COMPETENCY-BASED CURRICULUM DEVELOPMENT ON AUTOMOTIVE TECHNOLOGY SUBJECTS FOR MECHANICAL TECHNOLOGY EDUCATION PROGRAM

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ABSTRACT

The purpose of the study was to develop a competency-based curriculum model on automotive technology subjects for the mechanical technology education program (MTE) at King Mongkut's University of Technology Thonburi in Thailand. The qualitative data was collected through document analysis and through interviews a number of in-depth insights with 21 specialized in academics experts and automotive industries who were involved in curriculum development/training program development. They are used to illustrate and further analyze these findings. The purposed competency-based framework describes social demands, competencies profiles, faculty requirements and instruction design for the mechanical technology education program.

Keyword: Automotive technology, Competency-based curriculum, Curriculum development model, Mechanical technology education program.

INTRODUCTION

The vision of Thailand is to develop the country to be the green and happiness society through the King's Philosophy of Sufficiency Economy. The content deals with Human Resources Development are: (1) to develop the quality of people and Thai society to be the wisdom and learning society; (2) to develop the potential, competency and skills of people to cope with the competitiveness of the country by increasing knowledge and skills for working such as analytical skill, innovation, problem solving, decision-making, team working, ethics and working discipline for working with the new technology as well as increasing productivity; and (3) to set up the system of learning and training that can be working with new technology. Networking from the basic to the professional level, and link between government, private sector, and the community for the labour development (Areeya Rojvithee, 2007).
According to UNIDO (2002) proposed countries can sustain industrial growth today only if the key players – individual enterprises – are able to develop competitive capabilities.

Building capabilities requires conscious technological and other effort. And this effort is not very different whether an enterprise is creating new technologies or learning the efficient use of technologies brought from other countries. Technological capabilities are the result of technological learning. In this process a company acquires codified knowledge, combines it with existing tacit knowledge and builds up a stock of firm specific tacit knowledge. It is assumed that the most fundamental resource in the modern economy is knowledge and accordingly, that the most important process is learning (Lundvall, 1993).

Basically, learning is process whereby an individual or a firm "acquires, creates, and disseminates new knowledge" (Kim, 1999) by combining and recombining different pieces of knowledge into something new (Gregersen & Johnson, 1997). Strictly speaking, only individuals can learn, organizations – made up of individuals – can foster this individual learning and try to integrate it into their routines, organizational processes and finally products. In industrial education system, the technological progress will cause the maladjustment of the manpower supply and demand. As a result, the industrial education should head for the directions of high-qualitative life, technology progress, productivity upgrade, manpower requirement, economical development, and modernization to greet the epoch-making approach of the high-tech age (Chang, 1998). Hsiao and Chen (2004) proposed that teaching in technical universities have existed some problems, which is more theory oriented rather than application oriented. It seems difficult to cultivate technologists and also difficult to cultivate qualified engineers who need more sound academic foundation courses. Chang (1998) indicated that there exists a disparity between technical university curriculum and need of the industries.Teichler (2000) also indicated that there were four problems between industrial employment and higher education. The first is that the process of transition from higher education to employment has become more complex and protracted. The second is that a mismatch is felt to be on the rise in many countries between certain fields of study and the demand for graduates of certain profiles. The third is many graduates as far as socio-economic status is concerned and which only offer limited opportunities for utilizing their skills on the job. The last is employment fewer stables compared to the situation that was the norm in most industrialized societies over the last few decades.

The rapid growths of automotive technology also present a big challenge in Thailand economics driven and are issues continuous link between transfer technologies to university/education system. Previously, MTE curriculum development has been purposed by academics experts in industrial education and mechanical engineers. The curriculum development in the mechanical technology education program side has lagged behind. However, the nature of MTE requires the integration of different disciplines such as mechanical, electrical, electronic, educational, and training, etc. In fact, many of today's automotive technology and processes are of a mechatronic nature while the application areas are broad and diversified. Therefore, any curriculum development in MTE requires contribution both mechanical engineering and applied education. The purposed education development is motivated by the need for a systematic MTE educational curriculum between mechanical engineers and technical teacher education (Technologist/Experts in training)

