Review Article
ISSN (Online): 2350-0530
ISSN (Print): 2394-3629

International Journal of Research - GRANTHAALAYAH
July 2024 12(7), 144–149

APPLYING BLOOM'S TAXONOMY IN NEUROSCIENCE: A PRACTICAL EXAMPLES

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Received 03 June 2024
Accepted 08 July 2024
Published 14 August 2024

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DOI
10.29121/granthaalayah.v12.i7.2024.5713

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

ABSTRACT

Bloom's Taxonomy serves as a structured framework in neuroscience education, guiding educators in designing, implementing, and assessing learning objectives across various cognitive levels.
This abstract explores the practical application of Bloom's Taxonomy in teaching neuroscience concepts, offering insights into effective student engagement.
In neuroscience education, Bloom's Taxonomy is invaluable for curriculum development, instructional strategies, and assessment methods. At the foundational "remembering" level, students recall neuroanatomical structures, physiological processes, or terminology. For example, they identify brain regions or recall neurotransmitter functions.
Progressing to the "understanding" level, students comprehend neuroscientific principles.
This entails explaining action potential propagation or neural pathways in sensory perception. Educators use case studies, discussions, or multimedia for deeper understanding.
At the "applying" level, students apply neuroscience knowledge to solve real-world problems. They analyze clinical cases and propose interventions based on neuroanatomy and physiology understanding.
"Analyzing" prompts critical evaluation of neuroscience theories or research. This involves literature reviews, study critiques, or experiment design.
Finally, at the highest level of "creating," students are challenged to synthesize their understanding of neuroscience concepts to generate novel ideas, designs, or solutions. This could entail developing research proposals, designing educational materials, or proposing innovative treatments for neurological disorders.

Keywords: Practical Examples, Neuroscience Education, Neurotransmitters, Neuroplasticity

1. INTRODUCTION

Bloom's Taxonomy, a framework originally developed by Benjamin Bloom in 1956, offers a hierarchical structure for categorizing educational objectives and cognitive processes. In medical education, in medical schools, Bloom's Taxonomy serves as a valuable framework for designing curriculum, teaching strategies, and assessment methods. For example, educators can create multiple-choice questions (MCQs) that target various cognitive levels, allowing for assessment of not only recall but also higher-order thinking skills such as synthesis and decision-making.

By incorporating Bloom's Taxonomy into medical education, educators can design learning experiences that foster deeper understanding, critical thinking, and clinical reasoning skills among students. This approach not only prepares future healthcare professionals to excel in their clinical practice but also promotes lifelong learning and professional growth. Bloom (1956)

Moreover, in clinical settings, Bloom's Taxonomy mirrors the process of conducting a differential diagnosis. Students begin by recalling symptoms, then move on to understanding and applying medical concepts, analysing patient data, evaluating potential diagnoses, and ultimately formulating a comprehensive plan of care. The aim of the article is to ensure that students are equipped with the critical thinking skills necessary for effective clinical practice to learn at a higher cognitive level. Krathwohl (2002)

Figure 1

Figure 1 States the Different Levels of Blooms Taxonomy Simplified in Medical Education

2. APPLICATION PRINCIPLES

Medical curriculum and assessments often focus on knowledge acquisition aiming at lower levels of Blooms taxonomy. The taxonomy provides a clear framework for guiding students through increasingly complex cognitive tasks, starting from basic recall and moving towards higher-order thinking skills. Shaughnessy et al. (2014) This structured progression helps students understand and navigate the vast and dense curriculum of medical studies more effectively. By encouraging students to move beyond simple recall and engage in activities such as analysis, synthesis, and evaluation, the taxonomy fosters the development of critical thinking skills. Tay et al. (2016) In the context of medical education, where students must be able to diagnose and treat patients based on limited information, these critical thinking skills are essential. The taxonomy is applicable across various subjects within medicine, from anatomy and physiology to pathology and pharmacology. Its versatility allows educators to tailor their teaching methods to different topics and scenarios, ensuring that students receive a comprehensive and relevant education that prepares them for diverse medical situations. Black (1998)

3. LEVELS OF BLOOMS TAXONOMY SIMPLIFIED IN MEDICAL EDUCATION: (FIGURE 1)

Remembering: At the lowest level of Bloom's Taxonomy, students are expected to recall factual information relevant to medical concepts. This may involve memorizing anatomical structures, physiological processes, medical terminology, or diagnostic criteria.

