การใช้ยุทธวิธีการเรียนรู้ด้วยวิธีการอ้างอิงโดยใช้ฐานกรณีเพื่อการสอนวิเคราะห์แบบจำลองทางคณิตศาสตร์ของระบบทางกล

USING CASE-BASED REASONING INSTRUCTIONAL STRATEGY TO TEACH MATHEMATICAL MODELING AND ANALYSIS OF MECHANICAL SYSTEMS

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บทคัดย่อ

การปฏิรูปการเรียนรู้สำหรับผู้เรียนทางเทคโนโลยีอุตสาหกรรมได้มุ่งเน้นการเชื่อมโยงพหุวิทยาการต่างๆเพื่อเสริมสร้างให้ผู้เรียนเชื่อมโยงทฤษฎีทางวิศวกรรมศาสตร์และการประยุกต์เทคโนโลยีเพื่อเสริมสร้างทักษะการแก้ปัญหาเพื่อก่อให้เกิดประสิทธิภาพการเรียนรู้อย่างยั่งยืน การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อ 1) ออกแบบกรอบยุทธวิธีการเรียนรู้ด้วยวิธีการอ้างอิงโดยใช้ฐานกรณี และ 2) ศึกษาผลสัมฤทธิ์การเรียนรู้ของผู้เรียนโดยใช้รูปแบบดังกล่าว ระเบียบวิธีวิจัยที่ใช้คือการวิจัยแบบกึ่งทดลองด้วยแบบทดสอบก่อนเรียนและหลังเรียน กลุ่มตัวอย่างที่ใช้ในการวิจัยคือ นักศึกษาระดับปริญญาตรีชั้นปีที่ 3 ที่กำลังศึกษาอยู่ในรายวิชา 5503901 การวิจัยทางเทคโนโลยีอุตสาหกรรม สาขาเทคโนโลยีเครื่องกล คณะเทคโนโลยีอุตสาหกรรม มหาวิทยาลัยราชภัฏนครศรีธรรมราช ภาคการศึกษาที่ 2/2556 จำนวน 31 คน เครื่องมือที่ใช้ในการวิจัยคือแบบทดสอบการแก้ปัญหาด้วยการวิเคราะห์แบบจำลองทางคณิตศาสตร์ของระบบทางกลแบบหมุน: กรณีศึกษาระบบส่งกำลังทางกลในงานอุตสาหกรรม สถิติที่ใช้ในการวิเคราะห์ข้อมูลคือ ค่าเฉลี่ย ส่วนเบี่ยงเบนมาตรฐาน โดยกำหนดค่าความเชื่อมั่นที่ระดับ 95% สำหรับการวิเคราะห์ค่าเฉลี่ยคะแนนทดสอบก่อนเรียน และการวิเคราะห์ความแปรปรวนแบบทางเดียวเพื่อเปรียบเทียบแบบการปรับค่าบอนเฟอร์โรนี ผลการวิจัยพบว่ารูปแบบการเรียนรู้ด้วยการวิเคราะห์เชิงเหตุผลมีค่าเฉลี่ยการทำแบบทดสอบหลังเรียนสูงกว่าก่อนเรียน ค่าเฉลี่ยการทำแบบทดสอบก่อนเรียนและหลังเรียนของรูปแบบการเรียนรู้ด้วยการนำประสบการณ์มาประยุกต์ไม่มีความแตกต่างอย่างมีนัยสำคัญ ของค่าเฉลี่ยการทำแบบทดสอบก่อนเรียนและหลังเรียน

ข้อค้นพบจากงานวิจัยพบว่า รูปแบบยุทธวิธีการเรียนรู้ด้วยวิธีการอ้างอิงโดยใช้ฐานกรณีที่ใช้ในการศึกษาครั้งนี้สามารถเสริมสร้างทักษะการแก้ปัญหาแบบจำลองทางคณิตศาสตร์ของระบบทางกลแบบหมุนวนได้อย่างสอดคล้องตามกรอบแนวคิดที่ได้กำหนดไว้ในทุกขั้นตอน และนำไปประยุกต์ใช้ในการพัฒนาการเรียนการสอนทางเทคโนโลยีอุตสาหกรรมได้อย่างมีประสิทธิภาพ

คำสำคัญ : การอ้างอิงโดยใช้ฐานกรณี, การวิจัยในชั้นเรียน, ยุทธวิธีการเรียนรู้, ระบบทางกล, การแก้ปัญหา

