Construction of Educational Objectives: An Analysis from Blooms Perspectives

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ABSTRACT: The purpose of this study was to create educational objectives based on different levels of the cognitive domain of Bloom's taxonomy. Moreover, it aimed to identify the action verbs related to science education at the secondary level for bachelor-level students. To achieve this, a qualitative research methodology was used with 15 students selected through a purposive sampling procedure from campus A. In-depth interview guidelines and focus group discussions were prepared and validated by subject experts and colleagues. Seven students participated in the interview, and two FGDs were conducted using the research tools. The field data was coded and analyzed thematically. The study investigates the difficulties of Bloom's Taxonomy and its application in modern education and cognitive science. It also identifies the action verbs and their possible specific and behavioral objectives in science education. Each level of cognitive domain emphasizes its significance in curriculum building, instructional strategies, and assessing cognitive growth in science education. The research investigates the changing applications of Bloom's Taxonomy that should be used in today's technologically driven educational context.

Introduction

In 1956, Benjamin S. Bloom created the cognitive domain, which is now used to systematically understand human cognition and learning. Bloom's Taxonomy is a tool for educators that has been applied in various fields from psychology to instructional design (Anderson et al., 2001). This taxonomy categorizes cognitive skills into six levels: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. These levels build upon one another, with each subsequent level building upon the previous one (Larkin & Burton, 2008). Knowledge is the foundational level of cognitive development (Benvenuti et al., 2023). At this stage, learners recall facts, information, and concepts without understanding their deeper meaning. Memorization, repetition, and basic comprehension exercises are strategies that facilitate knowledge acquisition. Comprehension involves understanding and grasping the meaning of the acquired knowledge (Smejkalova & Chetail, 2023). Learners can interpret and explain concepts in their own words, demonstrating a deeper understanding than memorization.

Educators often use activities such as summarization and paraphrasing to promote comprehension. Application requires learners to apply their acquired knowledge and comprehension to solve problems or perform tasks in new and unfamiliar contexts (Weinstein & Underwood, 2014). This level demands the transfer of knowledge from theoretical understanding to practical situations. Real-world scenarios, case studies, and simulations are valuable tools for promoting application skills. The analysis involves breaking down complex ideas or situations into constituent parts to gain a deeper understanding (Csizmadia et al., 2015). Learners at this stage can identify patterns, relationships, and underlying structures. Activities that foster analysis include critical thinking exercises, comparison studies, and data interpretation tasks. Synthesis is the level at which learners combine information and ideas from various sources to create something new (Scardamalia et al., 2006). It requires creativity and the ability to integrate knowledge in novel ways. Problem-solving, project-based learning, and creative tasks encourage synthesis. The highest level in Bloom's Taxonomy, evaluation, involves the ability to assess the quality, significance, and validity of information and arguments (Widana, 2017). Learners at this stage can make judgments and recommendations based on critical analysis. Debates, peer reviews, and ethical dilemmas effectively promote evaluation skills.

In today's educational landscape, Bloom's Taxonomy remains highly relevant. It guides educators in developing curricula that promote progressive cognitive growth (Erickson, 2007). It also informs assessment strategies, ensuring learners are evaluated at the appropriate cognitive level. Additionally, technology has expanded the horizons of Bloom's Taxonomy, offering new tools and approaches for each level. Technology has become an integral part of modern education, from online quizzes for knowledge assessment to virtual reality simulations for application and synthesis. Bloom's Taxonomy is versatile and adaptable, making it applicable in various educational contexts. It can be used from early childhood education to higher education and beyond. Here, we explore how Bloom's Taxonomy can be implemented in different settings: In preschool and kindergarten, educators focus primarily on the lower levels of Bloom's Taxonomy, particularly Knowledge and Comprehension (Phee et al., 2020). Children are encouraged to absorb facts, learn new words, and understand basic concepts. Storytelling, arts and crafts, and interactive games are crucial in building foundational knowledge and comprehension skills. As students progress through primary and secondary education, the emphasis expands to include Application, Analysis, and Synthesis. Teachers create lessons that challenge students to problem-solve, experiment, and think critically (Glance et al., 2018). Assigning group projects and debates facilitates information synthesis and effective collaboration. In college and university environments, Bloom's Taxonomy is employed to design intricate learning experiences (Frerejean et al., 2019). Instructors attempt to promote Analysis, Synthesis, and Evaluation capabilities by assigning research papers, case studies, and independent projects to the students. Students are expected to think critically, question assumptions, and assess the validity of arguments. Beyond traditional education, Bloom's Taxonomy also informs professional development programs through the application to construct objectives, questions, and curricula. Employees and professionals engage in lifelong learning, often requiring them to apply and evaluate knowledge in their respective