Understanding: Students demonstrate comprehension by explaining medical concepts in their own words, summarizing complex information, or interpreting data presented in various formats. Understanding requires more than rote memorization; it involves grasping the significance and implications of medical knowledge.

Applying: In medical education, students apply their understanding of concepts to solve clinical problems, analyse case scenarios, or perform procedural tasks. This level of Bloom's Taxonomy emphasizes the practical application of knowledge in real-world medical contexts. Adesoji (2018)

Analysing: Students critically evaluate medical information by breaking down complex concepts into components, identifying patterns or relationships, and recognizing cause-and-effect relationships. Analytical skills are essential for diagnosing patients, interpreting research findings, and making evidence-based decisions. Nurmatova & Altun (2023)

Evaluating: At this level, students assess the validity, credibility, and relevance of medical evidence, arguments, or interventions. They critique research methodologies, assess the quality of clinical guidelines, and weigh the risks and benefits of treatment options. Evaluation skills enable students to make informed judgments in clinical practice.

Creating: The highest level of Bloom's Taxonomy involves generating novel ideas, designing innovative solutions, or developing new approaches to address medical challenges. Students may propose research hypotheses, devise treatment plans, or design educational interventions. Creativity in medical education fosters innovation and advances the field. Stringer & Stringer (2021)

4. PRACTICAL EXAMPLES

Examples of three clinical topics from Neuroscience will be reviewed to demonstrate the application of Blooms taxonomy levels in ascending order. A simplified topic will be discussed first for easier explanation and understanding. Topics in ascending complexity will then be discussed to expand the taxonomy application further. In conclusion, to minimize confusion and simplify understanding, all the taxonomy levels will be applied to each example.

Example 1: Neurotransmitters and Their Functions (Figure 2)

Level one: Remembering: Recall the names of major neurotransmitters. Identify the primary functions associated with each neurotransmitter (e.g., Dopamine is involved satisfaction, pleasure and motivation, Serotonin: Regulates mood, appetite, and sleep. Acetylcholine: Critical for muscle contraction, memory, and learning. Glutamate: Acts as an excitatory neurotransmitter, involved in learning and memory. GABA (Gamma-Aminobutyric Acid): Acts as an inhibitory neurotransmitter, regulates anxiety and stress. Norepinephrine: Modulates alertness, arousal, and stress response).

Level two: Understanding: Explain how neurotransmitters transmit signals between neurons. Describe the role of neurotransmitters in synaptic transmission and neural communication. Neurotransmitters are released from the presynaptic neuron into the synaptic cleft, where they bind to receptors on the postsynaptic neuron, leading to changes in membrane potential and signal transmission.

Level three: Applying: Apply knowledge of neurotransmitter functions to explain the mechanism of action of psychiatric medications. Analyse case studies to determine how imbalances in neurotransmitter levels. Case studies can help identify how interruption in neurotransmitter levels or signaling pathways may underlie the pathophysiology of disorders such as Parkinson's disorder, schizophrenia, or Alzheimer's disease.

Level four: Analysing: Analyse research findings to assess the impact of neurotransmitter dysregulation on cognitive processes such as memory, attention, and executive function. Consider factors such as study design, sample size, and validity of outcome measures.

Level five: Evaluate: Compare and contrast the therapeutic effects of different classes of psychotropic medications targeting specific neurotransmitter systems. Include information on common disorders associated with neurotransmitter dysfunction, available treatment options, and strategies for symptom management.

Level six: Creating: Design a research proposal to investigate the potential role of novel neurotransmitter targets in the treatment of neurodegenerative diseases. Develop educational materials explaining neurotransmitter function and dysfunction for patients and caregivers.

