

Chapter 2

Revised Bloom's Taxonomy—The Swiss Army Knife in Curriculum Research

Tools to Analyze Cognitive Demands: Why Revised Bloom's Taxonomy

Analyzing cognitive demands in a curriculum can map out what children are expected to learn and be able to do throughout their period of formal schooling. The question now is which tools are available or effective to analyze the dimensions and types of knowledge/skills required to teach/learn in schools. There are several tools available to analyze learning objectives in curriculum such as Bloom's Taxonomy (Bloom et al. 1956) and its revised version (Anderson et al. 2001), Klopfer's model (1971), the Structure of the Observed Learning Outcome (SOLO) taxonomy (Biggs 1995) and the New Taxonomy (Marzano and Kendall 2007). It is clear that each tool has its unique purposes, strengths, and limitations, and scholars using these tools have explained how these could help to understand cognitive dimensions of curriculum demands, students' learning process, and learning outcomes by compensating and overcoming the limitations of other tools. After scrutiny of these tools, revised Bloom's Taxonomy (RBT) was chosen as the most appropriate here, although it is not perfect for analyzing and comparing the cognitive dimensions of curriculum among the six states. In this section, we give an overview of those tools to explain why we chose RBT as the most suitable one for our study.

Bloom's Taxonomy (Bloom et al. 1956) was a widely used tool to characterize instructional objectives in educational documents such as curricula, perform objectives-based evaluation on students' achievement, and for aligning curriculum and assessment. The structural dimensions of knowledge and cognitive skills provided educators and policy developers practical ways to examine critical information on pedagogy and school practice for students' learning and cognitive development (Wee et al. 2011). Despite its practicality and accessibility, the early version of Bloom's Taxonomy was criticized for generalized and unidimensional domains of knowledge and skills that could not clearly explain the levels and dimensions of cognitive demands in the analyses of instructional objectives for

students' learning and assessment plans. Furthermore, this version was also criticized for not being able to address the emphasis of higher levels of thinking, which became the focus of science teaching in the 1980s. These constraints led other tools to emerge such as Klopfer's model and the updated version of Bloom's Taxonomy.

Klopfer's model (1971) was designed to overcome criticisms concerning the generalized format of the original version of Bloom's Taxonomy (Bloom et al. 1956). It suggested domain-specific cognitive dimensions of science such as science inquiry and attitudes of science to emphasize students' learning beyond conceptual knowledge. A couple of researchers have employed this model as an alternative to analyze science curriculum. However, they found that the knowledge dimension in this model was also too broadly categorized in a one-dimensional structure, and it was separated from inquiry processes (Wee et al. 2011). This tool was likely to lead curriculum analysis into two separate domains, thus, unable to unpack the complexity of knowledge and cognitive processes. Anderson and Krathwohl (part of the original Taxonomy authors) recognized the need for revising the original version to overcome the limitations of one-dimensional categorizations, generalizations of cognitive dimensions, and difficulties of coding cognitive levels based on rigid hierarchical categorizations (Anderson et al. 2001; Krathwohl 2002). They revised Bloom's Taxonomy and published their work, *Revised Bloom's Taxonomy* in 2001. Compared to the previous version published 60 years ago, RBT has in essence made 12 changes (four each in emphasis, terminology and structure) adding another dimension of knowledge and interchanging the ranks of the highest two cognitive processes (i.e., Evaluate and Create). The revision accordingly proposed a two-dimensional approach to map cognitive development (i.e., adding knowledge dimensions and cognitive process) and also suggested verb forms (Understand, Explain, Infer, Create, etc.) to describe the cognitive processes with greater clarity. Thus, we now have four levels of knowledge: Factual, Conceptual, Procedural, and Metacognitive as well as six categories of cognitive processes, namely, Remember, Understand, Apply, Analyze, Evaluate, and Create.¹ Since then, RBT has been used internationally in mathematics and science curriculum research (e.g., Ari 2011; Porter 2006), although this literature has been extremely limited with regards to work in elementary science.