fields. Continuing education courses and workshops are structured to promote higher-order thinking skills and practical application (Murphy et al., 2013).

Critics argue that the linear hierarchy of Bloom's Taxonomy oversimplifies the complexity of cognitive development (Dehibi, Hadji, & Nouri, 2022). In reality, learners may engage in multiple cognitive processes simultaneously. The taxonomy was developed in a Western context and may not fully consider the cultural and contextual differences that influence learning and cognition (Geary, 1995). Bloom's Taxonomy primarily addresses cognitive skills, leaving out the affective (emotional and attitudinal) and psychomotor (physical) domains, equally crucial in education. As education continues to evolve and adapt to the needs of learners and society, Bloom's Taxonomy will likely undergo further refinement and expansion (Fink, 2013). Similarly, researchers are exploring integrating emotions and physical skills into Bloom's Taxonomy for education. Technology's impact on learning and assessment shapes its application (Forehand, 2010).

Literature Review

According to Anderson et al. (2001), Bloom's Taxonomy is a versatile tool that educators use in various fields, from psychology to instructional design. It serves as the foundation for the entire educational program. Larkin and Burton (2008) also note that the levels of cognitive domains build upon one another, with each level depending on the previous one. For Benvenuti et al. (2023), knowledge represents the foundational level of cognitive development. To promote higher-order thinking skills and practical application, ongoing education courses and workshops are structured, as stated by Murphy et al. (2013). Furthermore, Glance et al. (2018) explain that as students progress through primary and secondary education, the emphasis gradually expands to include Application, Analysis, and Synthesis. Teachers design lessons that challenge students to problem-solve, experiment, and think critically. Bloom's Taxonomy is adaptable and applicable in various educational contexts, from early childhood education to higher education and beyond. Erickson (2007) emphasizes that in today's educational landscape, Bloom's Taxonomy remains highly relevant. It guides educators in developing curricula that promote progressive cognitive growth.

In their work, Dehibi, Hadji, and Nouri (2022) criticize the linear hierarchy of Bloom's Taxonomy for oversimplifying cognitive development. Frerejean et al. (2019) share their opinion that Bloom's Taxonomy is commonly used in designing complex learning experiences in colleges and universities. According to Widana (2017), the highest level of Bloom's Taxonomy, evaluation, requires the ability to assess the quality, significance, and validity of information and arguments. Meanwhile, Smejkalova and Chetail (2023) note that at the knowledge stage, learners mainly memorize facts, information, and concepts without understanding their underlying meaning. Basic comprehension exercises and repetition can help with knowledge acquisition. Comprehension, on the other hand, involves understanding and grasping the meaning of the acquired knowledge. Geary (1995) argues that the taxonomy was developed in a Western context and may not fully consider cultural and contextual differences that could affect learning and cognition. In this article, we discuss how Bloom's Taxonomy can be used in various settings. For instance, in preschool and kindergarten,

educators tend to focus primarily on the lower levels of Bloom's Taxonomy, particularly Knowledge and Comprehension.