The MTE program, approximately 60 percent of course is devoted in mechanical engineering and mathematics, in order that graduates will have the knowledge, skills and attitudes. The remaining 40 percent is pedagogy and the other applied education subjects. The concept is teacher training in mechanical technology. Program is to stress implementation of teaching technique principle and to emphasize the knowledge, skills and attitudes in field of mechanical engineering. Derived from the concept of industrial education is a terminology used more specifically in this research to describe social demands that need competency-based learning strategy for student development. With collaborative efforts, enterprise and university jointly design learning programs to meet the demands of student potential as well as the needs of social demand.

Therefore, the purpose of this study was to develop a competency-based curriculum model in industrial education for the department of MTE, King Mongkut's University of Technology. The research question included:

1. Does a competency-based curriculum model is the alternative that support to needs assessment of stakeholders?
2. How to construct a competency-based curriculum depend on social demand in the context of Thailand?
3. What is the most important of the context of a competency-based curriculum on automotive technology subjects for the mechanical technology education program ?

COMPETENCY-BASED CURRICULUM DESIGN

The effectiveness and efficiency of any educational programme is largely dependent on the philosophy of the curriculum design followed. The curriculum is the one that drives the engineering technology programme to its destination. If specific competencies are not focused in the curriculum design philosophy, the products of the engineering technology programme may not be "work-ready" and therefore not readily accepted by the industry. Therefore, to reduce the unemployment and 'under employment' levels, it becomes necessary to consider 'occupation-specific competencies' in the curriculum designs. Since different persons understand the term 'competency' differently (Joshua Earnest, 2001), defined the term competency to bring in more clarity for all concerned, especially with reference to engineering and technical education.

It states that 'the competency is a statement which describes the integrated demonstration of a cluster of related knowledge, skills and attitudes that are observable and measurable, necessary to perform a job independently at a prescribed proficiency level' (Joshua Earnest, 2001).

