

Fuzzy Students' Knowledge Modelling System through Revised Bloom's Taxonomy

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Abstract—The conveniences of web-based educational systems have attracted a large heterogeneous group of learners with various knowledge levels, learning goals, and others learning characteristics, to study online. To enhance the effectiveness of the web-based educational system in delivery knowledge, a system should be capable to identify the learners' learning characteristics, and adapt the instructional process accordingly. Hence, this paper presented a students' knowledge modelling system that is capable of infer and updating the students' knowledge level in accordance to the cognitive processes dimension in the Revised Bloom's Taxonomy. However, the students' knowledge modeling process consists of tasks and factors that are vague and unmeasured, thus Fuzzy Logic is integrated into the students' knowledge modeling system to deal with such uncertainties. The proposed fuzzy students' knowledge modeling system uses fuzzy sets to represent students' knowledge level and other influencing factors, and uses Mamdani type inference technique to determine and update knowledge levels.

Index Terms—Cognitive Processes Dimension; Fuzzy Logic; Knowledge Modelling System; Web-Based Educational System.

I. INTRODUCTION

Concurrent with the advances of computer and web technologies, the number of learners using web-based educational systems has increased. The main attractive of web-based educational systems is that the learners can gain knowledge through electronic information and communication technologies although they are separated with the instructor in space and time [1, 2]. In fact, the learners have different knowledge levels, cognitive and meta-cognitive abilities, learning needs, and others learning characteristics. Therefore, it is ineffective to deliver same learning materials to all learners through same instructional conditions.

To effectively deliver knowledge to the heterogeneous group of learners, the web-based educational systems should be capable of analysis the learning characteristics of the learners and their learning outcomes, and adapt the instructional process accordingly, like the teaching process of real classrooms education [3]. A system with such capabilities of collecting, reasoning and maintaining learners' learning characteristics is known as user modelling system. For an educational system, the important learners' learning characteristic is the learners' knowledge level [4]. Hence, this paper proposed to model knowledge level in accordance to the cognitive processes dimension in the Revised Bloom's Taxonomy, which described six major categories of intellectual knowledge development.

However, the learners' knowledge level is ambiguous in

description and subject to change. Therefore, the user modelling system should be capable of dealing with such vagueness in reasoning and updating the knowledge level of the learners and the corresponding changes occurred during the learning process throughout the learners' interactions with the web-based educational system [5].

Therefore, this paper presents a system that uses Fuzzy Set Theory to model learners' knowledge level in accordance to cognitive processes dimension in the Revised Bloom's Taxonomy [6]. An overview of cognitive process dimension and user modelling system in web-based educational system is provided first. Following is the description of the proposed fuzzy students' knowledge modelling system. The implementations of the proposed system are presented and discussed in the end.

A. Cognitive Processes Dimension

Bloom's Taxonomy, named after Benjamin Bloom, was originally published in 1956 [7]. This original Taxonomy is a framework for creating and classifying learning goals and measuring learning outcomes across subject matter and grade levels. The original Taxonomy consisted of three domains - cognitive domain, affective domain and psychomotor domain. This paper focuses on the cognitive domain as it describes the intellectual knowledge development. The cognitive domain of the original Taxonomy has six major categories - *Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation* [8]. Each category represents difference cognitive skills and learning goals.

Among several revisions proposed to the original Taxonomy, a revision published in 2001 [9], referred to as the revised Taxonomy, extended the original Bloom's Taxonomy to two dimensions - knowledge dimension and cognitive processes dimension. The cognitive processes dimension has six major categories like the original Bloom's Taxonomy, but changed the order of the *Synthesis* category and the *Evaluation* category, and renamed them to *Remember, Understand, Apply, Analyse, Evaluate, and Create* [6]. The changes are shown in Figure 1.

These six categories of the cognitive processes dimension in the revised Taxonomy are used to categorize learners' knowledge level in the proposed fuzzy students' knowledge modeling system.