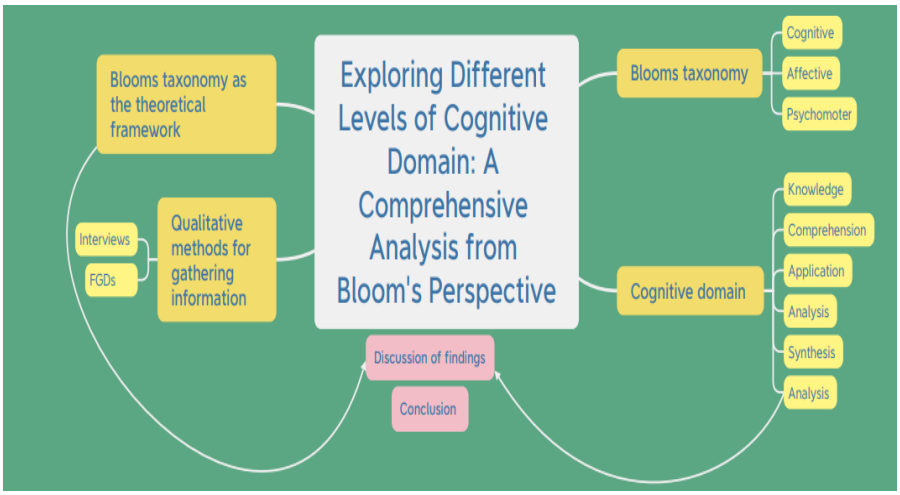
Methodology

This study is mainly based on the qualitative research design that was used as an interpretative paradigm. Fifteen students from campus A were selected as research participants using a purposive sampling procedure. The in-depth interview guidelines and focus group discussion were prepared and validated by the subject expert, and collogues, matching with the research purpose and literature review to validate these tools. Seven students participated in the interview and two FGDs were conducted through the researcher by the use of research tools. Through interviews, FGD, document study, and analysis, it explored the action verbs used to create instructional objectives related to science. These action verbs were then categorized into six different levels of the cognitive domain according to Bloom's taxonomy. Qualitative information was used to develop themes, which were analyzed through an interpretive procedure.

Bloom Taxonomy as the Framework

Bloom's Taxonomy is a widely recognized theoretical framework used in education to develop educational objectives and assess learning outcomes. Benjamin Bloom and his colleagues developed it in the 1950s. The taxonomy categorizes cognitive skills into a hierarchical model, which can guide educators in designing practical learning experiences and assessments. The taxonomy is typically a pyramid with six levels, from lower-order to higher-order thinking skills. Here is how to use Bloom's Taxonomy as a theoretical framework for developing educational objectives.

Figure 1: Conceptual and theoretical framework of the study



Findings and Discussion

The discussion is based on the thematic area like knowledge level, comprehension level, application level, analysis level, synthesis level, and evaluation level of the cognitive domain.

The Knowledge Level of the Cognitive Domain

As defined by educational psychologist Benjamin Bloom in the 1950s, the cognitive domain is a hierarchical framework that categorizes different levels of thinking and learning. Education often uses this framework to describe and assess learning objectives and outcomes (Bloom et al., 1956). The cognitive domain consists of six levels representing cognitive development and intellectual ability stages. In this area of the cognitive domain, respondents' responses are gathered from interviews, FGDs, and our experiences to list and tabulate the action verbs and their corresponding objectives into six levels of cognitive domains. These all are presented as follows:

> During a discussion about action verbs used in science education, one student, s_5, mentioned that these verbs may differ from those used in other subjects. In science, action verbs such as Tell, Give, Label, State, Name, Recognize, and Count are utilized to create precise, behavioral objectives (according to an interview conducted in September 2022).

Construct the specific/behavioral objective presented in Table 1 based on participant views discussed earlier.

Table1: *Action verbs and their objectives regarding knowledge level*

S.N	Action verbs	Cognitive level	Objectives
1	List	Knowledge	To list the types of solution
2	Tell	Knowledge	To tell the one function of mitochondria
3	Give	Knowledge	To give any two characteristics of fern
4	Label	Knowledge	To label the different parts of the human heart
5	State	Knowledge	To state the modern periodic law
6	Name	Knowledge	To name the different parts of the human eye
7	Recognize	Knowledge	To recognize the different parts of a plant
8	Count	Knowledge	To count the first twenty elements of the periodic table

Sources: Field data, 2022

Table 1 presents the action verbs and their constructed objectives regarding the knowledge level of the cognitive domain. The objectives associated with each action verb aim to assess learners' factual knowledge and retention of specific information related to various science topics. These action verbs require the ability of learners to perform recall, identify, list, tell, give, label, state, name, recognize, and count as the factual details of the specific area of the subject area in science learning.

