# Innovative of an Instructional Design for Thai Industrial Education Through Case-Based Reasoning

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## 1. Introduction

The main catalyst for this review deals with methods, models, and strategies to retrieval, reuse, revision, and retention in Case-based Reasoning (CBR). In an automotive technology courses practitioner's often a complete description of the target problem is assumed to be available in advance. In adaptive industrial education systems an experience approach can be used to deliver profession course based on the both current learner competence and on the competence of learners, together with the experiences of using narratives and teaching strategies. The suitability of a profession course offering can be determined by examining the learner's feedback, explicit and implicit knowledge [1], [2]. Moreover, a case-based reasoning approach is proposed for analyzing, identifying, presenting, and organizing potential problems with profession courses by matching, reusing, validating and stories cases, where cases may be individual learner models, narratives or individual content models.

This paper organized as follows: First authors describe an overview of the existing literature of CBR principles, methods, and apply is made within a general scheme. Authors' belief that best takes place by using stories elicited from skill problem solvers, indexed for the content models is necessary to teach, and made available to learners in the form of case libraries can provide a broader range of problem solving than other strategy or tactic. Furthermore, authors, address the characteristics of a comprehensive CBR. With outline the summary of the study for future research.

As automotive technology assumes an increasingly dominant role in highly-performance, technology literacy is becoming as essential as students' competency and the ability to service, repair and diagnosis. In providing the fundamentals of technological literacy, technology education increases capability prepare to live and work in a world of continuously evolving technologies. Current automobiles are a challenge to service and repair because of this advanced technology, but the

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future automobile will be even more complicated [3]. Hence, the Mechanical Technology Education (MTE) Program, Faculty of Industrial Education and Technology at King Mongkut's University of Technology Thonburi (KMUTT) is designing an instructional design via learning innovation through a constructivist approach. The MTE program is to stress implementation of knowledge construct and metacognition domain emphasizes the competency in field of mechanical engineering and educational technology. 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 potential student as well as the needs of social demand. Moreover, automotive technology changes affect adjustments in, and instructional system and design of, students' competencies. Thus, MTE program should use a suitable competency analysis model in order to establish the competency connation and standards in every domain. In this issue, the development of an automotive technology competency analysis profile model is actually an important requirement for undergraduate mechanical technology education students.

**2. Completing Perspectives**

Learning is a constructive, cumulative, self-regulated, goal-oriented, situated, collaborative, and individually different process of knowledge building and meaning construction [4]. The constructivist view of learning also influences the role of teachers. The main task that teachers are assumed to perform, according to constructivists, is no longer the transmission of knowledge, but the facilitation and coaching of learning [5], [6]. CBR is a problem-solving approach that relies on past similar cases to find solutions to problems [7], and prepare professionals to deal with ill-defined and ill-structured problems by exposing them to stories generated in the workplace [2]. Leake [8] suggested that CBR principle is based on an analogy to the human task of "mentally searching for similar situations which happened in the past and reusing the experience gained in those situations". Therefore, a query describing a target problem is natural, analogical reasoning cycle, stories of concrete problem- solving experience retrieved from dynamic memory (analogs) are adapted to interpreting and solving a new problem [1], [7], [9]-[13]. The problem solving experience affects dynamic memory by generating a solution, new story which is used in future.

As a result, dynamic memory involves with the integration of each new story. The CBR principle is based on an analogy to the human task of "mentally searching for similar situations which happened in the past and reusing the experience gained in those situations" [8]. In CBR, all the problems are represented as cases, which were defined by Kolodner and Leake [12] as: *"A case is a contextualized piece of knowledge representing on experience that teaches a lesson fundamental to achieving the goals of the reasoner."* A case usually has two major parts: the problem itself with the context describing the environments it should be retrieved; and the solution of the problem or the lesson it will teach. CBR can be seen as a 4 RE's cyclic process: ***Retrieve Reuse, Revise*** and ***Retain.***

