รูปแบบการพัฒนาหลักสูตรฐานสมรรถนะสำหรับรายวิชาเทคโนโลยียานยนต์

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บทคัดย่อ

การวิจัยครั้งนี้มุ่งนำเสนอกรอบแนวคิดเชิงวิเคราะห์ในบริบทของช่วงเปลี่ยนผ่านและความต้องการการพัฒนาผู้เรียนทางครุศาสตร์อุตสาหกรรมให้ก้าวสู่ความเป็นเลิศทางวิชาการโดยใช้การพัฒนาหลักสูตรฐานสมรรถนะเป็นกลไกในการขับเคลื่อนซึ่งผลลัพธ์การเรียนรู้ที่ได้สามารถส่งเสริมพฤติกรรมการเรียนรู้ในภาคปฏิบัติให้เกิดความเชี่ยวชาญและเป็นเลิศรวมถึงจัดการเรียนรู้ให้สอดคล้องกับความต้องการของสังคมและการก้าวทันต่อการเปลี่ยนแปลงของเทคโนโลยี โดยมุ่งปรับเปลี่ยนทักษะการคิด วิเคราะห์ การแก้ปัญหา ตลอดจนทักษะการปฏิบัติงาน วัตถุประสงค์ของการวิจัยในครั้งนี้ คือ 1) เพื่อสร้างกรอบเนื้อหาสมรรถนะการปฏิบัติงานรายวิชาเทคโนโลยียานยนต์สำหรับนักศึกษาปริญญาตรีภาควิชาครุศาสตร์เครื่องกล มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี 2) เพื่อกำหนดกรอบรายละเอียดเกี่ยวกับสมรรถนะการปฏิบัติงานในรายวิชาเทคโนโลยียานยนต์ และ 3) เพื่อนำเสนอรูปแบบการจัดทำโมดูลการเรียนรู้ที่พึงประสงค์ของรายวิชาเทคโนโลยียานยนต์ กลุ่มตัวอย่างที่ใช้ในการวิจัยถูกคัดเลือกโดยการสุ่มแบบเจาะจง จำนวน 21 คน โดยเป็นผู้เชี่ยวชาญในสถาบันอุดมศึกษาและผู้เชี่ยวชาญจากสถานประกอบการที่มีประสบการณ์ในการพัฒนาหลักสูตรและจัดการฝึกอบรมทางเทคโนโลยียานยนต์ ระเบียบวิธีวิจัยในครั้งนี้เป็นการวิจัยเชิงคุณภาพ เครื่องมือที่ใช้ในการวิจัยประกอบด้วย เอกสารการวิเคราะห์งานในรูปแบบ DACUM และเอกสารการวิเคราะห์ความสอดคล้องเกี่ยวกับวิธีการประเมินสมรรถนะการเรียนรู้ ร่วมกับการวิเคราะห์เอกสาร และการจัดประชุมเชิงปฏิบัติการ ผลการวิจัยพบว่า 1) ผู้เชี่ยวชาญมีความเห็นที่สอดคล้องกันเกี่ยวกับกรอบเนื้อหาสมรรถนะการปฏิบัติงานรายวิชาเทคโนโลยียานยนต์ โดยจำแนกสมรรถนะการเรียนรู้ออกเป็น 14 กลุ่มงาน 2) กรอบรายละเอียดเกี่ยวกับสมรรถนะการปฏิบัติงานในรายวิชาเทคโนโลยียานยนต์ จำแนกออกได้เป็น 7 ด้าน และ 3) รูปแบบการจัดทำโมดูลการเรียนรู้ที่พึงประสงค์ของรายวิชาเทคโนโลยียานยนต์ ประกอบด้วย 7 ขั้นตอน

คำสำคัญ: การจัดการเรียนการสอนทางเทคโนโลยียานยนต์ หลักสูตรฐานสมรรถนะ การจัดการเรียนการสอนโดยใช้ฐานสมรรถนะ ครุศาสตร์อุตสาหกรรม

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A Competency-Based Curriculum Development Model in Automotive Technology Subject