While RBT was under development, Marzano (2000) and his colleagues (Marzano and Kendall 2007) recognized the limitations of Bloom's Taxonomy and strove to develop a better tool for analyzing cognitive demands that they called the "New Taxonomy." They attempted to solve the issues of higher level thinking and sophisticated knowledge dimensions by looking into students' cognitive perception toward knowing and learning process. They emphasized the level of self and metacognitive domains of learning. This model consists of three systems (i.e., self-system, metacognitive system and cognitive system) and knowledge domains.

¹These four dimensions of knowledge and six cognitive processes will be in capitals throughout this book. Thus, for example, we will simply state that an item is in Conceptual without attaching the word "category" after it.

They explained that when students are engaged in a new task or unfamiliar ideas, they always go through the initial process of cognition, that is, students perceive and pay attention to the task and ideas. This step is called self-system. Then later, students pay attention to what they would like to learn and how they achieve their goals, which is a dimension of the metacognitive system. And students process necessary information (cognitive system) to learn and accomplish their task. In this process, knowledge provides the content of thinking. This cognitive system is broken down to four components: Knowledge retrieval, comprehension, analysis, and knowledge utilization (Marzano 2000). Similar to RBT, the New Taxonomy also suggested a two-dimensional model to understand the complexity of students' learning and thinking. This model suggests an important lens to look into how students behave encountering new tasks, and it is critical to recognize the importance of self and metacognitive systems in students' learning. Yet self- and metacognitive systems in this model focus on the beginning part of students' learning process, whereas instructional objectives in curriculum focus on the targeted goals and outcomes of learning. Since our study of curriculum analysis does not have access to understanding students' learning behaviors or the process of cognitive development over time, the New Taxonomy is not the best tool to deliver our research goals.

The SOLO taxonomy is another popular tool to comprehend cognitive development in students' learning. This model proposes several dimensions of cognition; prestructural, unistructural, multistructural, relational, and extended abstract to understand the complexity and nonlinearity of children's cognitive development. It is particularly useful for evaluating the growth of students' cognition in classrooms (Biggs 1995). That is, it assesses what levels of cognition students develop over time. For instance, teachers can evaluate whether a learner can list the stages of life cycles of a butterfly (unistructural) before being able to explain the complexity and interrelation of life cycles and habitats (relational). Thus, this tool is more appropriate to assess process of children's cognitive development in classrooms (Brabrand and Dahl 2009) rather than analyzing intended cognitive demands in curriculum.

Given that this study intends to analyze and compare the learning objectives stated in curriculum documents, the RBT was chosen as the most appropriate tool. SOLO and the New Taxonomy are better for examining students' behaviors and learning progression while Klopfer's model was not able to unpack the complexity of students' learning. There are also some tools developed in local regions such as semantic network analysis in a study of Korean curriculum analysis (Chung et al. 2013) that suggested the importance of being critical toward various tools to analyze learning objectives in curriculum. Yet due to the regional uniqueness and language, those tools also had their own limitations. Understanding the strengths and weakness of each tool, we decided to employ revised Bloom's Taxonomy (RBT) as the most suitable and effective tool to reach the goals of our study.

We do not claim that RBT is a perfect tool to analyze cognitive dimensions of learning objectives. We acknowledge there are certain limitations in RBT. As students' thinking and learning is a complex, nonlinear notion, the hierarchical

approach in RBT regarding the levels and dimensions of knowledge and process might be too simplistic to explain the complexities of cognition. In this regard, it is important for us to further unpack some of the problems with RBT and use the tool with mindfulness and clarity.

Further Critiques of Bloom's Taxonomy

In a chapter on reading comprehension research in science, Holliday and Cain (2012) report that popular strategies in this domain have been largely ineffective, including those that all rely on Bloom's Taxonomy:

Bloom's taxonomy sounds like a good idea, except for the lack of supportive evidence-based theory and research, as noted by Richard C. Anderson (1972). More generally, it is amazing how long myths can stay alive, resulting in preservice teachers in universities being taught and tested about, for example, Bloom's six dreamed-up levels and their mythical hierarchy (p. 1406).