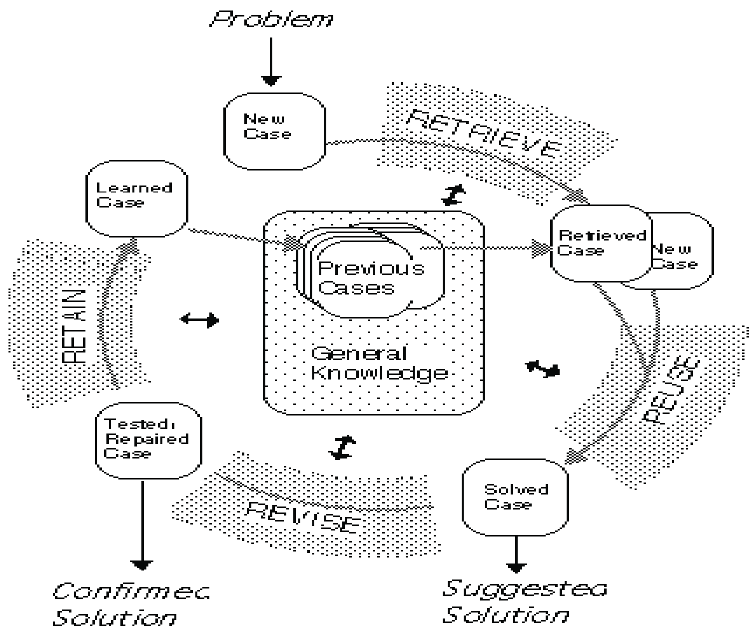


**Figure 1** The CBR cycle [1]

This cycle is cited in Figure 1 can be represented as follows:

1. ***Retrieve:*** the system searches and retrieves the case(s) most similar to the problem case, according to a predefined similarity measure.

2. ***Reuse:*** the user evaluates it in order to decide if the solution retrieved is applicable to the problem.

3. ***Revise:*** if it cannot be reused, the solution is revised (adapted) manually (by the user) or automatically (by the CBR system).

4. ***Retain:*** the confirmed solution is retained with the problem, for future reuse, as a new case in the database.

CBR methodology usually concerns the following issues so that different components can work co-operatively, contributing to efficient and effective system performance. CBR has been very successful in a wide range of problems over the last decade [7]. A vast amount of work has been carried out concerning a wide range of issues and different techniques in CBR [1]. Although the CBR cycle is a ***retrieve-evaluate-adapt-learn*** process, a CBR system may very well implement only the retrieve step, as this is the expression of the concept of reuse of experience.

Additionally, the difference between a database search and CBR retrieval is that the latter employs searching mechanisms that are based on classification and decision tree algorithms, or on assessment of the similarity of cases using predefined similarity measures. This section, instead, will highlight the fact that unlike knowledge-based systems, where the problem solving algorithms are expressed in rules, CBR systems deal with case specific knowledge and do not require that the domain must be modeled in rules.

**3. Analyzes of Current, Trends and Issues**

Interpretive CBR involves reusing previous cases for classification tasks, such as diagnosis, evaluation and prediction – applications can be found in, for example, medical diagnosis and helpdesk situations (i.e., Symptom-based diagnosis). Using CBR for problem solving, on the other hand, involves reusing and adapting solutions of past, similar problems in order to solve new problems. Most contemporary models of instruction, including anchored instruction [14], problem-based learning [15], open-ended learning environments [16], constructivist learning environments [17], goal-based scenarios [18] share an essential characteristic. The learning outcome for each is problem solving. That is, each of these models supports learning how to solve some kind of a problem. The emphasis on problem solving in the field of instructional design has increased. Problem solving is a complex, multifaceted, and poorly understood kind of learning.