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Abstract

This paper presents a practical discussion of the emergent requirements for effective Thai industrial education calls for a paradigm shift in competency-based curriculum development. With a paradigm shift away from a behaviorist conceptualization of teaching and learning toward a cognitive point of view, a trend toward investigating competency aspects of learning. The objectives of the study were: 1) to construct a competency analysis profile content framework on automotive technology subject for the mechanical technology education program (MTE) at King Mongkut's University of Technology Thonburi; 2) to identify a competency-based curriculum framework on automotive technology subject; and 3) to describe the typical module format on automotive technology subject. The participants were selected by purposive sampling with 21 specialized in academic instructor in higher education and automotive trainers 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. Although each of these aspects may be found in some conventional curricula, it is their collective use that constitutes a true competency-based program. The result showed that the experts' consensuses variously described of competence as focusing on several key areas in 14 tasks. A competency-based curriculum framework on automotive technology subject can be divided into 7 aspects. The typical module format on automotive technology subject was 7 steps. The areas include the nature of competencies, criteria used to assess the competencies, ways that student competence is assessed, student progress though the program, and the program's instructional intent.

Key Words: Automotive Technology Education, Competency-based Curriculum, Competency-Based Education, Industrial Education

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1. Introduction

There are several approaches that have gained much support from educators. That is competency-based education (CBE). CBE has been shown to be most effectiveness as an alternative to conventional forms of industrial education (Achtenhagen, 2001; Arguelles & Gonczi, 2000; Finch & Crunkilton, 1999; Hong et al. 2008; Hoogveld, Pass, & Jochems, 2005; Posner, 2004; Samuelowicz, 2001; Wiles & Bondi, 1998). According to Hong et al. (2008) defined such rationale underscores as "the necessity for a country to improve the quality of its teaching faculty during education reform in order to increase its national competitiveness" (as cited in Reid and Donoghue, 2004, p. 561).

In recent year, the effectively teaching and learning in automotive technology areas can be provided in the field of industrial education for preparing pre-service teacher from knowledge-oriented to competency-based education. Competency-based Education (CBE) is focused on student learning outcomes with the knowledge, skills, and attitudes to enhance them to skill development and solving the problems in their domain of study or future work, i.e., authentic tasks. (Lyle & Spencer, 1993; Hoogveld, Pass, & Jochems, 2005) 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, the Department of Mechanical Technology Education (MTE), Faculty of Industrial Education and Technology at King Mongkut's University of Technology Thonburi curriculum development have 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 subject for the mechanical technology education program (MTE) at King Mongkut's University of Technology Thonburi; 2) to identify a competency-based curriculum framework on automotive technology subject; and 3) to describe the typical module format on automotive technology subject. The research question included:

1. How to construct a competency analysis profile content framework on automotive technology subject for the mechanical technology education program?

2. What is the most important of the content framework of a competency-based curriculum on automotive technology subject?

3. Has a competency-based curriculum affect to the typical module format on automotive technology subject?

2. 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, 2001), defined the term competency to bring in more clarity for all concerned, especially with reference to engineering and technical education.

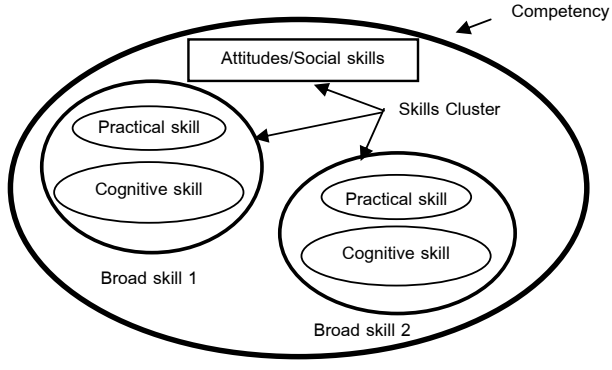

Figure 1 Concept of Competency

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, 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 is 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, can be proposed 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

2.1 The Function of Competency Analysis 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.

2.2 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. Participants can be divided into 2 groups. The first one was 11 academics experts in higher education of Thailand technology universities. The second one was 10 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.

3. Research Methodology

The DACUM workshop brings together all these experts and provides the topic for identify a competency analysis profile content framework with 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 (Norton, 2004). 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.

4. Results and Discussion

DACUM workshop was held at Faculty of Industrial Education and Technology, King Mongkut's University of Technology Thonburi in October 11-12, 2006. 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 was conducted in this step. So we can illustrate requirements framework have the following: (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 conation and operation model; and (14) to proceed with results seminar.

The key terms of competencies are:

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 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.

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

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 in Table 2, attributes of a MTE undergraduate 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. Understand 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. Understand of 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 2.

Table 2 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.

The typical module formats have found 7 aspects on the typical module format that based on Finch & Crunkilton (1999) were divided:

1. Task Orientation: In this step, the student is explaining 'how the module may serve as a means of developing certain knowledge, skills, and attitudes. Specific prerequisites are detailed and directions for seeking the workshop manual and job specification with the module are provided.