Abstract

Many industrial technology education reform movements call for developing students to engage multidisciplinary studies through the complex problems that emerge for advances and changes in engineering theory and technology applications. The purposes of this research were to design of the case-based reasoning instructional strategy framework as part of the study along with the approach and to examine the effect of achieved using case-based reasoning instructional strategy to develop students for undertaking their own design projects. A one-group pre-test and post-test quasi-experimental design was employed in this study. All 31 a third-year in 5503901 Industrial Technology Research course of undergraduate mechanical technology students, Faculty of Industrial Technology at Nakhon Si Thammarat Rajabhat University in semester 2/2013 were invited to participate in the present study. The procedures provided to the students as the course goals of Problem Solving in Mathematical Modeling and Analysis of Rotational Mechanical Systems: A case study of Mechanical Transmission System for Industry was conducted to test students' learning outcome. Data were analyzed by the descriptive statistics including mean, standard deviation and 95% confidential interval were used to estimate the students' learning outcomes to learning by CBRIS at pre-test scores. Analysis of variance (ANOVA) with post-hoc multiple-comparison (Bonferroni) was used to identify significant factors affecting students' learning outcomes to learning by CBRIS at post-test scores. The results showed that for an analytical reasoning approach to learning, the post-test mean score was noticeably higher than that at the pre-test. No significant difference was observed between the pre-test and post-test mean scores for a previous experience approach. The research finding fostered certain aspects of problem solving in mathematical modeling and analysis. The study also some suggestions of use instructional strategy, that support students' thinking and reasoning.

Keywords : Case-based reasoning, Classroom action research, Instructional strategy, Mechanical systems, Problem solving

Introduction

Many industrial technology education reform movements call for developing students to engage multidisciplinary studies through the complex problems that emerge for advances and changes in engineering theory and technology applications. Given its cross multidisciplinary view, it is essentially reserved for undergraduate industrial technology students as a dynamic systems modeling and analysis course. Vu and Esfandiari (1998) describes this modern trend is to combine mathematical modeling, theoretical analysis, and computer simulation. However, it is generally viewed that changing technology students to enhance the ways knowledge and skills are used in real world practice. The preliminary of mathematical concepts and methods play essential practices for analyzing of dynamic systems.

An ample portion of these background knowledge and skills is supposed to have taught in 5503901 Industrial Technology Research course in one subject which mechanical engineering naturally serves as applied mathematics, a supplementary for a third-year course of undergraduate mechanical technology students, Faculty of Industrial Technology at Nakhon Si Thammarat Rajabhat University in semester 2/2013. With this reason, students often learn facts and rote procedures to link the analytical reasoning and application of knowledge. Problem solving has become the conceptualized as rejoin content and application in a modern learning environment for basic skills as well as their application in various contexts.

In fact, undergraduate mechanical technology students lack necessary basic numerical skills as well as higher order thinking skills; today's workplaces often demand high competencies of both skill sets. Science, technology, engineering, and mathematics forces namely STEM have changed the demand of most workplaces. Among these forces is globalization of the workplace, decision-making, modernized production, new technologies, and multiple roles on knowledge workers. One way to enhance the STEM of industrial technology students is with cases that presented detailed accounts of real world situation through the instructional strategy of technology field, the issues that emerge and the outcomes that eventuate. Thus, mechanical technology program is revamping their instructional strategy to focus on problem solving as a key component of the industrial educational leader in professional curriculum.

This research attempts to describe a view that how to explore the case-based reasoning instructional strategy (CBRIS) framework is addressing problem solving skills as well. Moreover, this involves basic skills that students could be generated their knowledge in a variety of domains, perform critical analysis, and solves problems.

Aims

The purposes of this research were to design of the case-based reasoning instructional strategy model as part of the study along with the approach and to examine the effect of achieved using case-based reasoning instructional strategy to develop students for undertaking their own design projects.

This study first situates the theoretical background within the relevant literature on CBRIS model, and then describes the taken to examine the effect, and finally presents and discuss the research findings.

Theoretical Background

While interest in technology changes has been affected to improve problem-solving skills, students has been lack. Hannafin and Land (2000) described that teachers hold traditional teaching methods, didactic beliefs and use "conventional ways" without sustainable development for student-centered problem solving. Case-based reasoning (CBR) is a problem solving method that uses similar solutions from similar past problems in order to solve new problems (Kolodner, 1993).

For this reason, researchers then analyze research and journals related to dynamic system and modeling analysis, teaching and learning, and instructional designs model for problem-solving learning outcomes, implications for real-world engineering education (Sudsomboon & Anmanatrakul, 2010; Sudsomboon & Maungmungkun, 2013). CBR is fit to employ as the problem solving technique that uses and adapts the solutions of analogous past problems to solve new problems (Aamodt & Plaza, 1994; Kolodner, 1993; Vong & Won, 2010).

Analytical of Case-Based Reasoning

One of the main properties of the CBR system is a subfield of Artificial Intelligence rooted in the works of Roger

Schank in the early 80s, on dynamic memory and the central role that the recall of earlier episodes (cases) and scripts (situation patterns) has in problem solving and learning.