According to Jonassen [17], [18] has attempted to articulate different kinds of problem solving and different learning and instructional requirements for each. However, insufficient advice is available to instructional designers to help them to design and develop learning and instructional supports for every kind of problem solving. In this paper, we describe the application of CBR to decision support for Automotive Suspension and Transmission systems field subjects in Industrial Education by using stories to support problem solving. This study examined how stories, in the form of a CBR, affected undergraduate novices' abilities to solve complex and ill-structured problems. It is thought that in order to develop professional skilled to deal with the complexity of workplace situation (i.e. to deal with ill-structured problems) they should be supported by providing stories generated at the workplace itself.

In professional practice, situations abound with indeterminacy, value conflict, and conflicting views. In these ill-structured contexts, the successful practitioner must be able to "choose among multiple approaches to practice or devise his own way of combining them". Unfortunately, novices in schools are only allowed to work on problems that are decontextualized and well-structured, while problems in everyday and professional contexts are complex ill-structured [17] - [19]. CBR assumes that cases in the form of stories are useful for supporting problem solving focus on the novice's attention on what is an important, making available idea on how to move forward, and giving grounds for reassessing the consequences of their decision or actions [20].

The process of understanding and solving new problems in terms of previous experiences has three parts: recalling old experiences, interpreting the new situation in terms of the old experience based on the lessons that were learned from the old experience, or adapting the old solution to meet the needs of the new situation [20]. Given the lack of previous experiences among novices, substitute experiences available through a case library are expected to augment learners' repertories of experiences by connecting to the experiences of others (experts), forewarning us of potential problems, realizing what to avoid, and foreseeing the consequences of decisions or actions. Reasoning from stories or cases supports 'inferences necessary for addressing the kinds of ill-defined or complex problems that arise in the workplace, at school, and at home'.

## 4. Examples of Research in CBR

In an ethnographic study of problem solving among refrigeration service technicians, Henning [21] found that stories served as a mechanism for promoting an ongoing discourse between technicians, machines, products and people. Stories afforded technicians a means to form and express their initiation. By being able to tell stories to their co-workers, technicians, particularly the newer ones, were able to form and strengthen the bonds that give cohesiveness to their community of practice. Technician shared stories about initiation, identity formation, their sense of pride, and in general about the drama of facing responsibility, and unusual and difficult situations. These stories reinforced the technicians' identity, which contributed to their further participation in the community they were continuously building. On the other hand,

Lave and Wenger [22] found stories to be critical also for initiating new members into a practice. While studying apprentices in their work setting, they found that "apprenticeship learning is supported by conversations and stories about problematic and especially difficult cases". In these setting, stories were used as "communal forms of memory and reflection". In this paper, these studies in Professional contexts have shown that narrative dialogue of reflection and interpretation sustained by these practitioners is how "experience is transformed into pedagogical content knowledge" [22].

Jonassen and Hernandez-Serrano [23] proposed that the result on *'The effects of case libraries on problem solving'*. From a CBR perspective, the problem-solving approach involves the research process.

They found that the effects of providing access to a case library of related stories while undergraduates solved ill-structured problems. While solving complex food product development problems, the experimental group accessed experts' stories of similar, previously solved problems; the comparable group accessed fact sheets (expository representation of stories' content); and the control group accessed text selected at random from a textbook dealing with issues unrelated to the stories. On multiple-choice questions assessing processes related to problem solving (prediction, inferences, explanations, etc.), experimental students out-performed the comparable and control groups. Performance on short-answer questions also assessing problem-related skills was not significantly different, in part because of test fatigue. Analysis of interviews identified a number of factors that students used in deciding how to apply their study strategies, including causal factors, grounding phenomenon, grounding in context, and outcomes.

Moreover, Althuizen and Wierenga [24] found that CBR as a support technology for sales promotion (SP) decisions. CBR-systems try to mimic analogical reasoning, a form of human reasoning that is likely to occur in weakly-structured problem solving, such as the design of sales promotions. In an empirical study, it finds evidence that use of the CBR-system improves the quality of SP-campaign proposals. Creativity, in turn, is positively related to the (practical) usability of a proposal. The results suggest that the CBR-system is most effective when it is used as an idea-generation tool that reinforces the strength of divergent (creative) thinkers.