The Understanding Level of the Cognitive Domain

Understanding goes beyond simple memorization. Learners at this level can explain ideas or concepts in their own words, interpret information, and demonstrate comprehension (Kintsch & Kintsch, 2005). This level involves grasping the meaning of information rather than just repeating it.

> In the discussion of action verbs of understanding level used in science education, one student, s_7, mentioned that these verbs might differ from those

used in other subjects. In science, action verbs such as Discuss, Describe, Distinguish, Translate, Select, Differentiate, Illustrate, etc. are used to create specific, behavioral objectives (according to an interview conducted in September 2022).

Construct the specific/behavioral objective of understanding the level of cognitive domain presented in Table 2 based on participant views discussed earlier.

Table 2: *Action verbs and their objectives regarding understanding level*

S.N	Action Verbs	Cognitive Level	Objectives
1	Discuss	Understanding	To discuss covalent bond
2	Describe	Understanding	To describe the solar system in the universe
3	Distinguish	Understanding	To distinguish the plant and animal cells in terms of their structure
4	Translate	Understanding	To translate the word formula into the molecular formula
5	Select	Understanding	To select the unicellular animal from the given specimen
6	Differentiate	Understanding	To differentiate between mass and weight at any three points
7	Illustrate	Understanding	To illustrate the types of chordate

Sources: Field data, 2022

Table 2 shows the action verbs and their prepared objectives regarding understanding level. The various action verbs like discuss, describe, distinguish, translate, select, differentiate, and illustrate correspond to the "Understanding" level of the cognitive domain. The objectives associated with each verb provide insight into the types of tasks and activities. Students are expected to perform in their intellectual capacity in specific science learning areas. These tasks often involve explanation, comparison, translation, and representation, all contributing to a deeper understanding of the subject matter.

The Application Level of the Cognitive Domain

The application level, also known as the "apply" level, represents a higher level of cognitive thinking than lower-level cognitive skills like remembering and understanding (Adams, 2015). At the application level, learners are expected to take the knowledge and concepts they have acquired and use them in new and meaningful ways. It involves applying their knowledge to solve problems, make decisions, analyze situations, or create something new. It requires a deeper understanding of the material and the ability to transfer knowledge to different contexts. The application level is crucial in education because it goes beyond rote memorization and encourages more profound understanding and critical thinking. It helps learners develop the ability to use their knowledge in meaningful ways, preparing them for real-world challenges and problem-solving situations. Educators often design learning activities and assessments that target this level to ensure students can apply what they have learned in practical and relevant contexts.

In the discussion of action verbs of application level used in science education, one student, s_4, and s_6 mentioned that these verbs might differ from those used in another subject. In science, action verbs like Demonstrate, Show, Measure,

Apply, Verify, Derive, Draw, Calculate, Solve, Prove, Manipulate, Find Out, Sketch, etc. are used to create specific and, behavioral objectives (according to an interview conducted in September 2022).

Construct the specific/behavioral objective of the application level of the cognitive domain presented in Tables 3 and 4 based on participant views discussed earlier.

Table 3: *Action verbs and their objectives regarding application level*

S.N	Action Verbs	Cognitive Level	Objectives
1	Demonstrate	Application	To demonstrate the electrolysis of water by the use of given materials
2	Show	Application	To show the relationship between heat and temperature by the use of a thermometer
3	Measure	Application	To measure the length and breadth of a science book
4	Apply	Application	To apply the formula of Newton's second law of motion for solving the numerical problem
5	Verify	Application	To verify the Ohm law
6	Derive	Application	To derive the Newton's second law of motion
7	Draw	Application	To draw the label diagram of the circulatory system

Sources: Field data, 2022

Table 3 shows the action verbs and their objectives regarding the application level of the cognitive domain. The action verbs like demonstrate, deliver, apply, measure, verify, derive, and draw are associated with particular areas of students' learning outcomes. These outcomes are written in both specific as well as behavioral terms. Similarly, this level is crucial in education as it exceeds simple memorization and fosters deeper comprehension and critical thinking (Kennedy, 2002). Table 4 also represents the application level of educational objectives.

