Ilkogretim Online - Elementary Education Online, 2021; Vol 20 (Issue 5): pp. 5616-5620
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2021.05.633

THE REVISED TAXONOMY STRUCTURE BASED ON COGNITIVE PROCESS AND KNOWLEDGE DIMENSION

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Abstract- The need for the taxonomies and how educators use taxonomy are discussed in this article. The two-dimensional arrangement of the taxonomy table for the knowledge dimension and cognitive process dimensions is provided. The article deals with the importance of objectives for facilitating communication in the classroom. The noun and verb indicators are also discussed. The four main categories of the knowledge dimension and their associated subcategories were also discussed here. The importance of differentiating among these four types of knowledge is also mentioned.

Keywords: Taxonomy, Knowledge dimension, Cognitive process, Factual knowledge, Conceptual knowledge

I. INTRODUCTION

Taxonomy is a special kind of framework in which the categories lie along a continuum. This continuum is one of the organizing principles of the framework. In the taxonomy of education, we are classifying objectives. A statement of an objective contains a verb and a noun. The verb generally describes the intended cognitive process. The noun describes the knowledge that the students are expected to acquire or construct as a result of teaching.

In education, objectives indicate what we want students to learn: they are explicit formulations of how students are expected to be changed by the educative processes (Handbook, 1956, p.26). Objectives are especially important in teaching because teaching is an intentional and reasoned act. Teaching is intentional because we always teach for some purpose, primarily to facilitate student learning. Teaching is reasoned because what teachers teach their students is judged by them to be worthwhile.

It is high time to find the answer to the question: What is worth learning? At an abstract level, the answer defines what it means to an educated person. At a more concrete level, the answer defines the meaning of the subject matter being taught. While looking through the lens of the Taxonomy Table, teachers can see more clearly the array of possible objectives as well as relationships among them. A more complete understanding of the curriculum will be obtained when we analyze all parts of a curriculum in terms of the Taxonomy Table. The Taxonomy framework helps teachers to translate standards into a common language for comparison with what they hope to achieve, and by presenting the variety of possibilities for consideration, the Taxonomy may provide some perspective to guide curriculum decisions.

Categories of the knowledge Dimension

Factual, Conceptual, Procedural, and Metacognitive are the four general types of knowledge. Factual knowledge is the knowledge of discrete, isolated content elements-'bits of information'. It includes knowledge of terminology and knowledge of specific details and elements. Conceptual knowledge is the knowledge of more complexes, organized knowledge forms including knowledge of classification and categories, principles and generalizations, theories, models, and structures. Procedural knowledge is knowledge of how to do something. It includes knowledge of skills and algorithms, techniques, and methods. Metacognitive knowledge is knowledge about cognition in general as well as awareness of and knowledge about one's cognition. It encompasses strategic knowledge, knowledge about cognitive tasks including contextual and conditional knowledge, and self-knowledge.

Figure 1 depicts the analytic approach from the statement of an objective to its place in the Taxonomy Table. The approach begins by locating the verb and noun in the objective. The verb is examined in the context of the six categories of the cognitive process dimension: remember, understand, apply, analyze, evaluate and create. The noun is examined in the context of the four types in the knowledge dimension: factual, conceptual, procedural, and metacognitive.

Theknowledge dimension	The cognitive process dimension					
	1.Remember	2.Understand	3.Apply	4.Analyze	5.Evaluate	6.Create
A. Factual						
B. Conceptual						
C. Procedural						
D. Metacognitive						

Figure 1: The taxonomy table for the knowledge dimension

Each of the six major categories is associated with two or more specific cognitive processes, 19 in all described in verb forms as shown in Figure 2. To differentiate specific cognitive processes from six categories, the specific cognitive processes take the form of gerunds. Thus recognizing and recalling are associated with remembering, interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining are associated with understanding and so on.

