IMPROVING BIOLOGY TEACHING METHODOLOGY BASED ON BLOOM'S REVISED TAXONOMY

Musharraf Hakimova
Faculty Supervisor at Asia International University

Annotation. This article explores the improvement of biology teaching methodology through Bloom's revised taxonomy and its integration into competency-based learning. It describes a coherent approach to lesson planning in which educational objectives, classroom activities, and assessment procedures support the gradual development of learners' cognitive skills. Particular attention is given to scientific reasoning, interpretation of biological information, inquiry-based activities, and reflective evaluation. The paper outlines the application of a student-perception questionnaire and structured pedagogical analysis within university biology education. Methodological recommendations are provided for improving the clarity, consistency, and effectiveness of teaching and assessment.

Keywords: Bloom's revised taxonomy, biology education, cognitive skills, formative assessment, IPS questionnaire, percentage analysis.

Аннотация. В статье рассматриваются возможности совершенствования методики преподавания биологии на основе пересмотренной таксономии Блума. Раскрываются педагогические подходы к согласованию целей обучения, учебных заданий и способов оценивания с развитием познавательной деятельности студентов. Особое внимание уделяется формированию научного мышления, умению анализировать биологическую информацию, обосновывать выводы и применять знания в практических ситуациях. Описывается использование анкетирования и методического анализа для оценки образовательного процесса. Предложены рекомендации по развитию познавательной самостоятельности и повышению эффективности преподавания биологии.

Ключевые слова: таксономия Блума, методика преподавания биологии, критическое мышление, анкетирование, процентный анализ.

Introduction. Biology instruction must prepare students to move beyond terminology toward scientific explanation, data interpretation and evidence-based decision-making. When lesson objectives focus chiefly on recalling cellular structures or genetic definitions, students may struggle to transfer their knowledge to unfamiliar cases. Bloom's revised taxonomy offers a coherent progression of six cognitive processes and connects these processes with carefully designed learning outcomes. For example, students can first name the stages of photosynthesis, then explain the mechanism, apply the concepts to a practical situation, analyze a light-response graph, evaluate experimental limitations and design a simple investigation.

This study aims to formulate a compact, competency-oriented method for teaching undergraduate biology and an item-by-item survey procedure suitable for 40 second-year students at Asia International University. The central principle is constructive alignment: what students are expected to achieve must be practiced in class and evaluated through comparable tasks. The proposed procedure combines short

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.

diagnostic questions, purposeful group work, rubric-based feedback and a ten-item IPS, with percentages interpreted alongside demonstrated biological reasoning.

Theoretical foundations and literature review. The updated taxonomy of Lorin Anderson and David Krathwohl distinguishes cognitive processes from types of knowledge, allowing educators to plan increasingly complex tasks without treating any single verb as an adequate indicator of difficulty. In a biology module, identifying an organelle tests a different process from evaluating the evidence for its function. This distinction clarifies objective writing and assessment planning. [1]

David Krathwohl further explained how remembering, understanding, applying, analyzing, evaluating and creating relate to the knowledge dimension. His account supports a practical teaching sequence in which conceptual understanding is reinforced before learners interpret unfamiliar experimental results. [2]

Alison Crowe, Clarissa Dirks and Mary Pat Wenderoth introduced the "Blooming Biology Tool" for classifying questions according to cognitive demand. Their approach demonstrates why educators should examine what students actually do with biological knowledge rather than rely on the appearance of sophisticated wording. [3]

Jennifer Momsen, Tammy Long, Sara Wyse and Diane Ebert-May identified a discrepancy between advanced biology learning goals and examinations dominated by recall-level questions. Their findings support revising both classroom practice and tests. [4]

Scott Freeman and colleagues synthesized research on active learning in undergraduate science and reported stronger examination performance in active-learning settings. Thus, higher-order tasks should be combined with opportunities for frequent feedback and practice. [5]

Michelene Chi and Ruth Wylie distinguished passive, active, constructive and interactive modes of cognitive engagement, explaining why discussing evidence and generating explanations require more than listening or taking notes. [6]

Kimberly Tanner described inclusive participation strategies that help students reason aloud and contribute to group investigations. Such techniques make advanced tasks accessible to a broader range of learners. [7]