Table 4: *Action verbs and their objectives regarding application level*

S.N	Action Verbs	Cognitive Level	Objectives
1	Calculate	Application	To calculate the solubility of a given salt by the use of the formula
2	Solve	Application	To solve the numerical problem of acceleration due to gravity
3	Prove	Application	To prove v2=u2+ 2as as the equation of motion
4	Manipulate	Application	To manipulate the alternative materials for the preparation of carbon dioxide gas
5	Find Out	Application	To find out variable valences of given elements in terms of their combination
6	Sketch	Application	To sketch the well-labeled diagram of animal cells.

Sources: Field data, 2022

Table 4 also shows the action verbs and their objectives regarding the application level of the cognitive domain. In this level of the cognitive domain, the students apply the acquired knowledge to new situations of science learning. The action verbs like calculate, solve, prove, manipulate, find out, and sketch are associated with particular areas of students' learning outcomes. These outcomes are written in both specific as well as behavioral terms.

The Analysis Level of the Cognitive Domain

The analysis level, the fourth level in this hierarchy, is crucial in progressing cognitive skills. It involves taking information or data and breaking it down into its components, identifying patterns, and understanding how these components relate to one another (Assaraf & Orion, N. 2010). Analytical thinking is essential in various fields, such as science, mathematics, critical reading, and problem-solving. Learners at this level are encouraged to engage in activities that require them to dissect and explore the underlying structures and connections within the subject matter. The analysis level in the cognitive domain represents a critical stage of cognitive development where learners move beyond basic comprehension and start examining, dissecting, and understanding the structure and relationships within the information they encounter. It is a fundamental step in fostering critical thinking and problem-solving skills.

> During a discussion about analysis-level action verbs used in science education, a student named s_2 suggested that these verbs might differ from those used in other subjects. In science education, action verbs such as separate, expose, elaborate, explain, classify, categorize, and analyze were used to establish specific and measurable objectives (an interview conducted in September 2022).

Construct the specific/behavioral objective of the analysis level of the cognitive domain presented in Table 5 based on participant views discussed earlier.

Table 5: *Action verbs and their objectives regarding analysis level*

S.N	Action verbs	Cognitive level	Objectives
1	Separate	Analysis	To separate the different parts of a given flower
2	Expose	Analysis	to expose the iron tack in the air and draw the inference from the activity
3	Elaborate	Analysis	To elaborate, the acceleration due to gravity
4	Explain	Analysis	To explain the metallurgical process
5	Classify	Analysis	To classify the invertebrates into the different class
6	Categorize	Analysis	To categorize the plants into different class
7	Analyze	Analysis	To analyze the solubility of sparingly soluble salt in terms of solubility curve

Sources: Field data, 2022

Table 5 represents the action verbs and their objectives regarding the analysis level of the cognitive domain. Action verbs like separate, expose, elaborate, explain, classify, categorize, and analyze are associated with these levels, where students can break down the material into its parts.

The Synthesis Level of the Cognitive Domain

Synthesis, the fifth level of Bloom's Taxonomy, occurs when learners go beyond what they have learned, understood, applied, and analyzed to create a product or develop a new method (Stanley & Moore, 2013). Building, developing, formulating, and inventing plans and ideas are all part of the process.

> During a discussion on synthesis-level action verbs used in science education, a student named s_1 suggested that these verbs may differ from those used in other subjects. In science education, action verbs such as Compare, Prepare, Rearrange, Formulate, Collect, Construct, Combine, and Create were used to establish specific and measurable objectives (an interview conducted in September 2022).

Based on the earlier discussed participant views, create a specific/behavioral objective for the synthesis level of the cognitive domain presented in Table 6.