PROCESS CATEGORIES	COGNITIVE PROCESSES
1. REMEMBER	Retrieve relevant knowledge from long-term memory
1.1 Recognizing 1.2 Recalling	
2. UNDERSTAND	Construct meaning from instructional messages, including oral, written, and graphic communication
2.1 Interpreting 2.2 Exemplifying 2.3 Classifying 2.4 Summarizing 2.5 Inferring 2.6 Comparing 2.7 Explaining	
3. APPLY	Carry out or use a procedure in a given situation
3.1 Executing 3.2 Implementing	
4. ANALYZE	Break materials into constituent parts and determine how parts relate to one another and an overall structure or purpose
4.1 Differentiating 4.2 Organizing 4.3 Attributing	
5. EVALUATE	Make judgments based on criteria and standards
5.1 Checking 5.2 Critiquing	
6. CREATE	Put elements together to form a coherent functional whole; reorganizing elements into a new pattern or structure
6.1 Generating 6.2 Planning 6.3 Producing	

Figure 2: The six categories of the cognitive process dimension and related cognitive processes

Current conceptions of learning focus on the active, cognitive and constructive processes involved in meaningful learning. Learners are assumed to be active agents in their learning, they select the information to which they will attend and construct their meaning from this selected information. Learners are not passive recipients, nor are they simple recorders of information provided to them by parents, teachers, textbooks, or media. This will move away from passive views of learning toward more cognitive and constructivist perspectives that emphasize what learners know (knowledge) and how they think (cognitive processes) about what they know as they actively engage in meaningful learning.

In instructional settings, learners are assumed to construct their meaning based on their prior knowledge, their current cognitive and metacognitive activity, and the opportunities and constraints they are afforded in the setting. Learners come into any instructional setting with a broad array of knowledge, their own goals, and prior experiences and they use all these to make sense of the information they encounter. This constructivist process of making sense involves the activation of prior knowledge as well as various cognitive processes that operate on that knowledge.

The students can construct meanings that do not coincide with the authentic aspects of reality or with well-accepted, normative conceptions of the information. Much of the literature on conceptual change and student learning is concerned with how students come to construct conceptions of everyday phenomena that do not match the commonly accepted scientific knowledge and models of those phenomena. Educators should guide students toward the authentic and normative conceptions that reflect the most commonly accepted and best current knowledge and thinking in the academic disciplines and subject matter areas.

A. Factual Knowledge

Factual knowledge encompasses the basic elements that experts use in communicating about their academic discipline, understanding it, and organized systematically. Factual knowledge comprises the basic elements students must know if they are to be acquainted with their discipline or to solve any of the problems in it. The elements are usually associated with some strings of symbols.

Knowledge of terminology: It includes knowledge of specific verbal and non-verbal labels and symbols (e.g., words, numerals, signs, pictures). The novice learner must be cognizant of these labels and symbols and learn the generally accepted referents that are attached to them and the experts must communicate with these terms. Experts usually find their labels and symbols so useful and precise that they are likely to want the learner to know more than the learner needs to know or can learn. Example: Knowledge of scientific terms.

Knowledge of specific details and elements: It refers to the knowledge of events, locations, people, dates, sources of information, etc. specific facts are those that can be isolated as separate, discrete elements in contrast to those that can be known only in a larger context. Every subject matter contains some events, locations, etc. such specific facts are basic information that experts use in describing their field and in thinking about specific problems or topics in the field. These facts can be distinguished from terminology, terminology generally represents the conventions or agreements within a field whereas facts represent findings arrived at by means other than consensual agreements made for purposes of communication. Example: Knowledge of major facts about particular cultures and societies.

B. Conceptual Knowledge

Conceptual knowledge includes knowledge of categories and classifications and the relationship between and among them. It includes schemas, mental models, or implicit explicit theories in different cognitive psychological models. These models or schemas represent the knowledge an individual has about how a particular subject matter is organized and structured and how the different parts of information are interconnected and interrelated in a more systematic manner and also how these parts function together. Conceptual knowledge includes three subtypes: knowledge of classifications and categories, knowledge of principles and generalizations, and knowledge of theories, models, and structures.

Knowledge of classifications and categories: This includes the specific categories, classes, divisions, and arrangements that are used in different subject matters. As subject matter develops, individuals who work on it find it advantageous to develop classifications and categorizations that can use to structure and systematize the phenomena. This type of knowledge is somewhat more general and often more

abstract than the knowledge of terminology and specific facts. Each subject matter has a set of categories that are used to discover new elements as well as to deal with them once they are discovered. Knowledge of classifications and categories is an important aspect of developing expertise in an academic discipline. Example: Knowledge of the variety of types of literature.

Knowledge of principles and generalizations: These are composed of classifications and categories. Principles and generalizations tend to dominate an academic discipline and are used to study phenomena or solve problems in the discipline. One of the hallmarks of a subject matter expert is the ability to recognize meaningful patterns and activate the relevant knowledge of these patterns with little cognitive effort. Example: Knowledge of the fundamental laws of physics.

