

# Chapter 6

## Taxonomies of Problems and Generic Skills

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### ABSTRACT

- Generic Skills as Problem-Solving Processes
- Generic Skills as Active Meta-Knowledge
- Generic Skills within Learning Objectives
- An Integrated Cycle of Skills for Education
- Comparison of Taxonomies of Skills
- Concept of Generic Skill

The aim of this chapter is to define what we call “generic skills,” i.e. structured sets of intellectual actions, attitudes, values, and principles that are at the heart of human competencies. We will first

examine the various systems that offer different yet convergent views regarding skills.

One multi-viewpoint approach to the concept of skill first analyses the taxonomies of generic problems developed in software engineering. Generic problems correspond to human problem-solving skills as described in cognitive science. Another viewpoint is the concept of active meta-knowledge that situates skills in the realm of meta-cognition, i.e. as knowledge acting on other knowledge. A third viewpoint considers research in education that presents skills in the form of taxonomies of learning objectives in relation to cognitive, affective, social, or psychomotor domains.

We will conclude the chapter with a comparison of the various analysis systems and a definition of generic skills, thus forming the basis for an inte-

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grated taxonomy of skills that will be developed in the next chapter.

## 6.1 GENERIC SKILLS AS PROBLEM-SOLVING PROCESSES

The notion of “generic” problems, tasks and methods, is at the heart of research in software and knowledge engineering (expert systems). Generic problems, tasks, and methods are three widely interchangeable terms representing different viewpoints of the same reality. They will be given specific meaning using the MOT representation system.

The notion of generic problems or tasks was already present in one of the first reference books about knowledge-based systems (Hayes-Roth, Waterman & Lenat, 1984, Waterman 1986, Paquette & Roy 1990); in this work, we find a first classification of generic problems into ten categories. In pioneer studies about generic tasks at Ohio State University (Chandrasekaran 1983; 1987) these are defined through a problem description and a resolution method, which is a specific information processing algorithm. It introduces the idea of combining a small number of generic methods to solve large classes of more complex problems. Other work on generic problems (McDermott 1988), and the “expertise components” approach (Steels, 1990) must be mentioned.

The KADS method (Schreiber, Wielinga & Breuker, 1993), and its most recent version CommonKADS (Breuker & Van de Velde, 1994), is a synthesis of these studies. It actually constitutes a complete methodology integrating knowledge acquisition for expert systems with concepts of project management, organizational analysis, knowledge and software engineering. In KADS, an engineering software project materializes by building seven models. Four of them are of interest here: the “domain model”, the “inference model”, the “task model” and the “strategic model”.

In the *inference model*, we find a decomposition of the generic task into a task tree and a set of inference schemas associated to the leaves of this tree. The *task model* provides control principles, i.e. rules to manage the order of execution within the tasks. The “strategic model”, corresponds to heuristic principles that guide tasks execution. Together, these three models correspond to the notion of a generic process, applicable to various application domains (called “domain models” in KADS).

A **generic problem** is characterized by one or several goals or results to be produced (which are meta-concepts); initial data (also meta-concepts) and a number of operations (meta-procedures) that transform the initial data into results or goals. One recognizes here the notion of a process, one of the categories of problem presented in Chapter 3.

The KADS method defines eight classes of generic problems presented in Table 1.

To each generic problem corresponds a **generic task**, which is a goal to be attained by applying a generic procedure to the input and to produce results, as indicated in Table 1. Breaking down this generic procedure into sub-procedures results in the KADS tasks tree. After a number of levels, terminal-level tasks are reached, to which the KADS method associates an inference schema that details a simple procedure to be executed in a single step.

Figure 1 shows a MOT model for the generic problem of diagnosis similar to the example in Figure 14 in Chapter 3. The Control principles, similar to those on Figure 13 in Chapter 3, correspond to the task model in KADS.

The model is composed of an input: the model of a system of components to be diagnosed. The model main knowledge objects is a generic task, “make a diagnosis”, and an expected result or problem solution: a list of defective components. The generic task is broken down into sub-tasks, up to terminal tasks such as “decompose the model”, which generates some hypothesis about faulty components. An inference schema, selected in

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