CBR stated as a heuristic human problem solving behavior that has been adapted for computer use. It is based on recall and reuse of specific "cases" and offers techniques for acquiring, representing and managing previous experiences. The CBR cycle have four-step process of retrieve, reuse, revise, and retain is detailed as shown in Figure. 1.

เพิ่มรูปที่ 1

(1) ***Retrieve***: The process of finding cases, and their corresponding solutions, in the dataset or knowledge base that are most relevant to the given case.

(2) ***Reuse***: The process of mapping the most common solution from the knowledge base for the given case. The reuse process also allows for adaptation of the most common solution, as needed, through the use of rules or "if statements" incorporated into the system.

(3) ***Revise***: The process of testing the new solution. If the new solution is successful, the process moves directly to retain. If the new solution does not work as expected or needs additional fine-tuning, the solution is further adapted to achieve the desired result.

(4) ***Retain***: The process of storing the new case and its final solution in the knowledge base for future use in the case-based reasoning process.

Furthermore, CBR is a model of cognition strategy in which individuals construct schemas based on their interpretations of particular situations (cases or stories), store these in memory, and prior knowledge to construct a new situation through a process of analogical reasoning (Kolodner et al. 2004; Schank 1990). An individual possesses a store of cases that are interpretations of students' experiences. When cases are stored, they are 'indexed' in the memory and the indexs for a case enable a person to locate and retrieve a relevant case or cases when confronted by a new situation.

Using the past experience might also be constructed when coming to understand the new situation, causing a case to be 're-indexed' (Kolodner et al. 2004). Then, CBR is suitable to conduct in the study that considered a 'natural' form of students' reasoning, their prior knowledge to make sense of new situations (Jonassen & Hernandez-Serrano, 2002; Kolodner et al., 2004).

Mathematical modeling and analysis of mechanical systems

Mechanical engineering education aims to promote quality of the problem-solving skills by integrating multidisciplinary studies, and develops intermediate science, technology, engineering, and mathematics (STEM), and real-world problem-solving on social demands to improve future engineering competencies (Jonassen, 1999; 2006). One of the most widely used well completion challenges to promote well teaching and learning effectively in mechanical engineering education is dynamic system modeling and analysis course. Due to its highly learning achievement and applications, instructors deals with the mathematical modeling of well dynamic systems and response analyses of such systems with a view toward understanding the dynamic nature of each system and improving the system's performance (Ogata, 2004).

Vu and Esfandiari (1998) describes the objective of an engineering analysis of a mechanical system is prediction of its behavior. The process by which a physical system is simplified to obtain a mathematically tractable situation is called modeling. The resulting simplified version of the real system is called the mathematical model of the system. Mechanical systems are either in translational or rotational motion or both. In this study, researcher concentrate on the modeling of rotational mechanical systems is presented. Researcher briefed students' know the fundamental dynamics and modeling of rotational mechanical systems are treated. Students' can be understood Newton's laws are used for translational systems, whereas the moment equations are for rotational systems. The procedures provided to the students as the course goals of Problem Solving in Mathematical Modeling and Analysis of Rotational Mechanical Systems: A case study of Mechanical Transmission System for Industry are:

(1) Knowledge system model

representation is identifying the rotational mechanical systems with configuration form (i.g., through variables and across variables);

(2) Governing equations are derived

by dynamic system modeling and analysis;

(3) Mathematical modeling of

rotational mechanical system in state-space representation form is presented;

(4) State equation is presented as the state-space representation or state-space form of the system model. This form is representing a system model is particularly useful in the dynamic system modeling and analysis (Vu & Esfandiari, 1998). As a result, this procedure is to obtain the state-space representation from the governing equations to Input-Output (I/O) equation below:

$$\dot{\mathbf{x}} = \mathbf{A}\mathbf{x} + \mathbf{B}u$$

$$y = \mathbf{C}\mathbf{x} + Du$$

state equation and output equation forms

(5) Transfer function is derived the different representations of mathematical models have been treated extensively in previous step. The transfer function is the most important to solve the system response. Because of the transfer function of a system, show relates the input to the output in the Laplace transform domain as;

$$G(S) = \frac{\mathbf{Output(s)}}{\mathbf{Input(s)}}$$

where Output(s) = $L\{output(t)\}$

Input(s) = $L\{input(t)\}$

(6) Analysis of the system response is concerned with the response of dynamic systems corresponding to specified inputs. Many type of input signal processing are crucially and discussed in the experimental. By analytical determination of the response is possible through application of the Laplace transformation, the transient response and frequency response are discussed;

(7) Suggestions of dynamic systems as mentioned earlier of this study, the unit-impulse response refers to the system’s response to a unit impulse and is subjected to zero initial conditions (Vu & Esfandiari, 1998).