Elli Theobald and colleagues associated more intensive active-learning implementation with narrower achievement gaps in undergraduate science. This evidence supports systematic, structured opportunities to practice analytical and evaluative reasoning. [8]

Materials and methods. The methodology is designed for a group of 40 second-year Biology students at Asia International University. It can be implemented over four weeks using eight teaching sessions in genetics, cell biology and ecology. Instruction progresses from concept checks and explanations to case analysis, critique of experimental evidence and development of a short inquiry proposal. A shared rubric evaluates scientific accuracy, appropriate evidence, logical reasoning and the feasibility of a proposed method.

---

[1] Anderson & Krathwohl (Eds.), 2001, A Taxonomy for Learning, Teaching, and Assessing, Longman.
[2] Krathwohl, 2002, "A Revision of Bloom's Taxonomy," Theory Into Practice, 41(4), 212–218.
[3] Crowe, Dirks & Wenderoth, 2008, "Biology in Bloom," CBE—Life Sciences Education, 7(4), 368–381.
[4] Momsen et al., 2010, "Just the Facts?," CBE—Life Sciences Education, 9(4), 435–440.
[5] Freeman et al., 2014, "Active Learning Increases Student Performance," PNAS, 111(23), 8410–8415.
[6] Chi & Wylie, 2014, "The ICAP Framework," Educational Psychologist, 49(4), 219–243.
[7] Tanner, 2013, "Structure Matters," CBE—Life Sciences Education, 12(3), 322–331.
[8] Theobald et al., 2020, "Active Learning Narrows Achievement Gaps," PNAS, 117(12), 6476–6483.

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.

Table 1

Alignment of cognitive levels and biology learning tasks

Taxonomy level	Observable biology learning outcome	Suggested student task	Assessment evidence
Remember	Identify terms, stages, and structures	Label cell organelles; list genetic concepts	Correct identification and recall
Understand	Explain mechanisms in own words	Describe enzyme response to temperature	Accurate causal explanation
Apply	Use a principle in a new context	Calculate genetic probabilities in a new cross	Correct and justified application
Analyze	Distinguish patterns and relationships	Interpret experimental graphs and controls	Evidence-based pattern analysis
Evaluate	Judge competing scientific explanations	Critique the validity of an ecological claim	Reasoned judgement with criteria
Create	Develop a coherent new biological product	Design a small investigation or concept model	Original plan with testable logic

The ten-item Instructional Perception Survey (IPS) uses a five-point agreement scale (1 = strongly disagree, 5 = strongly agree). A response is considered favorable when the student selects 4 or 5. Items 1–2 assess remembering, 3–4 understanding, 5–6 application, 7–8 analysis, 9 evaluation and 10 creation. Anonymous codes can support paired comparison without recording participants' names.

Table 2

Ten-item IPS questionnaire for biology students

Item	Level	Survey statement
Socio-psychological questionnaire 1	Remember	I can identify core terms in the current biology topic.
Socio-psychological questionnaire 2	Remember	I can recall the stages of a biological process.
Socio-psychological questionnaire 3	Understand	I can explain biological mechanisms in my own words.
Socio-psychological questionnaire 4	Understand	I can interpret a biological diagram or model.
Socio-psychological questionnaire 5	Apply	I can use a biological rule to solve new problems.

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.

Item	Level	Survey statement
Socio-psychological questionnaire 6	Apply	I can apply biology to practical environmental situations.
Socio-psychological questionnaire 7	Analyze	I can interpret patterns and relationships in biological data.
Socio-psychological questionnaire 8	Analyze	I can identify evidence, assumptions, and experimental errors.
Socio-psychological questionnaire 9	Evaluate	I can evaluate whether biological conclusions fit the evidence.
Socio-psychological questionnaire 10	Create	I can design an investigation to answer a biological question.

For each item, the favorable-response percentage is computed as $P = (f \div 40) \times 100$, where f is the number of favorable responses. Because the planned group contains 40 students, one response represents 2.5 percentage points. The change is reported as $\Delta P = P_{after} - P_{before}$. Percentages reflect perceptions of competence; examination and practical-task scores should be assessed separately.