Table 6: *Action verbs and their objectives regarding synthesis level*

S.N	Action Verbs	Cognitive Level	Objectives
1	Compare	Synthesis	To compare the vertebrates and invertebrates in terms of their adaptation characteristics
2	Prepare	Synthesis	To prepare the chart of the lungs
3	Rearrange	Synthesis	To rearrange the chemical reaction based on the particular example.
4	Formulate	Synthesis	To formulate the assumptions from the study of covalent bond
5	Collect	Synthesis	To collect the different types of rocks from the surrounding
6	Construct	Synthesis	To construct the electric circuit by the use of given materials
7	Combine	Synthesis	To combine carbon and oxygen for the formation of carbon dioxide through the crises method
8	Create	Synthesis	To create the model of ammonia molecule in three-dimensional form

Sources: Field data, 2022

Table 6 points out the action verbs and their objectives regarding the synthesis level of the cognitive domain. In this level of cognitive domain, the Students combine the parts to form a whole. Some action verbs like compare, prepare, rearrange, formulate, collect, construct, integrate, and create are aligned with particular Areas of subject matter in science teaching.

The Evaluation Level of the Cognitive Domain

Evaluation is the level at which learners critically assess information or situations (Forawi, 2016). They make judgments based on criteria and evidence, considering multiple perspectives and potential solutions. They can also make recommendations and defend their choices. Students are expected to engage in critical thinking and reasoned judgments at the evaluation level. They might assess the validity of arguments and the quality of evidence or make decisions based on carefully considering available information. This level is essential for

developing higher-order thinking skills and preparing learners to think independently and critically in complex situations. Educators often design assessments and learning activities that target the evaluation level to challenge students to think deeply, analyze information critically, and make informed decisions.

> In the discussion on evaluation-level action verbs used in science education, a student named s_3 suggested that these verbs may differ from those used in other subjects. In science education, action verbs such as Justify, Test, Evaluate, Judge, and Recommend were used to establish specific/ behavioral objectives (an interview conducted in September 2022).

Based on the earlier action verbs discussed in a focus group and the views of participants create a specific/behavioral objective for the evaluation level of the cognitive domain presented in Table 7.

Table 7: *Action verbs and their objectives regarding evaluation level*

S.N	Action Verbs	Cognitive Level	Objectives
1	Observe	Evaluation	To observe the picture of cell division, withdraw the inference in terms of picture observation.
2	Justify	Evaluation	To justify the pressure of water increases by the depth
3	Test	Evaluation	To test any three properties of hydrogen gas.
4	Evaluate	Evaluation	To evaluate the crystallization process to draw the inference.
5	Judge	Evaluation	To judge the strong and weak points of the ecosystem
6	Recommend	Evaluation	To recommend the skills learning through the experimental work

Sources: Field data, 2022

Table 7 represents the action verbs and their respective objectives regarding the evaluation level of the cognitive domain. In this level of cognitive domain, the Students judge right or wrong and give their perspective toward the natural world. The action verbs observe, justify, test, evaluate, judge, and recommend are aligned with particular subject areas in science teaching.

Conclusion

After analyzing the findings and discussing them, it was concluded that Bloom's Taxonomy is still a valuable tool for understanding cognitive development and creating effective learning experiences. By taking into account the different levels of cognitive skills, teachers can adjust their teaching methods to meet the requirements of learners at various stages of development. Additionally, technology has opened up new opportunities for using Bloom's Taxonomy in education. As education advances, our comprehension and application of this enduring cognitive framework will also evolve. Bloom's Taxonomy remains a fundamental concept in education and cognitive psychology. Its continued significance lies in its ability to guide educators, shape curricula, and promote meaningful learning experiences. By

acknowledging the different levels of cognitive development, science educators can better assist learners in their pursuit of higher-order thinking and deeper understanding through action verbs and their corresponding behavioral objectives as their mental cognition. Bloom's Taxonomy will continue to have a crucial role in shaping the future of education.

Implications

Bloom's taxonomy has wider implications in the field of teaching and learning. It has a crucial role in formulating the policy, practice, theoretical, and research areas of educational programs. It is implemented that policymakers oversee the creation of educational materials, curriculum development, assessment methods, and teacher training. Teachers should incorporate different levels of cognitive thinking into their lesson planning, question creation, and assessments. This theoretical foundation, based on Bloom's perspectives, should guide the development of the entire educational program, including item bank writing, lesson planning, curriculum development, and assessment planning. Moreover, research should be conducted on the affective and psychomotor domains within the educational program.

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