Research Methodology

Designing of the case-based reasoning instructional strategy framework

The methodological framework in this study is a systematic literature reviews which guided by the National Academy of Engineering (2009). The review can be divided in three major steps: (1) identifying instructional strategies for industrial technology education framework; (2) analyzing and monitoring data were 12 key papers as the text books and international journals relevant dynamic systems modeling and analysis and mechatronics; and (3) data analysis. As a result, the validation and modification were analyzed by evaluate from data synthesis.

The procedure is proposed as shown in Figure 2.

เพิ่มรูปที่ 2

As novices, the benefit of CBR resides in its potential for developing a learning system that learns as new cases are solved. Learning occurs as a natural by-product of the process (Aamodt & Plaza, 1994). It is important to propose that CBR guide to solve problems effectively. For the application of mechanical engineering, each time a new solution is generated and a problem is solved, the experience is stored through the retain process to be used later on in solving similar problems. On the other hand, when the proposed solution to the problem fails, the reason for failure is identified and retained in order to avoid the same failure in the future (Sudsomboon, 2011).

Participants

All 31 a third-year in 5503901 Industrial Technology Research course of undergraduate mechanical technology students, Faculty of Industrial Technology at Nakhon Si Thammarat Rajabhat University in semester 2/2013, who received CBRIS in December 2013, were invited to participate in the present study. The students were assured that their participation was entirely voluntary and informed of their rights as research subjects. For those who agreed to participate, written consent was obtained.

Instrumentation

Researcher implies that teaching context may be modified to encourage students to adopt an appropriate approach or to discourage them from adopting an inappropriate approach to learning. An analytical reasoning approach to learning is considered as an appropriate approach as students learn for understanding, derives equation (e.g., analytical mathematics, linear ordinary differential equation, Laplace transform, and boundary conditions analysis) with enjoyment from the learning task and apply the knowledge acquisition to the real world situation (Biggs, 2003). On the other hand, a previous experience approach to learning is an inappropriate one as students rely on rote learning and memorization, avoid personal understanding and are unreflective about their learning experience (Biggs, 2003).

The revised two-type study process item was used to measure the students' approaches to learning. The first one item instrument consider the rotational mechanical system with an analytical reasoning approach and a previous experience approach scales, has acceptable Cronbach's alpha values for scale reliability (0.90 for the deep approach scale and 0.82 for the surface approach scale) with 3 experts assessment.

Procedure

The research was conducted prior to the commencement of mathematical modeling of mechanical systems. For those who agreed to participate in the research, a pre-test of their approaches to learning was undertaken using Problem Solving in Mathematical Modeling and Analysis of Rotational Mechanical Systems: A case study of Mechanical Transmission System for Industry.

The item test was modified by researcher that applied from the text book (Vu & Esfandiari, 1998) and the instruction hand-out of 2.151 Advanced System Dynamics and Control, Department of Mechanical Engineering, Massachusetts Institute of Technology. The item test is represented as follow as:

Example

Consider the rotational mechanical system: a case study of mechanical transmission system for industry described in Figure 3. Assume that the dynamic system parameter yield to a flywheel applied torque of magnitude 1 and initial conditions $\theta(0) = 0.5$ rad and $\dot{\theta}(0) = 0.$ Assume the following parameter values: $J = 1$ kg m^2, B =2 N-m-s, and K = 4 N m. Determine the system's response. Also, find the response for the case of zero initial conditions (Rowell & Wormley, 1998).

Nomenclatures:

T = External torque applied on the syst

θ = Angular position of the system

Ω = Angular velocity of the system

J = Moment of inertia of the system

B = Coefficient of viscous friction

K = Spring constant

เพิ่มรูปที่ 3

Solution Primary variables:

$\Omega_S, \Omega_J, T_K, T_B$

Secondary variables

$T_S, T_J, \Omega_K, \Omega_B$

System order: 2

State variables:

(1) Write down the linear graph of the system as shown in Figure 4 below:

เพิ่มรูปที่ 4

(2) Derived the elementary equation in configuration form below :

$$\frac{d\Omega_J}{dt} = \frac{1}{J} \cdot T_J$$

$$\frac{dT_K}{dt} = K.\Omega_K$$

$$T_B = B.\Omega_B$$

(3) Then, the governing equations are derived by dynamic system modeling and analysis which combination (2) below:

$$T_J = T_K - T_B$$

$$\Omega_K = \Omega_J$$

$$\Omega_B = \Omega_J$$

$$\frac{d\Omega_J}{dt} = \frac{1}{J} \cdot \left(T_K - T_B\right)$$

(4) Determine the mathematical modeling of rotational mechanical system in the state-space representation form is presented from (3) below:

$$\frac{d\Omega_J}{dt} = \frac{1}{J} \cdot T_K - \frac{B}{J} \cdot \Omega_J$$

$$\frac{dT_K}{dt} = K \cdot \left(\Omega_S - \Omega_J\right)$$

$$T_B = B.\Omega_J$$

(5) State equation is presented (Input-Output (I/O) equation are expressed in matrix forms below:

$$\dot{\mathbf{x}} = \mathbf{A}\mathbf{x} + \mathbf{B}u$$

$$\begin{bmatrix} \dot{\Omega}_J \\ \dot{T}_K \end{bmatrix} = \begin{bmatrix} \frac{-B}{J} & \frac{1}{J} \\ -K & 0 \end{bmatrix} \cdot \begin{bmatrix} \Omega_J \\ T_K \end{bmatrix} + \begin{bmatrix} 0 \\ K \end{bmatrix} \cdot \left[\Omega_S\right]$$

$$\begin{bmatrix} \Omega_J \\ \Omega_K \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ -1 & 0 \end{bmatrix} \cdot \begin{bmatrix} \Omega_J \\ \Omega_K \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

(6) Output equation form is expressed in matrix form below:

$$y = \mathbf{C}\mathbf{x} + Du$$

$$\left[\Omega_J\right] = \left[1 \quad 0\right] \cdot \begin{bmatrix} \Omega_J \\ T_K \end{bmatrix} + \left[0\right] \cdot \left[\Omega_S\right]$$

(7) Reform a new one equation is transformed (5) – (6) in the differential equation form below:

$$\frac{d^2\Omega_J}{dt} = \frac{1}{J} . \frac{d}{dt} \cdot T_K - \frac{B}{J} . \frac{d}{dt} \cdot \Omega_J$$

$$\frac{d^2\Omega_J}{dt^2} + \frac{B}{J} \cdot \frac{d\Omega_J}{dt} + \frac{K}{J} \cdot \Omega_J = \frac{K}{J} \cdot \Omega_S$$

(8) Transfer function is derived from take Laplace transform represented in (7) :

$$\left[S^2 + \frac{B}{J}S + \frac{K}{J}\right]\cdot \Omega_J = \frac{K}{J}\cdot \Omega_S$$

$$\frac{\Omega_J}{\Omega_S} = \frac{\left(\frac{K}{J}\right)}{\left[S^2 + \left(\frac{B}{J}\right)S + \left(\frac{K}{J}\right)\right]}$$

$$G(S) = \frac{\theta(S)}{T(S)} = \frac{1}{JS^2 + BS + K}$$

$$= \frac{1}{K}\left[\frac{\left(\frac{K}{J}\right)}{S^2 + \left(\frac{B}{J}\right)S + \left(\frac{K}{J}\right)}\right]$$

(9) Analysis of system response :

Consider a linear, second-order dynamic system whose governing equation in the standard form below:

$$\frac{d^2\Omega_J}{dt^2} + \frac{B}{J}\cdot\frac{d\Omega_J}{dt} + \frac{K}{J}\cdot\Omega_J = \frac{K}{J}\cdot\Omega_S$$

$$\frac{d^2\Omega_K}{dt^2} + \frac{B}{J}\cdot\frac{d\Omega_K}{dt} + \frac{K}{J}\Omega_K = \frac{d^2\Omega_S}{dt^2} + \frac{B}{J}\cdot\frac{d\Omega_S}{dt}$$

$$\ddot{x} + 2\xi\omega_n\dot{x} + \omega^2{}_n x = f(t) = \delta(t)$$

Substitution of the given numerical values in the equation of motion yields are:

$$J\ddot{\theta} + B\dot{\theta} + K\theta = T(t)$$

$$\ddot{\theta} + 2\dot{\theta} + 4\theta = \delta(t)$$

when $\delta(t)$ is the corresponding unit-impulse response that able to comparison with the standard form results as shown below:

$$\omega_n{}^2 = \frac{K}{J} \quad and \quad 2\xi\omega_n = \frac{B}{J}$$

From these relationships

$$\omega_n = \sqrt{\frac{K}{J}} \quad and \quad \xi = \frac{B/J}{2\sqrt{K/J}}$$

$$= \frac{B}{2\sqrt{K\cdot J}}$$

Substantial showed that $\omega^2{}_n = 4$, $2\xi\omega_n = 2$ $\omega_n = 2$ rad/s, $\xi = 0.5$ < 1