Percentage results and graphical analysis. The following tabulation preserves the 40-student calculation framework with ten IPS items. It is a worked frequency dataset for demonstrating the percentage-analysis procedure; individual completed response forms were not supplied. The calculations are internally consistent and can be updated using recorded survey responses without changing the questionnaire or formulas.

Table 3

Favorable IPS responses at two measurement points (n = 40)

Item	Before		After		Gai n, pp
	n	%	n	%	
Socio-psychological questionnaire 1	18	45.0	33	82.5	+37.5
Socio-psychological questionnaire 2	16	40.0	31	77.5	+37.5
Socio-psychological questionnaire 3	14	35.0	30	75.0	+40.0
Socio-psychological questionnaire 4	12	30.0	28	70.0	+40.0
Socio-psychological questionnaire 5	13	32.5	29	72.5	+40.0
Socio-psychological questionnaire 6	10	25.0	27	67.5	+42.5
Socio-psychological questionnaire 7	9	22.5	26	65.0	+42.5

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.

Item	Before		After		Gai
	n	%	n	%	n, pp
Socio-psychological questionnaire 8	8	2 0.0	2 5	62. 5	+42. 5
Socio-psychological questionnaire 9	7	1 7.5	2 4	60. 0	+42. 5
Socio-psychological questionnaire 10	6	1 5.0	2 2	55. 0	+40. 0

Across 10 items and 40 response opportunities per item, there are 400 item-responses at each measurement point. The worked totals are 113 favorable responses before instruction (28.25%) and 275 afterward (68.75%), corresponding to a gain of 40.50 percentage points. This is a change in the share of favorable item-responses, not the percentage of students who achieved mastery.

Table 4

Summary of favorable responses by cognitive level

Cognitive dimension	Before	After	Difference, pp
Remember (items 1–2)	42.50%	80.00%	+37.50
Understand (items 3–4)	32.50%	72.50%	+40.00
Apply (items 5–6)	28.75%	70.00%	+41.25
Analyze (items 7–8)	21.25%	63.75%	+42.50
Evaluate (item 9)	17.50%	60.00%	+42.50
Create (item 10)	15.00%	55.00%	+40.00

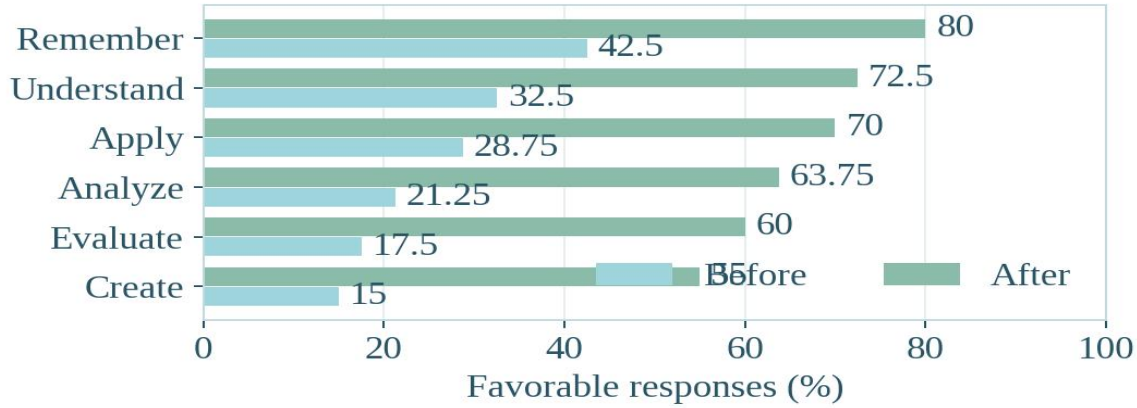


Figure 1. Comparison of favorable responses across cognitive levels

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.