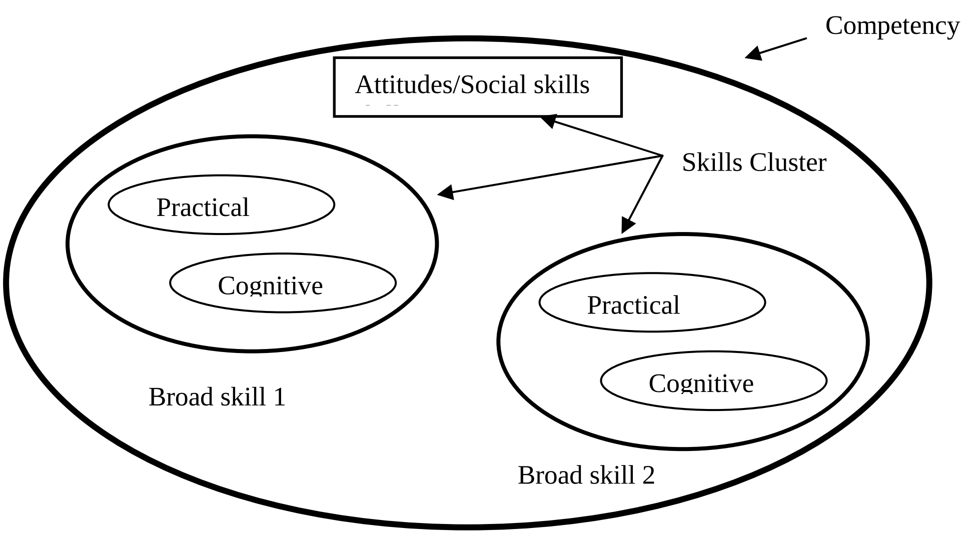

Figure 1
Concept of Competency

This definition is illustrated in Figure 1 as a complete system comprising of several broad skills and sub-skills (like the practical skills, cognitive skills and social skills and/or attitudes required in performing a given job/task). This definition means; (1) that the competency is an overt and measurable performance in terms of quantity, quality, time, cost or a combination of any of these, for which 'action' or 'performance' oriented verbs are to be used in writing competency statements; (2) a cluster of broad skills consisting of cognitive (intellectual) skills, practical skills, and social skills/attitudes, skillfully weaved together into an integrated whole; (3) the skill also involves higher order cognitive skills of Bloom's Taxonomy (Bloom, 1956) required to analyze, interpret, design, evaluate, create, plan, troubleshoot, diagnose etc. as well as lower level practical skills of Dave's taxonomy (Dave, 1966) such as cut, join, machine, measure, solder, paint etc; (4) a 'job' is an activity, which has a definite beginning and ending point, that can be performed over a short period of time, independent of other work and which results in a product, service or decision; and (5) 'perform' a job at a specified proficiency, means performing a given job successfully every time he/she is asked to do. In other words, tending towards more 'reality' and 'validity'. The 'proficiency level' here is the 'threshold level' (Haffenden, 1993) i.e. at the entry level to the industry after 4 years of study in the schools/colleges of engineering.

For the industry, the competency logically precipitates out in terms of cluster of broad skills as shown in Figure 1 for each job to be performed. On the other hand, the curriculum developer/teacher thinks still further in terms of practical skills, cognitive skills and social skills/attitudes within each broad skill, as they are the basic building blocks that make up a competency.

Tiechler (2000) indicated that curricula, teaching and learning for higher education should be more applied in nature or more practice oriented in various ways. Practice oriented higher education was advocated particularity in order to understand and tackle the complexity of real "phenomena" intellectually rather than take theory as an excuse for addressing the real phenomena only as far as the theoretical approaches seem to allow.

Hsiao et al., (2001) suggested three stages to develop a practical competency oriented curriculum. The first stage is the planning stage. In this stage, it must analyze what practical competency required for jobs related to the schools. The second stage is designing stage. In this stage, it can develop a curriculum that based on the results of practical competency analysis in the first stage. It will enhance the practical competences of its graduates. The third stage is to choose the representative subjects in this program, to develop the teaching materials and to proceed with the experimental instructions. After developing instructional objectives, the tools for program evaluation and the proceeding of the experimental instructions will be conducted by qualitative interviews and questionnaires for instructional effectiveness in this time. Based on the results of interviews and questionnaires it can discuss the effectiveness of this program and justify its existence.

Hsiao & Chen (2001) proposed five stages in the process of curriculum development for engineering education. The first stage is to search occupational titles for which the field wants to cultivate. These occupations can be got by newspaper advertisement, classification of occupations and visiting senior engineers. The second stage is to solicit representative occupations for competency analysis. The third stage is to analyze competencies needed by these occupations through DACUM technique or Delphi method. It can invite senior workers in relative business, professionals and senior instructors to find importance and frequency for these general competencies and professional competencies for these professionals. The fourth stage is to synthesize these general and professional competencies. The fifth stage is to transfer these competencies into courses design.

RESEARCH METHODS

The study was conducted in consecutive eight stages, as follows:

