Mechanism For Applying Interactive Methods In Teaching Biology Based On A Web-Quest

Salimova Sarvinoz Farxodovna

d.p.p.s., associate professor at Bukhara state university, Uzbekistan

Tuxtamurodova Dilsuz

1rst year master's student at Bukhara state university, Uzbekistan

Abstract: Contemporary biology education increasingly depends on learners' capacity to interpret evidence, evaluate information quality, and construct explanations collaboratively. A WebQuest—an inquiry-oriented learning format built around curated online resources and a problem-centered task—can function as an instructional carrier for interactive methods if it is designed and facilitated as a coherent system rather than as a web search exercise. This article proposes a mechanism for applying interactive methods in biology teaching based on the WebQuest format and describes how learning outcomes are translated into transformative tasks, how collaboration is structured to ensure epistemic interdependence, how teacher facilitation supports scientific discourse, and how assessment produces valid evidence of both product quality and learning processes. The mechanism is intended for practical classroom use and for research-based analysis of implementation fidelity. Expected outcomes include deeper conceptual understanding of biological mechanisms, improved competence in scientific argumentation, and stronger learner engagement supported by clear roles, structured inquiry steps, and rubric-based evaluation.

Introduction: Biology as a subject in school poses a unique teaching challenge because its material is both observable and abstract, based on real-world examples and models. Students can directly observe organisms and ecological interactions; however, the explanatory framework of biology often functions through imperceptible mechanisms and multilevel causal chains that link molecular processes, cellular systems, organismal functions, populations, and ecosystems. When teaching deals with this complexity mostly by adding more information and terms, learning often becomes reproductive instead of explanatory. Students might memorize bits and pieces without learning how to think logically, understand evidence, or use biological ideas in new situations.

This article defines interactive methods in education as pedagogical strategies that facilitate reciprocal interactions among learners and between learners and the teacher, enabling learning through dialogue, collaboration, and collective problem-solving. In biology, interaction is not only motivational; it is epistemically warranted. Scientific knowledge is generated and validated through collective processes wherein assertions are scrutinized against evidence, interpretations are contested, and explanations are negotiated until they satisfy established standards of coherence, plausibility, and empirical validation. If school biology is to reflect scientific reasoning rather than merely scientific terminology, classroom activities must facilitate opportunities for students to engage in evidence-based explanation and critique.

The digital information environment has also changed how people learn biology. Students can use a lot of

different resources, such as texts that explain things, animations, datasets, and simulations. But just because something is easy to get to doesn't mean you understand it. Students may suffer from cognitive overload, resort to superficial "copy-and-paste" techniques, or perpetuate misconceptions by utilizing unreliable sources. The challenge for educators is to utilize digital resources while preserving epistemic authority and guaranteeing that student engagement leads to quantifiable learning outcomes.

A WebQuest gives a structured answer to this problem. It is an inquiry-based format in which the teacher selects a limited number of resources, sets up a meaningful task, and guides the process so that students turn information into an explanation, decision, model, or product. But in practice, WebQuests can turn into guided browsing unless interactive methods are built into the task logic, collaboration structure, facilitation moves, and assessment criteria. Technology does not ensure interactivity; interaction necessitates deliberate design.

The main point of this article is that a WebQuest in biology only becomes a powerful teaching tool when interactive methods are built in through a clear mechanism. This mechanism must address pragmatic inquiries: how biological outcomes are transformed into tasks that require reasoning instead of mere recall; how collaboration is organized to ensure that each learner assumes epistemic responsibility; how teacher facilitation fosters constructive scientific discourse; and how assessment holds both the inquiry process and the final product accountable. The mechanism proposed below is meant to help teachers create WebQuest-based lessons that work and give researchers a model of how to do it that they can study.

To create and validate a system for using interactive methods in biology teaching that is based on a WebQuest format. This system should make sure that tasks are in line with learning goals, that collaboration and discussion are structured, and that inquiry products and processes are fairly evaluated.