They concede, however, that "if these...notions seem to work for you, then perhaps you should not categorically dismiss them" (p. 1406). Such strong criticisms of Bloom's Taxonomy, in fact, are not new and have been around for a number of decades. Most of them revolve around the empirical basis for the hierarchy of processes, the categories, and questions about its efficacy in/for curriculum work (see Anderson and Sosniak 1994). Even after the publication of the revised version of the Taxonomy, such doubts have continued although there is now room for some optimism. For example:

The results of the meta-analysis provide slight support for the cumulative hierarchy assumption....Our re-analysis supports the conclusions reached in most of the individual studies—namely, that, excluding knowledge, the support for a cumulative hierarchy is clearest for the simpler categories of the structure. Kreitzer and Madaus (1994) reached this same conclusion (Anderson et al. 2001, p. 293).

Other problems regarding its rather theoretical or abstract manner for curriculum-making have been perhaps overstated; in particular, there have been a number of concerns regarding its application for curriculum development, instruction as well as for assessment (see Anderson et al. 2001, Chap. 17). Looking back over the 60 years since the first version of the Taxonomy was published, it is nonetheless insightful to read how Benjamin Bloom himself cogently justified the Taxonomy for educational purposes.

The Taxonomy does not impose a set of teaching procedures, nor does it view objectives as so detailed and restrictive that a single teaching method is implied. Rather, a teacher has a wide range of choices in making instructional decisions related to objectives associated with each level of the Taxonomy. The Taxonomy does emphasize the need for teachers to help students learn to apply their knowledge to problems arising in their own experiences and to be able to deal effectively with problems that are not familiar to them. This emphasis

alone should guard against the rote learning of ready-made solutions. It is obvious, at least to me, that many of the criticisms directed towards the Taxonomy have resulted from very narrow interpretations of both the Taxonomy and its proper applications (Bloom 1994, p. 7).

As he indicated, some problems could take place in its narrow interpretations and implications in educational settings, but it is also critical to recognize the limitations of the hierarchical categorization of cognition in educational practice such as enactive learning and teaching. Despite the two-dimensional structure of revised Bloom's Taxonomy attempted to overcome the generalization of cognitive dimensions, there still remains the challenge of analyzing the level of thinking (Marzano and Kendall 2007). For instance, Evaluate is a higher level than Analyze in the hierarchy of RBT, but the latter often requires more complex cognitive process than a simple evaluate activity. That is, a learning objective such as "students draw a conclusion from data of population changes and environmental changes" (Analyze) requires a higher and more complex level of cognition than "students can judge if temperature affects plant growth" (Evaluate) (Anderson et al. 2001). Thus, just looking into the verbs of learning objectives in the hierarchy system is sometimes limited when explaining the level of cognitive demands. Thus, coding always requires careful interpretations through the Taxonomy. Furthermore, RBT aims to identify only knowledge and skills. That is, it is not able to understand students' learning process, values, and attitudes in students' learning. These latter categories are also critical aspects of science literacy and goals of science education, but there are no categories to recognize these in RBT. In this regard, RBT does not capture the holistic view of instructional objectives within science curricula.

Despite all these limitations and problems, RBT is still an extremely useful tool when used for specific purposes such as understanding cognitive demands of instructional objectives in curriculum documents, which is the intention of our study. As one of the few educational innovations that have come from academia and found an enormously welcoming acceptance in K-12 systems in the USA and even more overseas, Bloom's Taxonomy is a well-loved and respected tool despite known shortcomings (Schneider 2014). More so when the revised version has been intentionally updated for extensive adoption within K-12 school systems, a departure from its original domicile of higher education. We like to think that in some respects, RBT is analogous to how scientists have viewed the structure of the atom; there are elaborate models/theories backed by various degrees of empirical evidence, but the exact structure of an atom can never be known with complete certainty. It is perhaps too cynical to label all these categories in RBT as mere hypothetical constructs or useful fictions as some are wont to do given the immense contribution that the Taxonomy has functioned as a curriculum tool over the past 60 years. As long as researchers recognize the limitations of RBT and are clear about their research intentions with this tool, using RBT can be an effective method to serve their purpose.