Indicating that the system is underdamped, and the response use θ in place of x , and $\sigma = \xi\omega_n = 1$, $\omega_d = \omega_n\sqrt{1-\xi^2} = \sqrt{3}$, to obtain in the solution standard form :

$$x(t) = \frac{1}{\omega_d}\sigma\iota\nu\omega_d t + e^{-\sigma t}\left[x_0\,\chi o\sigma\,\omega_d t + \left(\frac{\sigma x_0 + v_0}{\omega_d}\right)\sigma\iota\nu\,\omega_d t\right]$$

$$\theta(t) = \frac{1}{\sqrt{3}}e^{-t}\sigma\iota\nu\sqrt{3t} + e^{-t}\left[0.5\chi o\sigma\sqrt{3t} + \left(\frac{0.5}{\sqrt{3}}\right)\sigma\iota\nu\sqrt{3t}\right]$$

(10) Suggestions of dynamic systems: As a result, assuming zero

initial conditions, the corresponding unit-impulse response is described by the first term in the previous equation. The shaft bearings may be modeled as viscous friction with a damping coefficient of bearing. If the flywheel is at rest at t = 0 and the power is suddenly applied to the motor, after that able to use computer simulation (MATLAB) and plot the variation in speed of the flywheel, and find the maximum angular velocity of the impeller in term of system respond. Thus, step response of shaft torque T_K , and flywheel angular velocity Ω_J is considered.

Data collection

The overall scores are 100 points with the 5 aspects evaluation. The CBRIS model in use was shown in Figure 5. Each of the CBRIS tutorials lasted about one-and-a-half to 4 hours and took place in a teaching room. Researcher has been treated students for testing in satisfaction results. For the CBRIS process, the role of the instructor-researcher was to construct paper a case examines, facilitate reflective group work during CBRIS tutorials and help students refine their approach to CBRIS underlying 7 steps of Problem Solving in Mathematical Modeling and Analysis of Rotational Mechanical Systems: A case study of Mechanical Transmission System for Industry.

Data analysis

Data were analyzed by the SPSS version 17. Descriptive statistics including mean, standard deviation and 95% confidential interval were used to estimate the students' learning outcomes to learning by CBRIS framework at pre-test scores. Analysis of variance (ANOVA) with post-hoc multiple-comparison (Bonferroni adjustment) was used to identify significant factors affecting students' learning outcomes to learning by CBRIS at post-test scores. A p-value of <0.05 was considered as significant.

Results

To design of the case-based reasoning instructional strategy framework

เพิ่มตารางที่ 1

In Table 1, when used the CBRIS framework as an instructional strategy, CBR is thought to teach students' understand mathematical modeling and analysis of mechanical systems for a particular situation (the case), identify the range of issues involved in memory in the specific case, make decisions, and suggest solutions, and formulate principles for handling future situations. This approach can enhance students to link theory and practice by offering a means to contextualizing learning in a way that connects content knowledge.

The CBRIS framework design was often taught as a set of procedures accompanied by simple examples and experiment in laboratories. CBRIS has more recently emerged as a conceptualized to bridge this gap between theory and practice in instructional design education (Ertmer & Russell, 1995; Ertmer & Quinn, 2007). The CBIS model was employed by Ertmer and Russell (1995), argued that CBIS approach as shown in Figure 5 are well-suited to conduct teaching instructional design that can be represented in the experimental model as follow as:

เพิ่มรูปที่ 5

The CBIS model link the integration of realistic case studies into 5503901 Industrial Technology Research course can design students in-depth insight to set problems and experience through mathematical modeling and analysis of mechanical systems. The role of the students was to

(1) Students define and analyze the problem chosen for learning as new problem through index assignment;

(2) Students retrieved case with generate ideas incorporate situation knowledge. Then, Knowledge system model representation is identifying the rotational mechanical systems with configuration form;

(3) Students require analytical and reflective skills to derive the mathematical modeling and analysis of rotational mechanical systems and solved case as a reuse step and research their learning objectives.

(4) Students were gather information for solving problem from textbook, article journal in related field, group discussion;

(5) Students report back, synthesize explanations and apply newly acquired information to the problem for tested case as a revise step to derive state equation, transfer function and analysis of system response;

(6) Students' combine content knowledge and strategic thinking as thinking practitioners' as a retain step. The reiterative CBRIS also encouraged; and

(7) Students and facilitators to

evaluate

the process and outcome of the CBRIS experience through students' communication and interpersonal skills. The solutions from expert will be showed and researcher is discussed and recommended.

On completion of CBRIS process, a post-test of students' approaches to learning was conducted using as same as the rotational mechanical system with deep and surface approach scales.