Pedagogical design synthesis creates the mechanism by bringing together three different but related areas: inquiry-based science education, cooperative learning with structured academic discourse, and instructional

design logic for managing cognitive load and information quality. The method is based on ideas and design. The article does not just talk about one classroom experiment. Instead, it builds a reusable teaching tool that teachers can use and that can be tested in future research.

The synthesis progressed via a series of design choices. Initially, biology curriculum outcomes were categorized into two distinct sets: conceptual outcomes delineating the essential understandings regarding biological structures, functions, and mechanisms, and practice-oriented outcomes specifying the competencies students should acquire, encompassing evidence utilization, explanation formulation, model reasoning, and scientific communication. Second, these results were linked to the structure of a WebQuest, with each part of the WebQuest serving as a control point for interactive methods. In this mapping, the introduction is in charge of motivation and norms, the task is in charge of cognitive level, the process is in charge of learning actions and the order of collaboration, the resources are in charge of the quality of information and the availability of evidence, the evaluation is in charge of accountability and standards, and the conclusion is in charge of consolidation and transfer. Third, facilitation and assessment were built into the rules of the process, which tell teachers and students what to do at important times. These rules make interactivity more than just a general idea by making it observable behaviors.

The mechanism uses a curated-resource approach because WebQuest learning relies on information found on the web. To cut down on noise, make sure the resources are scientifically valid, and make sure they fit with the task's sub-questions, the teacher picks and annotates a limited set of resources. Curation doesn't get rid of critical evaluation; instead, it makes it safe and easy for students to compare resources, explain their choices, and put together evidence without wasting time looking for things that aren't useful. In places with poor internet access, curated resources can be made available offline through local storage or printed extracts. This keeps the mechanism the same while changing the way it is delivered.

The assessment is an integrated system that includes both formative checkpoints and a rubric-based final judgment. During learning, formative checkpoints

create evidence and give students chances to revise. Summative assessment looks at the final product and the quality of the reasoning shown in student work. The assessment design presupposes that in interactive learning, process evidence is significant as it demonstrates whether learning activities were executed as planned and whether collaboration facilitated comprehension rather than merely distributing tasks.

The proposed mechanism serves as a cohesive instructional system that connects four areas: aligning outcomes with tasks, designing WebQuests for interaction, facilitating scientific discourse, and assessing for accountability. These areas depend on each other. Weakness in any area can lessen the effect of the mechanism, even if the other areas are done well.

The process of outcome-to-task alignment starts by turning curriculum outcomes into a real biological problem that needs information to be changed. A WebQuest task is not framed as "find information about..." within the mechanism, as such prompts promote reproduction. Instead, the task is written as a performance demand that ends with a decision, explanation, model, or recommendation backed up by proof. For example, an ecosystem stability unit could be set up as an environmental management scenario where students have to guess what will happen if an invasive species is introduced and come up with ways to lessen the damage using ideas about food webs, population dynamics, and ecological resilience. A genetics unit can be structured as a counseling simulation where students elucidate inheritance patterns and risk probabilities while navigating ethical considerations. A unit on human physiology can be structured as a clinical case in which students must deduce impaired homeostatic mechanisms and substantiate an intervention strategy. In every case, you need to use integrated reasoning to put the product together; you can't just copy it.

WebQuest design for interaction shows how students will work on the task. The introduction establishes relevance, sets the scene, and outlines collaboration norms, such as the requirement that claims be substantiated. The task statement sets out what the expected product is and makes sure that synthesis happens by requiring people to look at things from different points of view. The process component consists of alternating cycles of individual evidence preparation and group synthesis. This stops learners from splitting up work too soon, when they only complete parts without sharing ideas. The mechanism employs roles as instruments for epistemic interdependence. Roles are not just for show; they are necessary for the final product because they correspond to different evidence responsibilities. In a WebQuest about infectious diseases, one student might look at the biology of pathogens, another might look at data and modeling of how diseases spread, another might look at how to stop diseases from spreading and how the immune system works, and another might look at how to talk to the public about diseases. The group cannot come to a clear conclusion until these pieces of evidence are put together.

