

# THE DEVELOPMENT OF INFORMATION TECHNOLOGY COMPETENCY WITH AN ADAPTIVE-ACTION LEARNING SYSTEM BASED ON THE CONSTRUCTIVIST APPROACH FOR GOVERNMENT OFFICIALS UNDER THE MINISTRY OF ENERGY

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**Abstract:** The purpose of the study was to develop the information technology competency with adaptive-action learning system based on constructivist approach for ministry of energy officers. The research and development procedure was divided into four phases: (1) Reviewing the literature on information technology competency development, adaptive learning, action learning and constructivist learning theory, (2) Developing the information technology competency with adaptive-action learning system based on a constructivist approach for ministry of energy officers, (3) Studying the effect of information technology competency with adaptive-action learning systems based on constructivist approach program with 30 ministry of energy officers, and (4) Presenting the system verified by five experts. Frequency, percentage, mean and standard deviation were used for statistical analysis. The results revealed that: The developed system for development of information technology competency with adaptive-action learning system based on constructivist approach for ministry of energy officers consisted of (1) the system principles comprising the competency evaluation, adaptive learning, action learning and constructivist learning, (2) the objectives of the system, (3) the competency development process comprising: pre-learning phase, competency evaluation phase, and adaptive-learning phase, and (4) evaluation using questionnaire, working observation form and working report. After using the information technology competency with adaptive-action learning system based on constructivist approach system, the participants had higher learning achievement scores in every competency and passed the 80% rating 3. The participants observed working performance was in good level 4. The working report of the participants did not pass the 80% criteria, which did not agree with the hypothesis.

**Keywords:** Information Technology, Competency, Adaptive Learning, Action Learning, Constructivist

## Introduction

Thailand's policy on information technology for the period 2001-2010 consists of three key components: 1) investment in the development of human resources with key fundamental knowledge; 2) support for innovation in the economic and social systems, and 3) investment in IT

infrastructure and support for the IT industry through these primary development strategies: information technology in support of e-Government and the introduction of electronic media in front office and back office tasks as a means of raising government-sector efficiency and effectiveness (National Information Technology Committee Secretariat, 2002).

In this research project to study guidelines for developing information technology knowledge and skills of government officials, the Research and Consulting Center at the SASIN Graduate Institute of Business Administration concluded that the skills that should be developed are Core Workplace ICT skills; ICT Information skills; and Basic ICT skills (SASIN Graduate Institute of Business Administration, 2004). This research shows that the ICT skills needed in the workplace are those skills most in need of immediate development, as majorities of government officials who use ICT have skills below the required level to perform their jobs effectively and efficiently. This is especially true of their skills related to the use of database and presentation programs. In these cases, the need for skills development correspond with employee competency development guidelines, which constitute a process of identifying and implementing staff development activities in order to reduce the gap between existing levels of expertise and the standard levels of expertise required of the various positions within the organization.

At present, organizations manage their human capital in accordance with the guidelines of an approach known as strategic and competency-based human resources management, a management system that assist in ensuring that the performance of an organization's human resources corresponds to the organization's key strategies. Plans are devised at various stages in order to raise levels and increase the likelihood of success. Implementation of these guidelines enables the organization to modify its strategies and to orient employee performances so that everyone is working toward a common goal. This management approach also accommodates organizational strategy and lays a foundation for excellence. The first step in the implementation process is designating a corporate strategy, which is comprised of a vision, values, culture, and mission. This is followed by setting organizational and employee competencies, and achieving excellent performance (Advisory Institute for the Development of Government Efficiency, 2006).