Knowledge of theories, models, and structures: This includes knowledge of principles and generalizations together with their interrelationships that present a clear, rounded, and systematic view of complex phenomena, problems, or subject matter. These are the most abstract formulations. Example: Knowledge of genetic models (eg. DNA)

C. Procedural Knowledge

It is the 'knowledge of how to do something. The something might range from completing fairly routine exercises to solve novel problems. Procedural knowledge takes the form of a series or sequence of steps to be followed. It includes knowledge of skills, algorithms, techniques, and methods collectively known as procedures.

Knowledge of subject-specific skills and algorithms: As procedural knowledge can be expressed as a series or sequence of steps collectively known as a procedure. Sometimes the steps are followed in a fixed order and sometimes decisions must be made about which step toward the next and in some cases, the result is fixed. Example: Knowledge of the various algorithms for solving a quadratic equation.

Knowledge of subject-specific techniques and methods: This includes knowledge that is largely the result of consensus, agreement, or disciplinary norms rather than the knowledge that is more directly an outcome of observation, experimentation, or discovery. This subtype of knowledge generally reflects how experts in the field or discipline think and attack problems rather than the results of such thought or problem-solving. Example: knowledge of the techniques used by the scientists in seeking solutions to the problems.

Knowledge of the criteria for determining when to use appropriate procedures: In addition to knowing subject-specific procedures, students are expected to know when to use them, which involves knowing the ways they have been used in the past. Such knowledge is nearly always of a historical or encyclopedic type. Before engaging in an inquiry, students may be expected to know the methods and techniques that have been used for similar inquiries. Example: Knowledge of the criteria for determining which statistical procedure to use with data collected in a particular experiment.

D. Metacognitive Knowledge

Metacognitive knowledge is the knowledge about cognition in general as well as awareness of and knowledge about one's cognition. One of the hallmarks of theory and research is the emphasis on making students more aware of and responsible for their knowledge and thought. With the development, students will become more aware of their thinking as well as more knowledgeable about cognition in general and so they will tend to learn better.

Strategic knowledge: This is the knowledge of general strategies for learning, thinking, and problem-solving. The strategies in this type can be used across many different tasks and subject matters, rather than being most useful for one particular type of task in one specific subject area. Strategic knowledge includes general strategies that represent the various general heuristics students can use to solve problems. In addition to problem-solving strategies, there are general strategies for deductive and inductive thinking, evaluating the validity of different logical statements, avoiding circumstances in arguments, making appropriate inferences from different sources, etc. Example: Knowledge of planning strategies such as setting goals for reading.

Knowledge about cognitive tasks, including contextual and conditional knowledge: In addition to the knowledge about various strategies, individuals accumulate knowledge about cognitive tasks. Flavell (1979), in his traditional division, included knowledge that different cognitive tasks that may be more or less difficult may make differential demands on the cognitive system and may require different cognitive strategies. As students develop knowledge of different learning and thinking strategies, this knowledge reflects both what general strategies to use and how to use them. This knowledge may not be sufficient for expertise in learning. Students also need to develop the conditional knowledge for these general cognitive strategies, they need to develop some knowledge about the when and why of using these strategies appropriately (Paris, Lipson and Wixson, 1983). Example: Knowledge that a primary sourcebook may be more difficult to understand than a general textbook or popular book.

Self-knowledge: Along with the knowledge of different strategies and cognitive tasks, Flavell (1979) proposed that self-knowledge was an important component of metacognition. In his model self-knowledge includes knowledge of one's strengths and weaknesses about cognition and learning. In addition to the knowledge of one's general cognition, individuals have beliefs about their motivation. If students are not aware they do not know some aspects of factual knowledge or conceptual knowledge or that they don't know how to do something (procedural knowledge), it is unlikely they will make an effort to learn the new material. A hallmark of experts is that they know what they know and what they do not know, and they do not have inflated or false impressions of their actual knowledge and abilities. Example: Knowledge of one's interest in a task.

II. CONCLUSION

The taxonomy table helps the educators to clarify and communicate what they intend students to learn as a result of instruction. These intentions are the objectives. The student will be able to or learn to 'verb noun' where the verb indicates the cognitive process and the noun generally indicates the knowledge. The taxonomy table emphasizes student-oriented, learning-based, explicit, and assessable statements of intended cognitive outcomes.

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