Resource curation helps the structure of roles. Each role gets a group of resources that includes at least one explanatory resource, one representation or dataset, and one applied or contextual resource. The teacher marks up the resources to show what kind of proof they give and how they should be used. This annotation makes it easier for students to understand by focusing their attention on the interpretive goal and encouraging them to see sources as evidence instead of just copying them. The resource set can include purposeful contrasts, like two explanations that focus on different things or two datasets from different situations, so that students can practice comparing and justifying.

Facilitation of scientific discourse delineates teacher interventions that uphold epistemic discipline during collaborative activities. The mechanism distinguishes between managerial facilitation and epistemic facilitation. Managerial facilitation makes sure that everyone stays on task, knows what their role is, and understands the steps in the process. Epistemic facilitation helps reasoning get better. It is put into action through short, predictable, and scientifically sound teacher moves that happen over and over again. The teacher often asks for proof of claims, tells students to tell the difference between a mechanism and a description, asks them to think about other possible explanations, and makes them link representations to verbal explanations. Instead of giving answers, the teacher focuses on the criteria:

what counts as evidence, how claims can be tested, and how explanations can be made to make sense at different biological levels. These steps stop interactive activity from becoming socially active but not very smart.

The WebQuest has built-in ways to hold people accountable. The mechanism has formative checkpoints where groups have to turn in things like a claim-evidence-reasoning paragraph, a draft model, a concept map, or a short explanation that fits with a rubric criterion. You need to make changes after getting feedback from your peers and teacher. Students must figure out what changed and why the change makes the evidence stronger or the explanation more coherent. This is called revision. A rubric is used for summative assessment to look at biological accuracy, how well the explanation fits together, how well the evidence is used, and how well the synthesis is done. The mechanism includes process evidence like role logs, peer feedback records, and short individual reflections that link the group product to personal understanding. This way, collaboration can be held accountable without relying only on self-reports.

The mechanism fixes a common problem with tech-enhanced lessons: they expect interactive outcomes but don't plan for them. When group work is initiated without epistemic structure, students frequently allocate tasks, gather information, and produce a final product with limited conceptual negotiation. Such collaboration may seem useful, but it may not lead to much learning because students don't express their reasoning, question their assumptions, or connect cause-and-effect relationships. The mechanism reduces this risk by incorporating epistemic interdependence. Roles assign essential evidence responsibilities, the task necessitates synthesis, the process involves alternating individual preparation and collaborative reasoning, and assessment renders discourse and revision transparent. In these circumstances, interaction becomes essential to learning rather than incidental.

From a biological learning standpoint, the mechanism is suitable as comprehension in biology often relies on integrative explanations. Students need to be able to connect different levels of organization, understand how structure and function relate to each other, and read graphs, microscopy images, phylogenetic trees,

and system diagrams. Interactive methods facilitate this coordination by necessitating that learners articulate meanings and validate them socially. Peer critique and teacher discourse moves facilitate opportunities for conceptual change, particularly when misconceptions are entrenched and impervious to passive instruction. In biology, where intuitive but wrong reasoning is common, like in evolutionary adaptation, physiological regulation, and ecological cause-effect, it's especially important to back up claims with evidence.

The curated-resource principle takes into account how digital information works in the real world. Unrestricted internet searching can lead to exposure to false information and ineffective time management. The teacher controls epistemic quality and cuts down on cognitive noise by choosing a limited set of high-quality resources. Students still practice evaluating by comparing sources, figuring out what different types of evidence mean, and defending their choices. This balance is very important in schools where students have different levels of digital literacy and there isn't much time for lessons.