The present research into guidelines for developing the information technology competency of government officials by the Research and Consulting Center of the SASIN Graduate Institute of Business Administration found that government officials remain severely lacking in information technology skills and are in need of urgent training and development. In conjunction

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with the Ministry of Energy, the researchers devised a master plan for accelerating the development of competency in the use of work-related information technology among government officials. The researchers felt that an adaptive-action learning system based on the constructivist approach would help to solve existing problems and be an effective tool for developing the IT skills of government officials. This approach is particularly suited to adult learners, who already have knowledge and experience. Training intended for adults must take into consideration adults' special need for further training to develop them and improve their work. They have clear learning objectives and are capable of finding knowledge independently and of choosing their own lessons. An adaptive-action learning system based on the constructivist approach responds to these particular needs by giving learners knowledge, learning sources, and advice. The system is also flexible and responsive to the various levels of knowledge of individual learners, and as a result, instruction using this model is effective in the cognitive, affective, and psychomotor domains.

### **Objectives of the Study**

The objectives of the study are following:

1. To study the theoretical guidelines related to the development of information technology competency using an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy;
2. To develop a two-part system for developing information technology competency using an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy, these two parts being, first, a measurement and assessment system, and second, an adaptive-action learning system based on the constructivist approach;
3. To study the results of implementing the system for developing information technology competency using an adaptive-action learning system based on the constructivist approach among Ministry of Energy officials who incorporate the system in their work.

### **Conceptual Framework of the Study**

Competency refers to an interrelated set of knowledge, skills, and attributes, which impacts on the primary work of a given position and relates to the outcomes of that post. Competency can be measured and assessed in comparison to an accepted standard, and can be built through participation in a program of training and development which enables an employee to perform his/her job at a level of excellence that surpasses that of other employees in the organization (McClelland, 1993; Boyatzis, 1982).

The evaluation and development of competency means the process of defining and implementing programs and activities for human resource development that reduce the gap between existing levels of expertise and raise the overall standard. The cognitive domain is evaluated by means of a test of knowledge; a portfolio and observation

form are used to evaluate the affective domain, and the psychomotor domain is assessed through the creation of an employee performance portfolio (Advisory Institute for the Development of Government Efficiency, 2007) (Thammsart University Research Institute, 2007). The primary purpose of the evaluation process is to provide a database for devising a staff development plan at the organizational, departmental and individual levels. The evaluation takes the form of an authentic assessment.

Fensham (1995) defined constructivism as a method of learning based on the principle that each employee creates his/her own personal meaning from his/her own experiences. According to Von Glaseisfeld (1991), constructivism posits that knowledge does not result from perception alone but is generated by an individual with knowledge and understanding. The role of perception is to assimilate and evaluate the individual's experiences but not in order to discover what is true. This corresponds with Fosnot (1996) and Henson & Eller (1999), who explain that constructivism is a theory of knowledge and learning rooted in scientific, philosophical and psychological knowledge, which asserts that learners construct knowledge from their experiences: i.e. that individuals learn more on their own than from others. This theory stresses the importance of the learner as the center of the learning process.

In the constructivist instruction method, Driver & Oldham proposed three stages in the learning sequence: 1) orientation, in which learners are motivated to learn about the topic, 2) elicitation, in which learners are encouraged to express what they already know about the lesson to be learned; elicitation of this knowledge may be achieved through group discussion or in writing, 3) restructuring of ideas, which consists of smaller segments, i.e. clarifying and exchanging views; generating new ideas; evaluating alternative ideas; application, and review. Yager (1991) proposed an alternative constructivist-learning model consisting of the following phases: 1) Invitation, 2) Exploration, 3) Proposed explanation and solution, and 4) Taking action, i.e. making decisions and applying knowledge and skills.