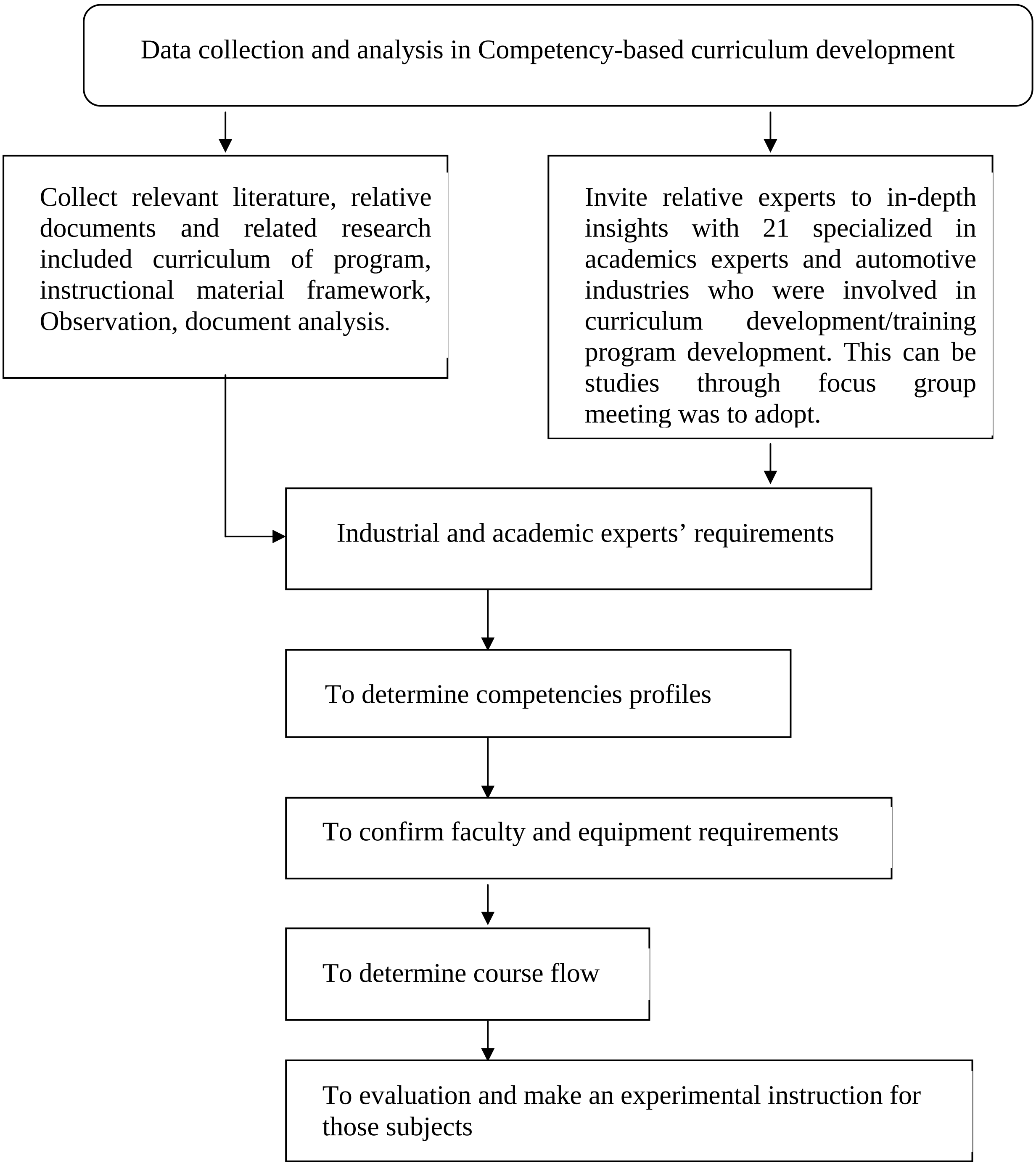

Figure 2
The Framework of competency-based curriculum development

Stage 1: to collect relevant literature, relative documents and related research included curriculum of departments, teaching material framework, Observation, document analysis and interview no formal with specialized in academics experts and automotive industries who were involved in curriculum development/training program development. academics experts.

Stage 2: to synthesis the collect data in the second stage has two components: specialized in automotive industries and academics experts by focusing a critical incident inventory for educators; and a focus group meeting with specialized in automotive industries and academics experts. Analyze the needs of industry and the occupation for identify the component that most important in this research.

Stage 3: to discuss what competences are MTE program in another field considerate in general perspective. Then, focus on automotive technology subjects by using SWOT analysis to assist in the development of a strategy which each syndicate was tasked to identify the strengths and weaknesses of the MTE department, and opportunities and threat facing. For strengths and weaknesses it was noted that while these are often considered by significantly affected by outside impacts over which the staff and the department may have little control e.g. funding levels. The most commonly cited strength were the combination sciences which are educational and engineering/technology mixed on program. And the facility was supported cover all of those subject that could share the material, analogy, laboratories and workshop linkage in good level. They have many experiences of the teaching staff full time. Less common responses were the university’s location, quality of student intake, and good facilities.