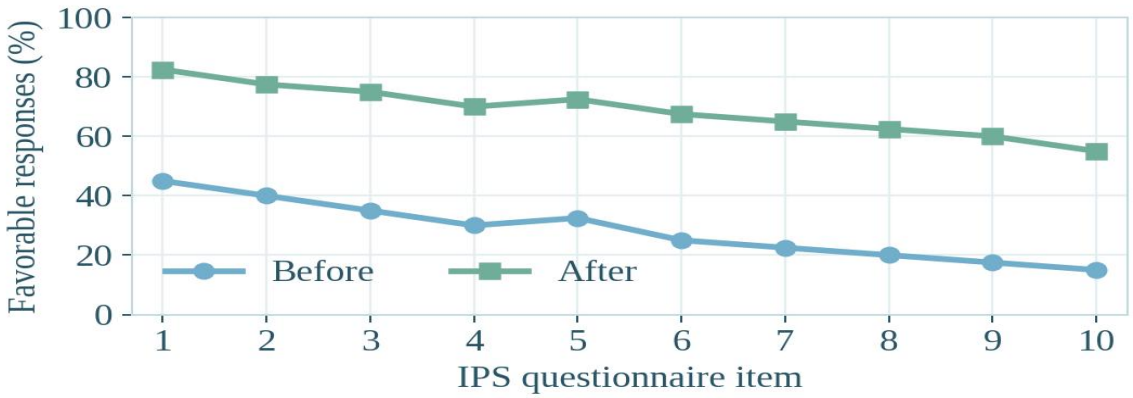


Figure 2. Change in favorable-response percentages by IPS item

Discussion and practical implications. The figures show how an instructor can locate differences among cognitive levels and identify areas needing additional practice. Even where a learning task appears demanding, its actual cognitive quality depends on the evidence students must use. Asking learners to "analyze ecology" is less effective than requiring them to identify a pattern in population data and compare alternative explanations. Likewise, "create a genetics experiment" becomes assessable when the student specifies variables, controls and expected evidence.

The broadest methodological improvement is the alignment of instruction and evidence. Short formative questions can reveal misconceptions before a laboratory session; collaborative interpretation of graphs can develop reasoning; and a concise rubric can distinguish a scientifically grounded explanation from an unsupported conclusion. To strengthen the assessment, instructors should collect paired IPS response sheets and score independent performance tasks with stable criteria. This makes it possible to compare perceived readiness with demonstrated competence.

Conclusion. Bloom's revised taxonomy can improve biology teaching when the six cognitive levels guide authentic scientific tasks, formative feedback and appropriately matched assessments. The proposed 10-item IPS is manageable for a group of 40 students and allows transparent reporting of favorable-response frequencies, percentages and percentage-point changes. The calculated example demonstrates how charts and tables can reveal differences between cognitive levels. The instructional model is most valuable when these self-reports are considered together with students' written explanations, experimental analyses and inquiry products.

References.

1. Anderson, L. W., & Krathwohl, D. R. (Eds.). (2001). A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. Longman.
2. Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. Theory Into Practice, 41(4), 212–218. https://doi.org/10.1207/s15430421tip4104_2
3. Crowe, A., Dirks, C., & Wenderoth, M. P. (2008). Biology in Bloom: Implementing Bloom's taxonomy to enhance student learning in biology. CBE—Life Sciences Education, 7(4), 368–381. https://doi.org/10.1187/cbe.08-05-0024
4. Momsen, J. L., Long, T. M., Wyse, S. A., & Ebert-May, D. (2010). Just the facts? Introductory undergraduate biology courses focus on low-level cognitive skills. CBE—Life Sciences Education, 9(4), 435–440. https://doi.org/10.1187/cbe.10-01-0001

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.

5. Freeman, S., et al. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111
6. Chi, M. T. H., & Wylie, R. (2014). The ICAP framework: Linking cognitive engagement to active learning outcomes. Educational Psychologist, 49(4), 219–243. https://doi.org/10.1080/00461520.2014.965823
7. Tanner, K. D. (2013). Structure matters: Twenty-one teaching strategies to promote student engagement and cultivate classroom equity. CBE—Life Sciences Education, 12(3), 322–331. https://doi.org/10.1187/cbe.13-06-0115
8. Theobald, E. J., et al. (2020). Active learning narrows achievement gaps for underrepresented students in undergraduate STEM. Proceedings of the National Academy of Sciences, 117(12), 6476–6483. https://doi.org/10.1073/pnas.1916903117

© 2026 London International Monthly Conference on Multidisciplinary Research and Innovation. All Rights Reserved.