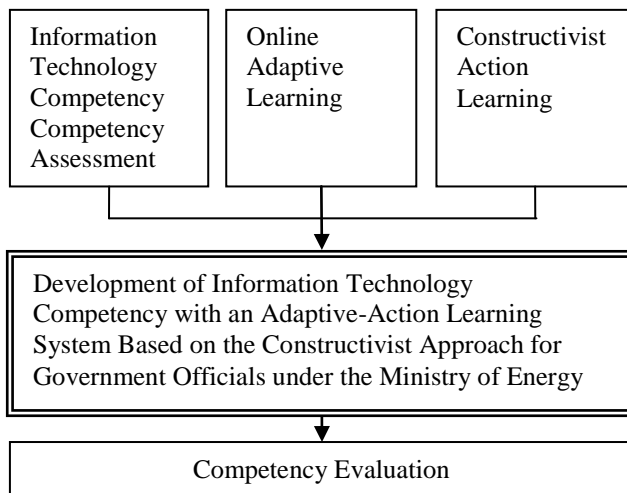
Action learning is an educational process for people in an organization, which yields maximum benefits for individuals, teams, and the organization as a whole, both in the short-term and the long-term. It is appropriate to modern conditions in which people are expected to learn quickly, clearly, thoroughly and accurately from their experiences in order to make prompt improvements in their performance.

Adaptive learning refers to instructional methods and techniques adapted to the divergent needs of individual learners (Corno & Snow, 1986). Adaptive learning is an educational method whose objective is to adapt instructional methods to meet the needs of individual learners while at the same time to assist individual students to develop the skills and knowledge necessary for effective learning (Park & Lee, 2004).

An online adaptive learning system is a learning management system consisting of various internal components and using an adaptive hypermedia format to respond to the needs of individual learners. Focus is on the primary goals of the lesson and content that is appropriate to individual learners. Bonfigli et al. (2000) divided these components into three parts: the student model, that part which concerns the knowledge of the learner; the domain model, which includes the structure of the lesson and related topics and is used to record all knowledge; and the dynamic model, which is that part responding to the dynamic construction of content, incorporating data from the student and domain models.

The development of information technology competency with an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy means a plan, which shows the structural relationships of the internal components of two systems: i.e. the competency measurement and assessment system and the adaptive learning system. These have been designed to comply with an adaptive-action learning model and constructivist theory, and are intended to develop information technology competency of government officials.

Competency assessment means evaluating learners in three domains: cognitive, through tests; affective, through a portfolio and observation; and psychomotor, by means of an employee performance portfolio (Advisory Institute for the Development of Government Efficiency, 2007; Thammasart University Research Institute, 2007).



**Figure 1: Conceptual Framework**

### Methodology

This study is a research and development study intended to improve information technology competency with an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy. The study was conducted in the following four phases as appropriate to the objectives of the study:

*Phase 1:* Study of relevant theories, concepts, and prior research; analysis and synthesis of materials pertaining to the development of information technology competency with an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy;

*Phase 2:* Development of a system for improving information technology competency with an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy.

*Phase 3:* Study of the effectiveness of the system for improving information technology competency with an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy.

*Phase 4:* Presentation of the system for improving information technology competency with an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy.

### **Presentation of the system for developing information technology competency with an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy**

The system for developing information technology competency with an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy consists of four key components:

#### 1. Principles

1) The competency measurement and assessment guidelines used are intended to give learners the cluster of knowledge, skills, and attitudes necessary to perform their jobs with a high degree of quality and efficiency. Competency measurement and assessment are divided into three domains: cognitive, measured by a test; affective, measured by observation, and psychomotor, measured by an employee performance portfolio. Once the results of the measurement and assessment of competency were obtained, they were verified by means of a joint evaluation of other employees. This 360° evaluation consisted of a joint evaluation involving three relevant parties: i.e. a self-evaluation, an evaluation by colleagues, and an evaluation by the employee's supervisor.

2) The theoretical guidelines employed follow a constructivist approach, Consisting of four stages: (1) *Invitation:* In this stage, learners are informed of the purpose and given an incentive to learn; they are encouraged to observe things around them out of a sense of curiosity, and questions are asked to stimulate learning. (2) *Exploration:* Here learners are given an opportunity to take part in activities, demonstrate existing knowledge, brainstorm, participate in-group discussions, search for information, and choose appropriate resources. (3) *Presentation of explanations and answers to questions:* Solutions to problems are reviewed and critiqued as a means of evaluating various solutions proposed and pointing out appropriate responses (4) *Presentation:* In this

final stage, learners apply their knowledge and skills to their own particular jobs.