## 5. Contextualization in CBR

### 5.1 Traditional Learning VS Case-based Reasoning

The skilled and techniques of traditional expertise, particularly as they are being taught in schools, do not match the complexity found in the fields of medicine, management, engineering and many other professions. Novices in industrial education are trained only to study on content-based that are, by nature, decontextualized and well structured, while problems in everyday and professional contexts are complex and ill-structured [17] – [19]. Unlike well-structured problems encountered in formal education, ill-structured problems do not have single solutions, are open-ended, are composed of many sub problems; they frequently have many possible solutions paths; and they posses no clear beginning or end [17], [25], [26]. Therefore, the skills required to solve well-structured problem are different than those required to solve ill-structured problems. Authors' believe that instructional materials supporting ill-structured problem solving skills should incorporate 'case that represent probable real-world problems in the domain, that is, that are authentic' [17].

Koul [27] explained that stories are the oldest and most natural form of sense making. Stories are the "mean [by] which human beings give meaning to their experience of temporality and personal actions" (as cited in Polkinghorne [28]. Cultures have maintained their existence through different types of stories, including myths, fairy tales, and histories. Humans appear to have an innate ability and predisposition to organize and represent their experiences in the form of stories. One reason for that proclivity is that stories require less cognitive effort than exposition because of the narrative form of framing experience [29]. To be part of a culture, it is necessary to be connected to the stories that abound in the culture. Telling stories has function: It is a method of negotiating meanings [30], [31] that allows us to enter into others' realms of meaning through the messages they utter in their stories [28].

### 5.2 The Domain Knowledge Acquisition for CBR

The type of knowledge includes abstract/general knowledge and concrete/specific knowledge [1], [7], [31]. Training in automotive technology involves both type of knowledge [32]. The CBR process is centered on concrete/specific knowledge, but execution and outcomes of the process often include abstract/general knowledge. This abstract/general knowledge is made in

1. Established procedures applied to solving the problems.
2. Indexes of cases.
3. Lessons learned from a problem-solving episode and included in a case.

CBR can be implementing to adapt both case-based (involving concrete/specific knowledge) and schema- mediated (involving abstract/general knowledge) [1], [33]. Research dealing with CBR-inspired applications in education and training often concentrates on the development based on CBR products [11], [13] and could be classified into four categories:

1. CBR-inspired learning environments.
2. Supports for reflection and interpretation of personal experience.
3. Case libraries.
4. Hybrids combining supports for reflection and interpretation with libraries.

Case libraries as learning resources rely on the available of multiple cases and this need has led to the development [13], [33], [36]. As an integral component of a library, the library's indexing scheme enables transfer and application of knowledge stored in the library to resolving new problem situations [37]. Richmond [38] summarized that the sample of case libraries serving as learning resources are presented in Table 1.

**Table 1** Example of Case Libraries Serving as Learning Resources

| Description | Type of Problems Solved |
|---|---|
| Archie-2 | Architectural design issues |
| STABLE | Computer programming skills |
| Case Application Suite | Application of cases |
| Parent-teacher conferences | Analysis of what happens in a conference |
| Technology integration | Analysis of technology integration |
| USDOE PT3/KITE database | Increase technology integration |
| Turfgrass management | Learn domain skills and knowledge |
| Medical case library | Diagnostic and casual reasoning skills |
| Susie | Issues of sustainable technology and development |

In training to solve problems in automotive technology, case library can go beyond simply a library to promoting also contributing to knowledge storage much more than another CBR tool. The library contained case about automotive problems, such as automotive engine systems, suspension systems, transmission systems, body electrical systems, electronic control systems, air conditioning systems, and etc. These practitioners acquired domain content by using and contributing to the library. One indicator of libraries' efficacy is whether or not libraries continued to be used. However, because continued use might reflect inertia more than efficacy, other indicators must be used. Two general findings as the efficacy of libraries relate to building cases and comparing/contrasting cases [31] – [36].