2. Performance Objectives: Automotive competency here are specific statements of performance the student should be able to demonstrate tools, equipments, methodology, and safety through the module. The enabling objectives identify the activities to be performed, the working conditions under which they are to be checked, performed, and the levels of competency.

3. Pre-assessment: This step is meaningful learning method that can be constructed the mental model and determining student entry level and provides a means of *"testing out"* of the module if the student can demonstrate personal mastery. Student workshop manual and outlines with an assessment form to employ in performance criteria are placed.

4. Learning Experiences: Learning experiences are detailed that correspond with each of the performance objectives. They are designed to provide each student with the best means of mastering module objectives. Each learning experiences consists of one or more activities followed by assessment and feedback to the student. Learning experiences may include experiment board, e-learning, information sheets, references, case representation, videotapes, computer multimedia, internet, and so on, that serves to enhance the learning process and helps individualize instruction.

5. Instructional Strategies: Kellie et al. (2002) argued that based on the competency framework able to propose the stages in the components of competency-based instruction are:

1) Instruction is developed around started objectives that can be observed or measured.

2) Learning is measured according to how well the learner performs in relation to competencies (objectives) rather than in relation to other learners.

3) All learners have the opportunity to succeed.

4) Learners receive immediate feedback on how much they have learned.

5) Instruction is individualized and various types of assessments – written as well as observational – may be used to monitor progress.

6) Learners who have problems can obtain individual help from instructors.

7) Learners may take competency-based tests *"criterion checks"* a number of times.

8) Learning outcomes can be replicated by other instructors in other locations or a later time.

Rather than assume that if a person sits in a classroom for a requisite number of hours he or she has "learned". Competency-Based Instruction (CBI) is an interactive process focused on a desired outcome and repetition of one that help both the learner and the instructor monitor progress toward the desired outcome. At the heart of this interaction is a contract between the instructor and learner. There are at least two critical conditions to consider in the best learning method. The first is the integration of the participant's life experiences into the delivery method. The impact of this condition can be summarized in the following chart from Laird (1985) as shown in Figure 2.

The second condition is the effectiveness of getting the learner to participate in the learning experience. In Figure 3, the higher the level of participation the more compatibility with adult learning tenets. In Figure 2, we do not overlook the opportunity for guided self-learning. Some authors argue that this is the only way to truly allow for individual needs and skill sets that each individual brings to the CBI learning environment. These opportunities, whether they are paper or electronic based, have clear advantages in rural areas. Learning using web-based technology has clear advantages and disadvantages but should not be overlooked. Likewise, two-way technologies such as

video conferencing may allow for the effective use of resources when delivering instruction to geographically separated or rural audiences.

6. Resource Materials: This step serves to reference all resource materials used in the various learning experiences and instructional strategies so that both academic instructor and student may locate them rapidly. The resource material listing aids the instructor in *"setting up"* for students and ensuring that all materials are available when they are needed.

7. Post-assessment: This step is finally calls and quite similar to the pre-assessment. In many cases, may be exactly the same. The post-assessment focuses on the terminal objective and an assessment form is used to determine whether or not it has been met.

