CONSTRUCTION OF A COMPETENCY-BASED CURRICULUM CONTENT FRAMEWORK FOR MECHANICAL TECHNOLOGY EDUCATION PROGRAM ON AUTOMOTIVE TECHNOLOGY SUBJECTS

Weerayute Sudsomboon
[1]Academic Lecturer for Department of Mechanical Technology Education
Faculty of Industrial Education and Technology
King Mongkut's University of Technology Thonburi, Bangkok, Thailand
Email: weerayute.sud@kmutt.ac.th,yute_243@hotmail.com

Abstract

The objectives of the study were: (1) to construct a competency analysis profile content framework on automotive technology subjects for the mechanical technology education program (MTE) at King Mongkut's University of Technology; and (2) to identify a competency-based curriculum framework on automotive technology subjects for the mechanical technology education program The sampling size selected by purposive sampling with 21 specialized in academics experts in higher education of Thailand technology universities and automotive training experts in private sectors who were involved in curriculum development and training program development. The qualitative data applied to the research instrument were job profile chart and the consequence assessment sheet. The research was collected through document analysis and DACUM workshop. Data was analyzed by content analysis and inspection the data exactly by using triangular technique for confirms data reliability. They are used to illustrate and further analyze these findings. The research finding of competency analysis profile content framework consisted of 14 critical work functions and 135 key activities. The purposed competency-based framework describes social demands, demand driven, faculty requirements and instruction design for the mechanical technology education program.

Key words Competency-based curriculum, Curriculum Development Strategy, Development of pedagogy in Industrial Education and Technology, Teaching of Automotive technology,

INTRODUCTION

Human resource development (HRD) is an organized set of learning experiences provided by an employer within a specified period of time to bring about the possibility of performance improvement and/or personal growth. Within HRD there are three activity areas: (1) Training results in learning that is focused on the present job of the learner; (2) Education is learning focused on a future job for the learner; and (3) Development is learning that is not focused or referenced to any particular job (Dubois. 1993). Consequently, HRD situations in Thailand describes 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).

Is industrial education and technology in Thailand ready for the challenges of the future? As automotive industry prepares to meet technological challenges of the future, what roles will vocational and technical teachers are called upon to play? The greatest factor that used to force the competency competitive must focus on the holistic systems. The training and preparation of these future vocational and technical teachers should be of paramount importance to government sector, industry sector, and education sector. 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.

Recognizing the high responsibility placed on vocational and technical teachers in social development, we must embark upon urgent improvements in industrial education and technology and curriculum design. Improvements are needs in technology education in order to continue to solidify the roles of vocational and technical teachers in the society. The arrant neglect of education of the past should no longer be accepted. Industrial education and technology educators must become education activists. Educators, employers, and

practitioners should demand better integration of science and technology with the concepts of pedagogy and instructional practice throughout the competency-based curriculum. Therefore, the objectives of the study were: (1) to construct a competency analysis profile content framework on automotive technology subjects for the mechanical technology education program (MTE) at King Mongkut's University of Technology; and (2) to identify a competency-based curriculum model on automotive technology subjects for the mechanical technology education program. The research question included:

1. How to construct a competency analysis profile content framework on automotive technology subjects consequence the context of higher education in Thailand?
2. What is the most important of the content framework of a competency-based curriculum on automotive technology subjects for the mechanical technology education program?
3. Does a competency-based curriculum is the alternative that support to needs assessment of stakeholders?

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.