Figure 2

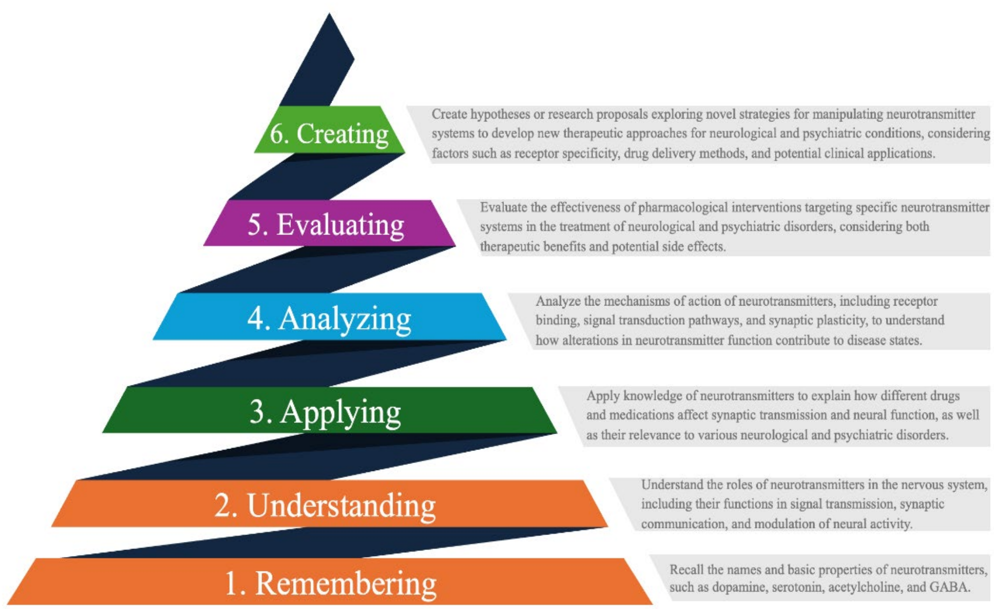

Figure 2 Explains the use of Blooms Taxonomy in Neurotransmitters and their Functions Adapted From "Krathwohl D. A Revision of Bloom's Taxonomy: An Overview. Theory Into Practice. 2002; 41 (4):212–218.

Example 2: Neural Pathways Involved in Motor Control

Level one: Remembering: Recall the names of key cerebrum areas: Primary Motor Cortex (Brodmann area 4), Primary Somatosensory Cortex (Brodmann area 3,1,2), Precentral gyrus, Postcentral gyrus, Central sulcus, Lateral sulcus, Longitudinal fissure. Recall neural pathways involved in motor control: Corticospinal tract, Corticonuclear tracts, Cerebellum.

Level two: Understanding: Explain how signals from the primary motor cortex are transmitted through the corticospinal tract to control voluntary movements. Describe the role of the cerebellum in coordinating and refining motor movements.

Level three: Applying: Apply knowledge of neural pathways to interpret diagnostic imaging findings in patients with motor disorders. Demonstrate proper techniques for performing neurological examinations to assess motor function.

Level four: Analysing: Analyse case studies to identify the specific neural pathways affected in patients with movement disorders such as Parkinson's disease or stroke.

Level five: Evaluate the effectiveness of different rehabilitation approaches for restoring motor function following neurological injury.

Level six: Creating: Design a novel therapeutic intervention targeting specific neural pathways to improve motor recovery in patients with spinal cord injury. Develop educational resources outlining the neural basis of motor control for healthcare professionals and patients.

Example 3: Neuroplasticity and Learning

Level one: Remembering: Recall the definition of neuroplasticity and its significance in learning and memory. Identify factors that influence synaptic plasticity, such as experience and environmental enrichment.

Level two: Understanding: Explain the mechanisms underlying synaptic plasticity, including long-term potentiation (LTP) and long-term depression (LTD). Describe how neuroplasticity contributes to adaptive changes in neural circuits during learning and memory formation.

Level three: Applying: Apply knowledge of neuroplasticity to explain the effects of neurorehabilitation interventions on functional recovery after brain injury. Implement strategies to enhance neuroplasticity, such as cognitive training exercises, in clinical practice.

Level four: Analysing: Analyse research studies investigating the role of neuroplasticity in various neurological conditions, such as stroke rehabilitation or neurodegenerative diseases.

Level five: Evaluate the efficacy of pharmacological interventions targeting neuroplasticity for enhancing cognitive function in patients with cognitive impairment.

Level six: Creating: Design a neurorehabilitation program tailored to harness the principles of neuroplasticity to optimize functional outcomes in patients with traumatic brain injury. Develop educational materials on neuroplasticity and its implications for lifelong learning and brain health for the general public.

In conclusion, Bloom's Taxonomy offers a comprehensive framework for educators to foster meaningful learning experiences in neuroscience education. By strategically incorporating activities and assessments aligned with each cognitive level, educators can empower students to develop a deep understanding of neuroscience concepts and cultivate critical thinking skills essential for success in the field.

AUTHOR CONTRIBUTION

Karkera S; concept, and discussion, writing the paper, and submitting Lakhani B discussion, editing, creating images.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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