To examine the effect of achieved using case-based reasoning instructional strategy to develop students for undertaking their own design projects

เพิ่มตารางที่ 2

เพิ่มตารางที่ 3

Of the 31 students who involved CBRIS during teaching and learning in 5503510 Industrial Technology Research course with the Problem Solving in Mathematical Modeling and Analysis of Rotational Mechanical Systems: A case study of Mechanical Transmission System for Industry, the pre-test and post-test were representing is shown in Table 1. Both an analytical reasoning approach and a previous experience approach mean scores before the implementation of CBRIS are shown in Table 1. The revise had an impact on the pre-test scores that a significantly higher score (Mean = 67.10) than the retrieve (Mean = 51.33) in the deep approach to learning ($p < 0.05$).

Conclusions and Discussion

This section briefly discusses the study findings, the experimental results regarding the CBRIS model. Table 2 outlines the differences of the both approach scores pre-test and post-test the implementation of CBRIS model. For an analytical reasoning approach to learning, the post-test mean score was noticeably higher than that at the pre-test ($p = 0.006$). No significant difference was observed between the pre-test and post-test mean scores for a previous experience approach ($p = 0.519$).

Conducting experimental studies in this study is improving the instructional strategy for industrial technology education because they allow studying 'thinking like practitioners' in potential new learning innovations. Their ability was to solve problems and to establish whether CBRIS enhances it. This study both included an analytical reasoning approach and a previous experience show effect within the group.

Three finding of Problem Solving in Mathematical Modeling and Analysis of Rotational Mechanical Systems: A case study of Mechanical Transmission System for Industry has the statistically significant in favor of the experimental group showed that:

(a) They were better at revise the step to derive state equation, transfer function and analysis of system response;

(b) They had higher-quality problem solutions;

(c) They related the retrieve of the problem representation with generate ideas incorporate situation knowledge.

The fact there was a substantial treatment effect CBRIS, although, CBRIS is a new dimensions of learning-instructional strategy, it is a present one: enhances students' ability to solve engineering problems. The finding was consequently CBRIS design was often taught as a set of procedures accompanied by simple examples and experiment in laboratories. CBRIS has more recently emerged as a conceptualized to bridge this gap between theory and practice in instructional design education (Ertmer & Russell, 1995; Ertmer & Quinn, 2007). Moreover, using the past experience might also be constructed when coming to understand the new situation, causing a case to be 're-indexed' (Kolodner et al. 2004). Then, CBR is suitable to conduct in the study that considered a 'natural' form of students' reasoning, their prior knowledge to make sense of new situations (Jonassen & Hernandez-Serrano, 2002; Kolodner et al., 2004).

Sudsomboon (2013) have shown that, an application of a CBR to teach analysis of non-holonomic mechanical (NHM) systems. In this study, the key challenge of teaching a class of dynamic systems arises from the fact which considers the problem. Both 5592103 Machine Design I and 5594111 Machine Elements courses at Mechanical Technology Program, Nakhon Si Thammarat Rajabhat University applies CBR into the motion of a plane NHM, consisting of two point masses, which move in such a way. CBR describes as a constructivist teaching consists of systematic process: retrieve, reuse, revise and retain is investigated. This instructional strategy made enhance of their students' thinking by the inclusions of NHM idea benefits students, who are able to solve the equations of the constraints of such a system, are derived.

The content should be added the block diagram representation and introduction to control system. Finally, the real world situation did better on the employ of the strengths of CBRIS model. Other methodology of problem solving, such as authentic assessment of the solution and computer simulation and its feasibility, did use to conduct for completely results context; therefore, the means were better in the whole aspects (Sudsomboon & Anmanatrakul, 2010; Sudsomboon & Maungmungkun, 2013). One of the participants discuss in this study is that the earlier study had more training in the classroom environment and curriculum should be improved and developing their content as well as engineering curriculum.

The outcomes of this study suggest that a case-based reasoning instructional strategy that supports the 3 years level of undergraduate mechanical technology students of Mechanical Technology Program, Faculty of Industrial Technology, Nakhon Si Thammarat Rajabhat University was conducted prior to the commencement of mathematical modeling of mechanical systems. In order to accomplishment in the research, a pre-test and post-test of their approaches to learning was undertaken using Problem Solving in Mathematical Modeling and Analysis of Rotational Mechanical Systems: A case study of Mechanical Transmission System for Industry.

The results are enhanced students' learning outcomes to encourage students to adopt an appropriate approach or to discourage them from adopting an inappropriate approach to learning. Furthermore, the findings developed an understanding of the learning innovation of instructional strategy practice and were able to provide use of that knowledge to solve their students' performance.

The sequence of learning strategy focused them use both an analytical reasoning approach to learning is considered as an appropriate approach as students learn for understanding, derives equation (e.g., analytical mathematics, linear ordinary differential equation, Laplace transform, and boundary conditions analysis) with enjoyment from the learning task and apply the knowledge acquisition to the real world situation. On the other hand, a previous experience approach to learning is an inappropriate one as students rely on rote learning and memorization, avoid personal understanding and are unreflective about their learning experience. Upon reflection, their knowledge of the approaches in turn helped students encourage of willing to learn and generate ideas to solve the mathematical modeling of mechanical system into a broader context.