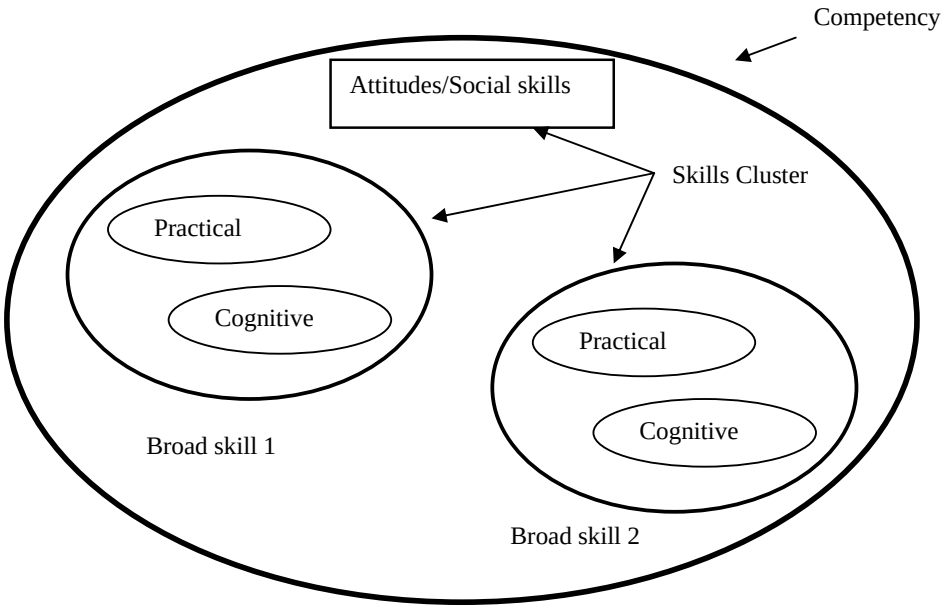

Figure 1 Concept of Competency

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). 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' i.e. at the entry level to the industry after 4 years of study in the schools/colleges of engineering.

The main idea of competency-based curriculum illustrates:

1. Instead of objectives, think "competencies";
2. Instead of content, think outcomes;
3. Learner activities will be based on performance of learner and accomplishment of criteria;
4. Teaching activities are learner centered;
5. Formative evaluation is necessary.

In table 1, is show the overviews compare and contrast between disciplined-based curriculum with competency-based curriculum are:

Table 1. Compare and contrast competency-based curriculum design

Disciplined-Based	**Competency-Based**
Content	Outcomes
Objectives	Competencies
Norm referenced grade	Criterion referenced grade
Subjective assessment	Objective assessment
Teacher centered	Learner centered
Passive Learning	Integrated learning
Pedagogy	Androgogy
Summative evaluation	Formative formulation
Instructional delivery	Learner performance
Knowledge/theory focus	Skills/performance focus
Structural /process focus	Outcomes focus
Assessed by counting	Assessed by performance
Exposed to specific content for pre-assigned time	Time and sequence derived by assessment

THE FUNCTION OF COMPETENCY ANAYSISs PROFILE

Competency analysis identifies the essential behavior model for professionals to carry out a task or mission. This behavioral model includes motive, characteristic and skill or knowledge of the fundamental characteristic. Specially, competency refers to the performance that a person has to implement in order to work effectively, especially when adequately playing a role or undertaking a task/mission. Furthermore, it can be observed and measured (International Labour Organization. 2002). Thus, competency is not only the aggregation of knowledge, skills, and attitude, but also a dynamic concept of putting action into practice.

The implementation of an educational training curriculum should be based on social demands, and the competency analysis process identifies whether students have attained the competency standards proficiently. The purpose is to let graduates devote themselves to the effect of globalization and revolutions in technology within social demands and graduates' skills. The main purpose of competency analysis is to analyze one occupation to improve a learner understand and approach in the content deals of work habit, work situation, and workplace. The essential have to integrate knowledge, skills and attitudes that he/she posses.

THE DACUM PROCESS

DACUM was derived from the phrase "Developing A Curriculum" and DACUM approach was created in July 1968 in British Columbia, Canada. It is a competency-based approach to curriculum development and places the emphasis on the learners gaining ability to meet specific objectives formulated according to a set of standards. DACUM is based on three assumptions as follows: (Mancebo)

1. Expert workers can define and describe their job more accurately than anyone else.
2. Any job can be effectively described in terms of the tasks that successful workers in that occupation perform.
3. In order to be performed correctly, all tasks demand certain knowledge and attitudes from workers.

The DACUM process consists of four components namely: (1) the selection of workshop participants; (2) the DACUM workshop; (3) data analysis; and (4) the development of the course. The participants in the workshop should be experts in their respective areas of specialization, articulate and forward thinking. In this research, the sampling size selected by purposive sampling with 21 specialized in academics experts in higher education of Thailand technology universities and automotive training experts in private sectors who were involved in curriculum development and training program development. The group met and discussed the content framework of the present mechanical technology education curriculum and analyzed the current, issues and situations of automotive technology subjects. Then, they were perceived new innovate a competency-based curriculum incorporating the feedbacks coming from the industry sectors, the requirements of the board of investment (BOI), the requirements set of the Commission of Higher Education, the role of council of engineers, the direction of social demands and trends of needs in industrial education and technology perceived as stakeholders.