In addition, students can learn as much or even more from constructing cases as form simply using them, assuming a case structure is specified. Second, comparing and contrasting multiple cases for relevance to problem-solving can be more effective learning experience than applying a single case.

### 5.3 CBR as a Technique for Instructional Design on Automotive Technology Courses

In order to analyze stories using CBR, it is necessary first to elect and capture relevant stories about previously solved problems from the practitioners [2] commended for the following four activities:

1. Identify skilled practitioners in the domain.
2. Show the practitioners the practitioners the problem for which you are seeking support.
3. Ask the practitioners if they can remember any similar problems that they have solved. If they can (and they usually can), allow them to tell a story about the problem without interruption. Audiotape or (better yet) videotape their recounting of the story. Following the telling of the story, analyze it with the practitioner. Work with the practitioner to:

1. Identify the problem goals and expectations.
2. Describe the context in which the problem occurred.
3. Describe the solution that was chosen.
4. Describe the outcome of the solution. Was it successfully? Was it a failure? Why? Identify the

points that each story makes (i.e., the lessons that it can teach).

4. Decide what the stories teach. The final step in the analysis process is to index the stories. Indexing stories is the primary analytic activity in the CBR process. It is described here because it is an important task-analysis method. Indexing a number of stories will also provide useful prompts to use when eliciting stories from other practitioners.

**6. Implications**

In order to accomplishment, Jonassen and Hernandez-Serrano [2] explained that a method for collecting stories from practitioners:

1. Identify skilled practitioners who have solved problems similar to the one that are being presented to the students;

2. Show the practitioners the problems, one problem at time. Ask the practitioners if they can remember any similar problems that they have solved. If they can, allow them to tell a story about the problem without interruption;

3. Following the telling of the story, analyze it with the practitioner. Work with practitioner to identify the problem goals, the context in which the problem goals, the context in which the problem occurred, the solution that was chosen, and why, and the outcome of the solution. It is important to identify the points that each story makes, that is, the lessons that it can teach;

4. Following the story telling, the cases should probably be indexed, a process that is set out in Kolodner [7]. And

5. Turf case library at Penn State: http://turfgrass.cas.psu.edu/caselibrary/.

In addition, the effectiveness of learning through CBR can be proposed a prescriptive design for a new Bachelors of Thai Industrial Education program in modernize studies. The process of CBR involves each of the following steps:

1. An encountered problem (the new case) appearance during operate in the workplace prompts the reasoner to retrieve cases from the memory.

2. To reuse the old case (i.e., interpret the new in terms of old), which suggests a solution.

3. If the suggested solution does not work, then the old and or new cases are revised.

4. When the effectiveness is confirmed, then the learned case is retained for later use [2].

Stories can be indexed in two ways, (a) the more common method is through direct input by the human user, who must appropriately index the stories order to make them accessible in a case library. (b) Stories can also be indexed for case libraries by adapting and reindexing already existing cases to new situations. For each case, identify the relevant indexes that would allow cases to be recalled in the situation. Choose from among the following indexes, most of which were suggested by Kolodner [7]:

***1. Problem-Situation-Topic Indexes***

1.1 What are the goals-sub goals-intensions to be achieved in solving the problem or explaining the situation? What constraints affect this goal?