The ability to implement depends on how good the teacher is and how the classroom works. Task design is the hardest part because it sets the cognitive level. Teachers need to write tasks that are open-ended enough to require reasoning but limited enough to be doable in the time and resources that are available. Facilitation necessitates a tolerance for student ambiguity and constructive dissent; educators must steer discussions while avoiding the substitution of inquiry for explicit teaching. You also need to know how to read and write well because the criteria for rubrics must show both biological content and reasoning quality, and feedback must be in line with these criteria to help with revision instead of just correction.

The mechanism is designed to be flexible across biology subjects and grade levels. For molecular and cellular subjects, roles might focus on elucidating mechanisms and interpreting representations. In ecology and evolution, roles might focus on analyzing data, thinking about systems, and making tradeoff decisions. The fundamental logic remains unchanged: a transformative task, role-based interdependence, sequential inquiry cycles, evidence-based discourse, and rubric-directed assessment with revision. Future

empirical research can evaluate the mechanism in diverse contexts, identify the facilitation strategies that most accurately forecast learning outcomes, and enhance assessment metrics for collaboration quality.

When seen as a system that includes goals, tasks, interaction structures, facilitation, and assessment, a WebQuest can become a strong way to use interactive methods in biology teaching. The mechanism proposed in this article operationalizes this integration by aligning curriculum outcomes with transformative biological tasks, designing WebQuest components to enforce epistemic interdependence, facilitating evidence-centered discourse through predictable teacher moves, and assessing both products and processes through formative checkpoints and rubric-based evaluation. With this system, interactive methods are not just an extra; they are needed for completing tasks successfully and for showing that learning has taken place. The mechanism is useful for the classroom and can be used as a basis for further testing and improvement.

REFERENCES

1. Dodge B. Some Thoughts About WebQuests [Electronic resource]. 1995 (accessed: 07.01.2026).

2. March T. Why WebQuests? An Introduction [Electronic resource]. 1998 (accessed: 07.01.2026).

3. March T. The Learning Power of WebQuests // Educational Leadership. 2003. Vol. 61, No. 4. P. 42–47.

4. Dodge B., Bellofatto L., Bohl N., Casey M., Krill M. A Rubric for Evaluating WebQuests [Electronic resource]. 2001 (accessed: 07.01.2026).

5. National Research Council. Inquiry and the National Science Education Standards: A Guide for Teaching and Learning. Washington, DC: National Academies Press, 2000. 202 p.

6. NGSS Lead States. Next Generation Science Standards: For States, By States. Washington, DC: The National Academies Press, 2013. 534 p.

7. Vygotsky L. S. Mind in Society: The Development of Higher Psychological Processes. Cambridge, MA: Harvard University Press, 1978. 159 p.

8. Jonassen D. H. Designing Constructivist Learning Environments // Instructional-Design Theories and Models: A New Paradigm of Instructional Theory. Vol. II / Ed. C. M. Reigeluth. Mahwah, NJ: Lawrence Erlbaum Associates, 1999. P. 215–239.

9. Mayer R. E. Multimedia Learning. 2nd ed. New York: Cambridge University Press, 2009. 304 p.

10. Black P., Wiliam D. Assessment and Classroom Learning // Assessment in Education: Principles, Policy & Practice. 1998. Vol. 5, No. 1. P. 7–74.

11. Brown A. L. Design Experiments: Theoretical and Methodological Challenges in Creating Complex Interventions in Classroom Settings // The Journal of the Learning Sciences. 1992. Vol. 2, No. 2. P. 141–178.

12. Barab S. A., Squire K. Design-Based Research: Putting a Stake in the Ground // The Journal of the Learning Sciences. 2004. Vol. 13, No. 1. P. 1–14.

13. ГОСТ Р 7.0.5–2008. Система стандартов по информации, библиотечному и издательскому делу. Библиографическая ссылка. Общие требования и правила составления. М.: Стандартинформ, 2008. 19 с.