RESEARCH METHODOLOGY

The DACUM workshop brings together all these experts and provides the topic for identify a competency analysis profile content framework with to consultation and negotiation of competency-based curriculum. The DACUM workshop includes the themes of Automotive Technology Profile by starting check the National Skills standards Board of America that proposes a common framework, as shown in Table 2, to be followed by each state or industry sector which desired to develop standard. Researcher was moderator explained about the overview of skills standard framework. Therefore, started at 1) Occupational title was synonymous to job title, which specifies the domain of competency standards. 2) Critical work function, equivalent to collective competency, was the major responsibility in a job area. 3) Key activity, synonymous to a single skill, is the major duty or task involved in carrying out a critical work function. 4) Performance indicator provides information on how to determine when someone was performing each key activity competently. 5) Technical knowledge was the related knowledge needed to perform the key activity. 6) Employability knowledge and skill was a general competency used to improve performs the key activity. Competency can be described as using a precise language to specify performance. The precision involves the consistent use of an "action verb" as the beginning word. The action verb, also called active verb, was a transitive verb had the meaning of acting, performing, or executing, and always provides important information about the content of a competency. An action verb was usually used to describe skill, competency, basic academic ability, educational objective, curriculum design, learning assessment, learner profile, curriculum vitae, and recruitment advertisement (Mansfield & Mitchell. 1996; Aurora University. 2003; Michelin Career Center. 2004; Norton. 2004). An action verb also needs an object. The object, a noun or a noun phrase, is the performing target of the action verb. Aside from this, it may need to specify the condition or circumstance to increase precision. Hence, a competency statement had the form of "action verb + object + condition" (Mansfield & Mitchell. 1996; Norton, 2004)

Table 2. Skill Standards Framework of America

Occupational Title: occupational name in industry sectors
Critical Work Function: main responsibilities associated with occupational
Key Activity: identifiable and measurable competencies
Performance Indicator: effective performance in key activity
Technical Knowledge: knowledge associated with key activity
Employability knowledge and skill: general competencies for key activity

The qualitative data applied to the research instrument were job profile chart and the consequence assessment sheet. Data was analyzed by content analysis and inspection the data exactly by using triangular technique for confirms data reliability. They are used to illustrate and further analyze these findings.

RESULTS

DACUM workshop 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.

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 competency analysis profile content framework of 21 specialized requirements are 14 critical work functions as follow as: (1) Performed scheduled Maintenance; (2) Conduct Exhaust System; (3) Conduct Engine Cooling System; (4) Conduct Brake System; (5) Conduct Body Component System; (6) Conduct Steering / Suspension System; (7) Conduct Electrical System; (8) Conduct Accessory System; (9) Conduct Air condition system; (10) Conduct Engine Mechanics System; (11) Conduct Emission System; (12) Conduct Fuel System; (13) Conduct Manual Drive Train System; and (14) Conduct Automatic Drive Train System. All of these contained 135 key activities.

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; MTE 272 Automotive Technology II; MTE 373 Automotive Technology III; and MTE 474 Automotive Technology IV. In the overview as shown as in the last page. 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 3.

Table 3 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.

CONCLUSION

The competency analysis profile content framework which had been developed in this research, can be applied to improve competency connation and establish curricula on automotive technology subjects. Theses are competency-based curriculum frame work on automotive technology subjects for MTE program usually established through courses by courses and does not focus on the basic social demands. 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.

The DACUM process is a utilize tool for developing any more innovative mechanical technology education program. Hence, competency-based curriculum content frameworks on automotive technology program are based on the competencies required to identify social demands. Stakeholders in mechanical technology education program that need to exploring industrial education and training able to the first prototype to change paradigm shift for upgrade competitiveness in the mission construct 'new generation' who can integrate competency apply to real situation for driven force the economic growth both have good moral and ethics.

LIMITATIONS

1. All these of a competency analysis profile content framework must develop performance indicator give consequence with authentic assessment method.
2. This research focused on mechanical technology program which any university adopt to implement should to modified curriculum content, instructional process, and measurement & evaluation have to support in the way of philosophy science.
3. The university/institution would like to apply this research, they must prepare budget for purchasing the hardware in training and identify training program for academic lecturer to learning with technology.

RECOMMENDATIONS

1. The competency analysis profile content framework in this research had been developed by document analysis and DACUM workshop. The method of practical verification may be used in a future study. In the next research should be study in order to design in experimental research to supplement strengthen the completeness of this study.

2. 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.

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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