3) The action learning system employed in the study consisted of the following stages: (1) identify appropriate learning situations from actual performance and set problems in order to generate solutions, (2) appoint learning teams based on performance to encourage cooperation in finding solutions, (3) facilitate team interaction and encourage team discussions, and (4) evaluate results of joint group discussions.

4) The study employed an adaptive learning system, which consisted of the following: (1) diverse resources were made available and adequate flexibility provided for a study stressing the central position of learners, (2) the training course had numerous starting points and choices in order to obtain the expertise desired by the study; evaluations were conducted at numerous stages; the training program was graded, and in order to achieve the goals of the study, the structure allowed for various levels of ability and knowledge among the learners, (3) information and training materials were open to allow learners free access, (4) at the testing and monitoring phases, learners were given information to determine individual progress, and the instructor set guidelines for advising learners; testing is considered as one part of the learning process, and regular testing of learners was carried out, (5) the role of the instructor and experts should be to advise individual learners in order to ensure that the learning process is learner-centered, (6) in an adaptive learning system, learners who do not meet the set standard at any point of the testing process are given remedial instruction. The need for this instruction is determined by learner test results, and remedial instruction is given only in those areas in which students fail to demonstrate the desired level of understanding.

2. Objective of the System

The objective of the system for developing information technology competency with an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy is to develop information technology competency in three domains: cognitive, affective, and psychomotor.

3. The Competency Development Process

The competency development process consisted of three stages of learning, as described below:

1) *Preparation*: The purpose of this stage was to prepare learners and familiarize them with the methods and guidelines for using the system.

2) *Measurement and assessment of competency*: At this stage, the competency of learners was measured and evaluated. Directions for improving competency were selected while waiting for the results of the 360° evaluation.

3) *Participation in the adaptive-action learning system*: Learners learn on their own from the adaptive-action system. The system assesses learners' competency and selects appropriate content for individual learners based on data from a previous test. If after learning, tests show that learners have failed to meet the desired standard,

they are given remedial instruction. Instruction is given specifically in those areas in which they have not demonstrated adequate competency in order to minimize learner frustration and boredom and ensure that learners are given content specific to those areas in which they lack knowledge. The system prepares the learning environment to facilitate cooperative learning and provides resources to allow learners to search for information quickly and conveniently.

4. Measurement and Assessment

Measurement and assessment was divided into three parts:

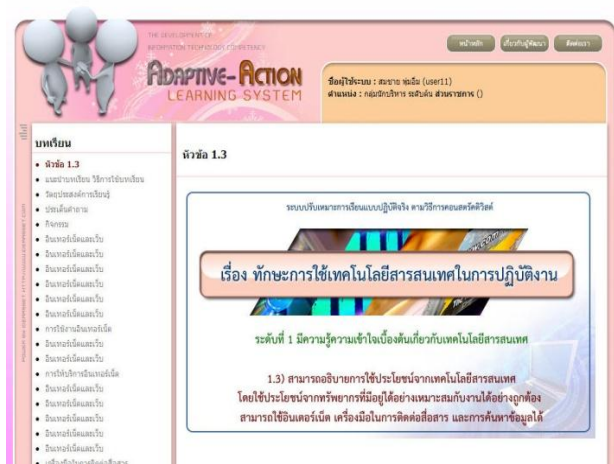
1) Measurement and assessment of the cognitive domain were performed by means of a multiple-choice test with four possible answers;

2) The affective domain was measured and assessed by means of observation;

3) Measurement and assessment of the psychomotor domain were conducted by means of a performance portfolio.