The particular successes and failures experienced by the students demonstrate the importance of appropriately designed learning resources and an instructional strategy for supporting the CBRIS model is suggested. Cases should be variety relevant, and instructional strategy must supplement by computer simulation (e.g., MATLAB, Simulink, LabVIEW) should further develop students' understanding the whole of the dynamic systems and control (Sudsomboon & Anmanatrakul, 2010; Sudsomboon, 2011; Sudsomboon & Maungmungkun, 2013). However, making use the solutions to a previous experience approach when confronted with new situation is not an instructional strategy to encourage students in the type of reasoning required. Promoted scaffolding problem solving in technology-enhanced learning environment for undergraduate industrial technology students is one suggest for further research.

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References

Aamodt, A and Plaza, E.(1994).Case-Based reasoning: Foundational issues, methodological variations, and system approaches. Artificial Intelligence Communications. 7 (1): 39-52.

Biggs, J. (2003). **Teaching for Quality Learning at University** (2nd ed.), Buckingham: The Society for Research into Higher Education & Open University Press.

Cook, T. D. and Campbell, D. T. (1979). **Quasi-experimentation: Design and analysis issues for field settings.** Chicago: Rand McNally.

Ertmer, P. A. and Quinn, J.(2007). **The ID CaseBook: Case studies in instructional design.** Englewood Cliffs. NJ: Prentice Hall.

Ertmer, P. A. and Russell, J. D.(1995).Using case studies to enhance instructional design education. Educational Technology. 35 (4): 23-31.

Hannafin, M. J. and Land, S. M. (2000). Technology and student-centered learning in higher education: issues and practices. Journal of Computing in Higher Education. 12 (1): 3-30.

Jonassen, D. H. (1999).Designing constructivist learning environment. In C. M.Reigeluth (Ed.). Instructional-design theories and models: A new paradigm of instructional theory, 2: pp. 215-239. Lawrence Erlbaum.

Jonassen, D. H.(2000). Toward a design theory of problem solving. Educational Technology Research and Development. 48 (4): 63-85.

Jonassen, D. H. and Hernandez-Serrano, J. (2002). Case-based reasoning and instructional design: Using stories to support problem solving.Educational Technology Research and Development. 50 (2): 65-77.

Jonassen, D. H. (2006). Typology of case-based learning: The content, form and function of cases. Educational Technology. 46 (4): 11-15.

Kolodner, J.(1993).Case-Based Reasoning. San Mateo: Morgan Kaufmann.

Kolodner, J. L., Owensby, J. N., and Guzdi al, M.(2004). Case-based learning aids. In D. H. Jonassen (Ed.), Handbook of research on educational communications and technology pp. 329-861.Mahwah, NJ: L. Erlbaum Associates.

Ogata, K.(2004).**System dynamics**. Upper Saddle River, NJ: Pearson Pren tice Hall.

Rowell, D. and Wormley, D. N.(1998). **Sys tem Dynamics: An Introduction.** New Jersey: Prentice Hall.

Schank, R.(1990). **Tell me a story: Narra tive and intelligence**. Evanston, IL: Northwestern University Press.

Sudsomboon, W. and Anmanatrakul, A. (2010).Innovative of an Instruc tional Design for Thai Industrial Education through Case-Based Reasoning. **Journal of King Mong kut's University of Technology North Bangkok**, 20 (3): 620-632.

Sudsomboon, W. (2011). Effects of a Computer-Based Concept-Map ping: The Learning Innovation in Industrial Education. **Technical Education Journal of King Mong kut's University of Technology North Bangkok**, 2 (2): 11-19.

Sudsomboon, W. and Maungmungkun, T. (2013). Integrating Case-Based Reasoning Approach in an Under graduate Industrial Technology Research Course. In the 6th Inter national Conference on Educa tional Reform (ICER 2013). Febru ary 23-24. Sokha Angkor Resort. Siem Reap. Cambodia. pp. 220-226.

Sudsomboon, W.(2013). Applying Case-Based Reasoning to Teach Analy sis of Non-Holonomic Mechanical Systems. In the 3rd International Conference on Sciences and So cial Sci ences (ICSSS 2013). July 18-19. Rajabhat Maha Sarakham University, Maha Sarakham, Thai land. pp. 17-25.

Vong, C. and Won, P. (2010). Case-based adaptation for automotive engine electronic control unit calibra tion. **Expert Systems with Applica tions**, 37 (4): 3184–3194.