1.2 Which features of the problem situation are the most important and what is the relationship between its parts?

1.3 What plans are develop for accomplishing the goal?

***2. Appropriate Solution Indexes***

2.1 What solution is use?

2.2 What activities are involved in accomplishing the solution?

2.3 What is the reasoning steps used to derive the solution?

2.4 How do you justify the solution?

2.5 What expectations do you have about results?

2.6 What acceptable, alternative solutions, is suggest but not choose?

2.7 What unacceptable, alternative solutions, is not choose?

***3. Appropriate Outcomes Indexes***

3.1 Is the outcome fulfilling?

3.2 Are expectations violating?

3.3 Is the solution a success or failure?

3.4 Can you explain why any failures occur?

3.5 What can you do to avoid the problem?

The result of the elicitation and indexing of stories from practitioners will provide more than enough information to design almost any form of problem-based learning environment. Although this information is activity oriented, links to theory will be obvious in the data. In fact, indexes that were produced to analyze each teacher story included the type of conference, classroom placement, reason for the conference plan, and result of the conference and so on. Stories can provide activity-based descriptions rather than a content description, linking to content is easy. The indexes is nearly all form of problem-based learning begin with a problem and teach the content in the context of the problem. With case-based reasoning, the task analysis also begins with the problem.

CBR puts forward a paradigmatic way to attack artificial intelligence (AI) issues, namely problem solving, learning, usage of general and specific knowledge, combining different reasoning methods, etc. In particular CBR emphasizes problem solving and learning as problem solving uses the results of past learning episodes while problem solving provides the backbone of the experience from which learning advance [1].

**7. Summary and Future Research**

In this paper, authors outlined an overview of the existing literature of CBR principles, methods, and applies is made within a general scheme. Authors believe that best takes place by using stories elicited from skill problem solvers, indexed for the content models is necessary to teach, and made available to learners in the form of case libraries can provide a broader range of problem solving than other strategy or tactic. An important issue is characteristics of a comprehensive CBR tool collected in the cases and used in the adaptation process and the validation process to insure quality and efficiency [39], [40].

This paper discussion provides a theoretical explanation that might, in contractdiction to CBR process, improve problem-solving and case-based reasoning skills. The pre-service teachers (undergraduate mechanical technology education students) will be highly adaptable and creative when integrating learning experience in the workplace. Educators would greatly benefit from the proliferation of this learning innovation.

A comprehensive CBR should support application of the CBR processes to ill-structured problem solving are: (a) Retrieve, (b) Reuse, (c) Revise, and (d) Retain [1]. Problem solving can be of two types: either an algorithmic-type problem-solving, or the more challenging ill-structured-type problem-solving. Algorithmic problem-solving skills follow a set pathway to the problem solution. In contrast, ill-structured problem-solving skills follow a circuitous and unpredictable pathway to solution, and rank at the highest level of intellectual skills. Moreover, a case library is simply an indexed database of solved cases, each including of the problem, solution, and outcome linked to support materials [41].

Finally, a CBR should include the capacity for collecting cases from domain content experts. A defining tenet of CBR is that the novice practitioners of a domain can look to the skilled performance of experienced practitioners of the domain for guidance in resolving domain issues [38], [42], [43] in Table 2.

**Table 2** Seven Theory as a Tool for Research-based Design Requirements

| Title | Requirement |
|---|---|
| 1. Integrated model | Reflect a model of cognition that integrates reasoning, understanding and learning, and dynamic memory |
| 2. Four major steps | Support performing four major steps of the CBR process |
| 3. Ill-structured problem solving | Support the ill-structured problem-solving process |
| 4. Two major parts | Consist of two primary parts: supports for reflection and interpretation of experience and a case library for storing these interpretations |
| 5. Integration | A versatility for ready integration into a range of domains |
| 6. Case construction and contribution | Support constructing cases and contributing them to the case library |
| 7. Expert modeling | Support contribution of cases by domain experts |

The plan for the future research is to construct a number of the idea and challenge outlined with concept maps. The goals of the research should be taken into account when solving the problem what is a good explanation in any situation. For enhancing the effectiveness of adaptive features of CBR approach, and implement them in a research project between the Office of National Research Council of Thailand (NRCT) and Department of Mechanical Technology Education, Faculty of Industrial Education and Technology at King Mongkut's University of Technology Thonburi (KMUTT). Authors are hoped that this approach will yield greater and more focused development to the undergraduate mechanical technology education students on automotive technology courses enabling them to improve the learning experience for the learner.

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