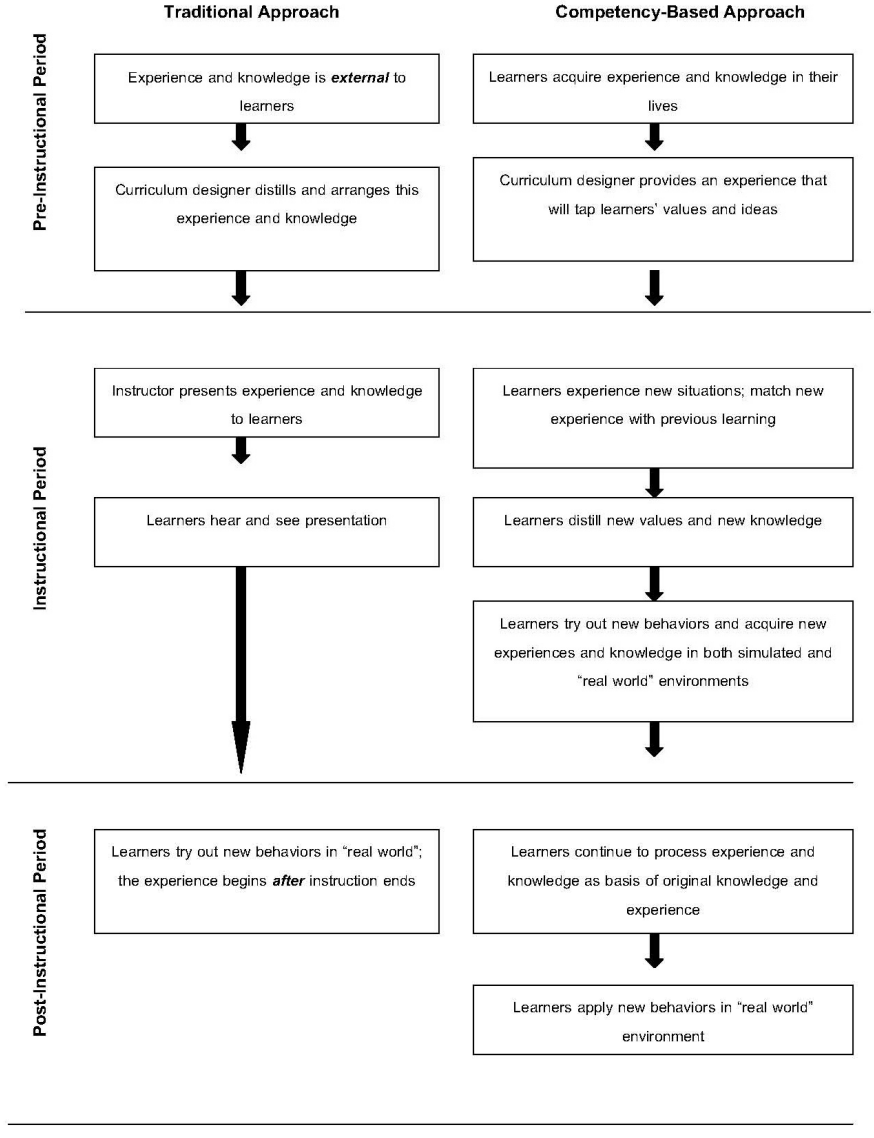

Figure 2 The comparative between Traditional Approach with Competency-Based Approach (Laird, 1985)

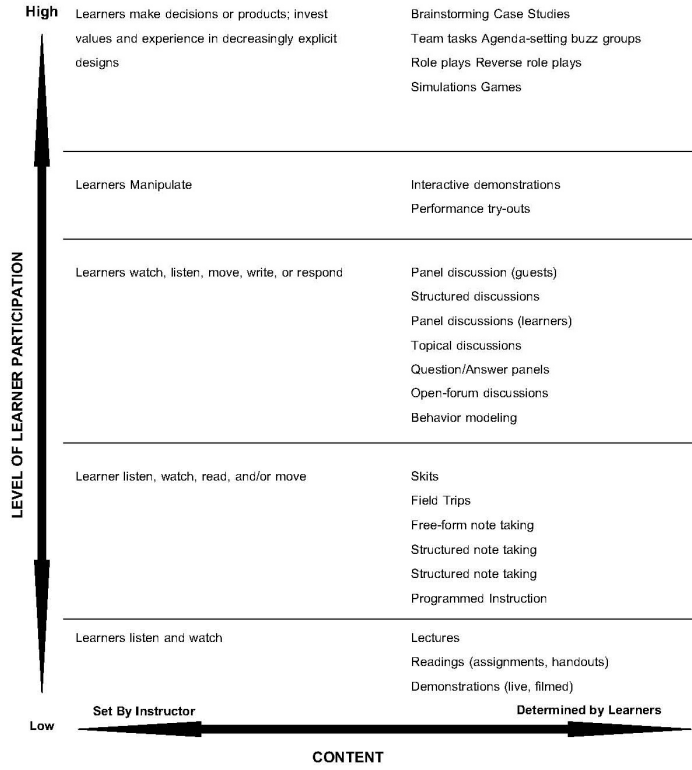

Figure 3 Delivery Methods Model

6. Conclusion

This study proposed that the competency analysis profile content framework, which had been developed in automotive technology subject. Theses are competency-based curriculum development model 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.

Consequently, Finch & Crunkilton (1999) proposes several aspects of CBE that distinguish it from traditional instruction. Although each of these aspects may be found in some conventional curricula, it is their collective use that constitutes a true competency-based program. The main issue has been variously described as focusing on several key areas. The areas include the nature of competencies, criteria used to assess the competencies, ways that student competence is assessed, student progress though the program, and the program’s instructional intent.

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