistically significant at .01 level of the predictors. Thus, the predictors employed in IOPD as well.

Table 4 Analysis of the predictors

Predictors	**b**	**S.E.$_b$**	**β**	**t**
(Constant)	6.451	2.847		3.778***
TA	.383	.032	.871	7.162***
TLE	-.576	.519	-.153	2.365***
OE	.422	.065	.591	6.857***
	R = .525	R^2 = .321		
	S.E.$_{est}$ = ± 4.056	a = 6.811		

*Note. **p < .01 ***p < .001*

In Table 4, the predictors was TA and OE positive, and TLE was only negative respectively. The Multiple Stepwise Regression Analysis showed the IOPD gained 32.10% and standard error was ± 4.056, which showed the predictors form of standard scores as follow as:

$$IOPD_1 = .871\ TA - .153\ TLE + .591\ OE$$

The predictor equation showed the raw scores as follow as:

$$IOPD_2 = 6.451 + .383\ TA - .576\ TLE + .422\ OE$$

6. Conclusions

The research results develop that PVET professional development TA and OE reveal to high degree. The PVET TA and OE revealed positive relationships with IOPD, and then TA and OE show positive prediction for IOPD. As a result, students' that participate in learning innovations indicate both individual and gainful competences. The positive relationship between OE and IOPD is the most significant. Second place refers to OE is relatively is relatively significant.

IOPD was classified with regard to effective prediction, which TA and OE could positively predict innovations in this study. The TLE was negatively, because of students' have not been experiencing into the performance skills. TLE was troubleshooting form that combined of problem solving skills, professional, diagnose faulty systems and take action in order to return the systems and components (Beugelsdijk, 2008) . Hence, TA is the new paradigm of the design of architecture instruction, students' achievements are emphasize integrated experiential, knowledge domain, and device knowledge in a learning system. OE enables leaner have to generate and test hypotheses for procedure, and they are conducted a conceptual model of the system (Neilsen & Neilsen, 2009). For instance, the EFI system looked to design the systematic approach as well as the typology to suggest as Fuel delivery system; Air induction system; and electronic control systems.

The students' satisfaction were collected by interviews. They have briefed in order to gain learning achievement in IOPD. Mr. S suggested "In this course, I have to train knowing the present state of AMS because my skill always adapts from novel practitioners' to professional. Although I may have gain continuous improvement, I must practice often, and then I will experience self-directed learning and a wholesome state of competences....." Miss A recommended "In the first time, I have asked a question in mind...why do we have to practice on IOPD? Finally, it is because MTE think aloud - about traditional methods that lack to gain the competency under the new challenge of AMS. So, I am practicing the AMS guidance upon the IOPD instructors supported. It is the greater our intention and perseverance. If we lack the effort and become low skill, effectiveness will not arise. This project is a great idea...."

7. Implications and Suggestions

The implications suggested the instructors would be designed the instructional strategies as well as strategic knowledge played an essential role in the problem space, isolating faults, and testing and evaluating hypotheses and solutions. The important issue is knowing what part of the AMS to locate, first when performing the EFI system that will not start is important strategic knowledge. TA and OE helps to confirm the hypotheses and solutions. Students' competence is the existing hypotheses or solutions are confirmed false or unfeasible.

Here is a novel practitioner challenge to articulate the knowledge states, system/device knowledge, and visual-spatial knowledge effectively. Rather than the workplace-based learning through a faulty system conceptually, experienced students match new problems with the real-world problems, event schemas resulting from their experiences and learning resources and apply the solutions (Jonassen & Hung, 2006). Suggestions guided a gradual shift from conceptual knowledge of the systems and context-independent knowledge of strategies to individual, context-dependent memories of similar systems.

8. Limitations

The limitation of this study is due to classroom action research and time limit. This study does not probe into other possible factors, such as educational background, performance requirements, teaching styles, subjects, levels, ages, satisfactions, and academic years. The study is in regard to concerns the only practical application in the undergraduate students of the research finding. The next research is employed in career professional and or vocational and technical education students are existing beneficially. By the way, learning integrated

into the multidisciplinary viewed, to enhance the holistic competencies and requirement skills in all area need.

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APPENDIX 1
The IOPD test on the AMS

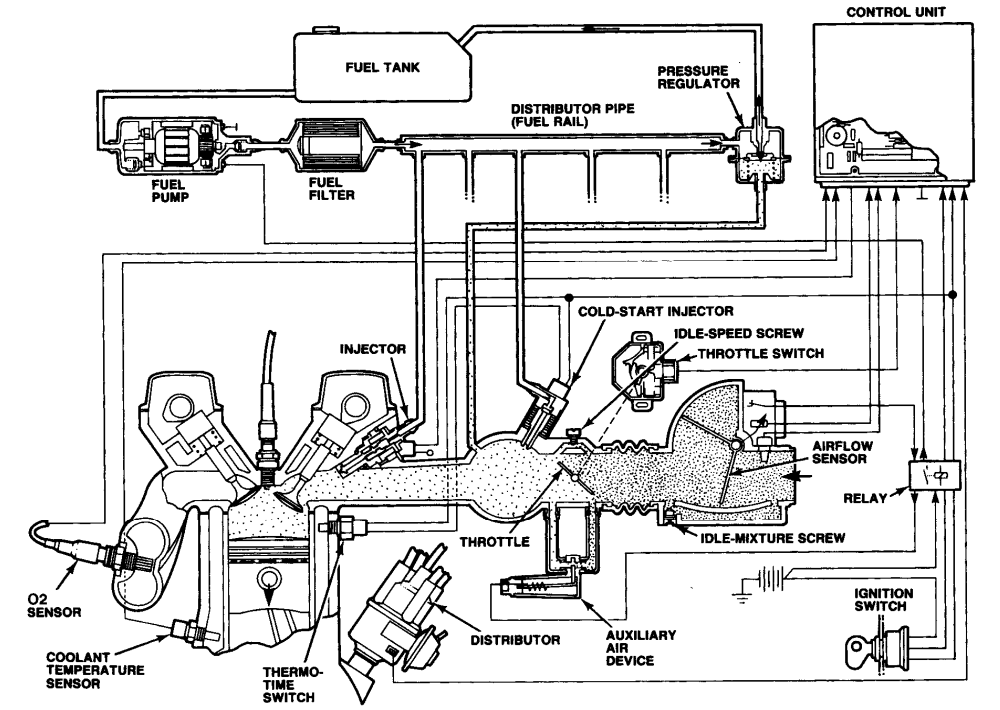

Figure 17-14. The Bosch L-Jetronic system has been used on various Japanese, European, and domestic vehicles. (Bosch)

Electronically Fuel Injection System (EFI)

Assessment Area	Questions in test	Percentage of Test
A. Sensors	12	30%
B. ECM	8	20%
C. Actuators	10	25%
D. Evaluation	10	25%
(preview the logics - problems - causes - solutions)		
	Total 40	**100%**

A. Sensors

1. Describe the sensors function base on the EFI system.
2. Demonstrate the functions of crankshaft position sensors.
3. Test, analyze, and report the variable resistances with analog/digital multimeter

B. ECM

1. Explain "How the ECM operates" and demonstrate the ECM possible damage causes.

C. Actuators

1. How do we check the state of injector? (i.e., case - injection pulse duration does not work?