Picture 1: Competency Assessment System



Picture 2: Adaptive-Action Learning System

### Findings and Discussion

1. The study of the system for developing information technology competency with an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy found that learners at all levels demonstrated greater competency after participation in the learning process. Learning was open and free, and four supporting components were identified: the principles underlying the form of competency development, the objective of the form, the competency development process, measurement and assessment, and two key systems: 1) The competency measurement and assessment system, which consisted of these sub-systems: competency assessment, the results of the assessment, individual development plans, and competency data; 2) the adaptive learning system, which was comprised of the following sub-systems: a preliminary diagnostic system, learning activities, adaptive lessons, and a post-training diagnostic system. A questionnaire given to participants at the end of the learning process showed high levels of satisfaction. The free, open-access learning model correlated with Knowles' notion of self-concept for adult learners, who have self-respect. Adults are aware of having decision-making abilities and are confident that they can determine the course of their own life. They can control themselves and find solutions to problems affecting them. Therefore, in designing any training program for adults, it is important to consider the age of the learners and assign those tasks appropriate to their level of responsibility. Adults must have an opportunity to make choices and decisions in the learning process and to use their knowledge, experience and intelligence to solve problems in an autonomous manner. The adaptive learning system provides a diverse learning environment in line with the ideas of Cronbach (1957) and Glaser (1977), who asserted that in order to promote effective learning among a diverse group of learners, it is essential to provide a diverse environment suited to the learning style of individual learners. The training approach must be learner-centered,

and information and learning materials must be open and freely accessible to learners. Testing results must be made immediately available so that learners can assess their own progress in real time.

2. Testing of learners trained under the system for developing information technology competency with an adaptive-action learning system based on the constructivist approach found that all of the trainees received a passing score on the post-training test. This result supports the original hypothesis, which posited that the average competency levels would increase after completion of the learning process, and that 80 percent of learners would achieve the desired competency level. The competency development system devised for the study allowed learners to learn at their own discretion, in line with the ideas of Wang & Lindvall (1984), who observed that adaptive learning is an educational method, which incorporates alternative methods of instruction and the use of resources through a flexible system that allows learners to determine their own directions, and learning time. Learning effectiveness is maximized when it responds to the needs of individual learners. In other words, individualized instruction yields better results than group instruction (Bloom, 1984; Kulik, 1982).

3. Learners who learned with the system for developing information technology competency with an adaptive-action learning system based on the constructivist approach showed improved on-the-job performance. This was in line with the study's original hypothesis, which stated that the system for developing information technology competency with an adaptive-action learning system based on the constructivist approach for government officials under the Ministry of Energy would result in improvements in learners' performance, which could be measured by means of observation by the employees' supervisor. Performance levels were found to be in the good range, and recommendations for improvement were generated by the competency development system, as noted by Marquardt (1999), who defined action learning as a process rich in potential for problem solving and a program with an amazing ability to effect changes in the organization as a whole and in individual employees. Under this process, small groups of individuals work together to solve problems while focusing on learning and individual learning methods, which in turn yields substantive benefits for both individual employees and the entire organization. According to Pearce (1997), action learning is a valuable attempt to accelerate the engine of employee learning and allow an organization to deal with situations such that appropriate individuals come together to solve current problems in a manner that everyone can observe and learn from. It provides opportunities for competency building while advancing solutions to problems.

4. After completion of the study, learners who learned under the system for developing information technology competency with an adaptive-action learning system based on the constructivist approach were still

found to have unsatisfactory performance. This contradicts the study's original hypothesis, which posited that 80% of learners would achieve the desired level of competency. The reason for this may have been that the learning materials selected for the study consisted of information technology with real application to employees in only certain sections of the organization. Findings show that the section with the best results was the IT Data Center, whose work is directly related to information technology. Employees in other departments use their IT knowledge only to supplement their work. In future research, it may be advisable to provide more detailed explanations of competency that are better suited to the specific employees and work units participating in the learning process and that relate more directly to the objectives of their departments. This would increase the likelihood that learners feel that they can apply what they learn to their jobs.

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