Stage 4: to analyze SWOT as follow as: For weakness, the most common responses concerned links with industries and technology resources, outdate equipment and special tools, lack of cooperation between staff and department, and an unwillingness of staff to change, as well as lack of automotive technology focus, low level teaching skills, lack of research focus, poor effectiveness management, and restrictive regulations. For Opportunities and threats, it was noted that while these largely come from external sources they impact from social demands. Commonly cited opportunities were improved cooperation with industry, construct teaching strategy, construct competencies to improve skills of students supported by need of stakeholders (industry, engineers’ council, vocational and technical education, etc) perspective, and often to training/internship or study tour in the fact work place. The most common threat was clearly because it has factors of the National Education Act B.E 2542 (1999) and 2545 (2002) was the best background. Then, declining financial support to sustain on automotive technology subjects and improved cooperation with automotive industries to support new know-how, materials and specific related field. The most important should improve the inflexibility of staff and unwillingness to accept change.

Stage 5: to develop curriculum framework. According above the framework of competencies profiles found, the focus group meeting conclusion suggests the obligatory courses for MTE department.

Stage 6: to confirm faculty and equipment requirements. When curriculum framework developed in the formal step, it needs to check faculty and equipment requirements.

Stage 7: to determine course flow that can base on foundation, pioneer, simple courses in the next academic year and application, integration courses in the later academic year.

Stage 8: to illustrate the course content to develop the instructional materials and to proceed with the experimental instructions. Evaluate Performance by checking competency and needs standard. The tools for program evaluation and the proceeding of the experimental instructions will be conduct in this step.

RESULTS

The Figure 2, the focus group meeting was held at Faculty of Industrial Education and Technology, King Mongkut's University of Technology in October 2006, covered two full days. The first day was considered to be core curriculum and competencies analysis for all participants. The second day was considered the tools for program evaluation and the proceeding of the experimental instructions will be conduct in this step. So we can illustrate requirements framework as follow as: (1) to construct instructional goals; (2) to select instructional strategy; (3) to develop instruction materials/modular learning; (4) to design practical instruction methods; (5) to decide experimental object; (6) to build up authentic assessment tools of instructions; (7) to take pre-test; (8) to proceed with experimental instruction; (9) to take post-test; (10) to interview with experimental students; (11) to survey performance for experimental instruction by observation and interviews; (12) to review with improvement; (13) to determine the competency connation and operation model; and (14) to proceed with results seminar.

In the key terms of competencies profile as follow as:

Competency – an observation and measurable behavior that has a define beginning and end; can be performed within a limited amount of time; and consists of two or more competency builders.

Competency builders – the skills, knowledge, and attitudes (written in measurable terms) needed to perform a given competency.

Entry level – position of students that requires no previous experience, but may require some training and/or specific skills, knowledge, or attitudes.

The competencies profiles of industries and academic experts' requirements are 10 units framework as follow as: ***(1) automotive workshop safety, (2) automotive engine repair, (3) automotive automatic transmission and transaxle systems technology, (4) automotive manual drive train and axles systems technology, (5) automotive suspension and steering systems technology, (6) automotive brakes systems and supplementary systems technology, (7) automotive electrical and electronics systems technology, (8) automotive air conditioning technology, (9) automotive engine performance, and (10) learning innovation in automotive technology***. These competencies and competency builders are designed to be the basis for curriculum development to ensure industry input that is relative and meaningful to the workplace. These competencies are intended to include all basic, necessary skills for this automotive technology area, but may be supplemented with additional competencies as faculty and advisory committee members see the need to do so.

The above process has been used in automotive technology subjects for MTE program at Faculty of Industrial Education, King Mongkut's University of Technology.

The minimum undergraduate credit is not less than 12 credits. It includes specific obligatory course 9 credits and professional obligatory course 3 credits. It should not identify in selective course because it necessary to linking for social demands in the future. That is when undergraduate to operate in mechanical engineers, trainers in industry, vocational and technical education professional teachers, and studying broad to graduate program. The subject includes start at 2nd year, 3rd year, and 4th year on MTE 271 Automotive Technology I is in ***unit 1 and 2***; MTE 272 Automotive Technology II is in ***unit 3,4,5 and 6***; MTE 373 Automotive Technology is in ***unit 7 and 8***; and MTE 474 Automotive Technology IV is in unit ***9 and 10***.