References

- Anderson, L. W., & Sosniak, L. A. (Eds.). (1994). *Bloom's taxonomy: A forty-year retrospective. Ninety-third yearbook of the National Society for the Study of Education. Part II*. Chicago, IL: The University of Chicago Press.
- Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich... Wittrock, M. C. (Eds.). (2001). *A taxonomy for learning, teaching and assessing. A revision of Bloom's taxonomy of educational objectives*. White Plains, NY: Addison-Wesley Longman.
- Ari, A. (2011). Finding acceptance of Bloom's revised cognitive taxonomy on the international stage and in Turkey. *Educational Sciences: Theory and Practice*, 11, 767–772.
- Biggs, J. (1995). Assessing for learning: Some dimensions underlying new approaches to educational assessment. *The Alberta Journal of Educational Research*, 41, 1–17.
- Bloom, B. S. (1994). Reflections of the development and use of the Taxonomy. In L. W. Anderson, & L. S. Sosniak (Eds.), *Bloom's taxonomy: A forty-year retrospective. Ninety-third yearbook of the National Society for the Study of Education. Part II* (pp. 1–8). Chicago, IL: The University of Chicago Press.
- Bloom, B. S., Engelhart, M. D., Furst, E.J., Hill, W.H., & Krathwohl, D., R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain*. New York: David McKay.
- Brabrand, C., & Dahl, B. (2009). Using the SOLO taxonomy to analyze competence progression of university science curricula. *Higher Education*, 58, 531–549.
- Chung, D. H., Lee, J.-K., Kim, S. E., & Park, K. J. (2013). An analysis on congruency between educational objectives of curriculum and learning objectives of textbooks using semantic network analysis-focus on Earth Science I in the 2009 revised curriculum. *Journal of the Korean Earth Science Society*, 34, 711–726.
- Holliday, W. G., & Cain, S. D. (2012). Teaching science reading comprehension: A realistic, research-based approach. In B. Fraser, K. Tobin, & C. McRobbie (Eds.), *Second international handbook of science education* (pp. 1405–1417). Dordrecht: Springer.
- Klopfer, L. E. (1971). Evaluation of learning in science. In B. S. Bloom, J. T. Hastings, & G. F. Madsus (Eds.), *Handbook on formative and summative evaluation of students learning*. NY: McGraw-Hill.
- Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into Practice*, 41, 212–264.
- Marzano, R. J. (2000). *Designing a new taxonomy of educational objectives*. Thousand Oaks, CA: Corwin Press.
- Marzano, R. J., & Kendall, J. S. (Eds.). (2007). *The new taxonomy of educational objectives*. Thousand Oaks, CA: Corwin Press.
- Porter, A. C. (2006). Curriculum assessment. In J. L. Green, G. Camilli, & P. B. Elmore (Eds.), *Handbook of complementary methods in education research* (pp. 141–159). Mahwah, NJ: Lawrence Erlbaum.
- Schneider, J. (2014). *From the ivory tower to the schoolhouse: How scholarship becomes common knowledge in education*. Cambridge, MA: Harvard Education Press.
- Wee, S.-M., Kim, B.-K., Cho, H., Sohn, J., & Oh, C. (2011). Comparison of instructional objectives of the 2007 revised elementary science curriculum with 7th elementary curriculum based on Bloom's revised taxonomy. *Journal of Korean Elementary Science Education*, 30, 10–21.

East-Asian Primary Science Curricula

An Overview Using Revised Bloom's Taxonomy

Lee, Y.-J.; Kim, M.; Jin, Q.; Yoon, H.-G.; Matsubara, K.

2017, XIII, 81 p. 2 illus., Softcover

ISBN: 978-981-10-2689-8