Attributes of a MTE undergraduate as purposed and listed below were discussed:

1. Ability to apply knowledge of basic science and engineering fundamental;
2. In-depth technical competencies more than one technology discipline such as electro technology, electronic, mechatronic, computer programming for engineers,

training skills, and instructional design development based on automotive technology;

3. Ability to undertaken problem solving, formulation and solution;
4. Ability to function effectively as an individual and in multi disciplinary terms with the capacity to be a leader or teacher as well as effective team member;
5. Understanding of social, ethics, moral, culture, global, environmental and social responsibilities all of the professional vocational and technical education teacher, and the need for industry/social demands;
6. Understanding of and a commitment to professional and ethical responsibilities;
7. Ability to leadership in vocational and technical education and related field of instruction.
8. A potential to undertake lifelong learning.

The undergraduate is expected to syndicate responses on attributes competencies on Table 1.

Table 1

Competencies framework of automotive technology subjects on attributes competencies

Knowledge and understanding	**skills**	**attitudes**
1. Knowledge of basic engineering and fundamental of automotive mechanics 2. Knowledge of chosen field of automotive technology 3. Good Understanding to automotive technology concepts. 4. Good Understanding to explorer the document, fix manual, advanced tools for inspection and guideline to solve problems. 5. Good understanding to applied engineering practice 6. Appreciate relevance to other fields 7. Knowledge requires students to engage in complex thinking and reasoning processes as they complete long-term, meaningful tasks.	1. Ability to application the knowledge. 2. Ability to Communication skills, both oral and written in Thai, English and universal language. 3. Ability to Brain-based education. 4. Possess problem solving skills 5. Skills on critical thinking, creative thinking and self-regulated thinking. (System thinking) 6. Adaptability 7. Have safety management ability. 8. Possess technical skills	1. Ethics, moral, and care full Thai culture. 2. Professionalism role. 3. Desire for life-long learning. 4. Openness to new ideas. 5. Positive attitudes. 6. Involves with community. 7. Have conscious in energy conservative and save environmental. 8. Have discipline itself.

CONCLUSIONS

The curriculum development on automotive technology subjects for MTE program is usually established through courses by courses and does not focus on the basic social demands of industry. As a result, students can learn portion rather than integration of the any field in mechanical engineering and applied education/training. In this research found the important of understanding the nature of knowledge. Although studying the distinctions between the types of knowledge is somewhat of a technical endeavor, many educators would argue that it is necessary in order to efficiently plan and implement competency-based curriculum, instruction strategy and authentic assessment. In fact, students are involved in an activity or something "hands-on," procedural knowledge (Skills cluster) in Figure 1 is being used. Activities and hands-on experiences (e.g., making a model of the solar system) are often methods that integration are used to up skills students practice or demonstrate declarative knowledge.

If purposed model can be indeed implemented, it means that the traditional automotive technology subjects will be changed. The industries and academic experts' requirements will be considered in the start of curriculum design. Students can get systematic competences, which are fitted industries and social demands needs, through above framework. This would more effectively reduce industries and social demands complain.

Final to conclusions, there are five recommendations in this study:

1. In order to make this framework successful, it must emphasize instructors/academic lecturer participation for set a study strategic plan, set objectives/goal, set instructional process, set learning activities, and set measurement and evaluation which it should to support competencies framework.
2. It can construct instructional design strategies to deliver Thailand Vocational Qualifications (TVQ) framework in the future.
3. In order to enhance these automotive technology subjects, it must emphasize on practicum and seminar out-university for students.
4. University can link automotive industry through practice of special project course or internship to make sure for problem solving of automotive technology. Then, students can receive the direct experience from real situations, climate, and workplace. So it must upgrade new knowledge for students.
5. It will recommend for the future researchers to construct any areas of industrial education and technology or engineering field to develop curriculum is better than nowadays. Because technology and science change in everyday.

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