HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

USING ARTIFICIAL INTELLIGENCE TOOLS IN TEACHING BIOPHYSICS

Teshaboyeva Gulmira Ma'mirjon qizi

Assistant
Department of Biological Physics, Informatics and Biomedical Engineering
Andijan State Medical Institute, Andijan, Uzbekistan

Doi: https://doi.org/10.5281/zenodo.23478172

Abstract: Artificial intelligence tools can support explanations, formative feedback and the preparation of learning tasks in medical biophysics. Their educational value depends on whether students develop reasoning that remains available when the tool is removed. This article examines evidence relevant to the use of generative artificial intelligence and proposes a teaching approach for undergraduate medical education. A focused narrative synthesis of educational studies, methodological commentary and international guidance was combined with the design of a biophysics learning activity. The reviewed evidence indicates that carefully structured tutoring can improve learning in particular settings, whereas unrestricted assistance can improve task completion without improving independent performance. The proposed approach requires an initial student solution, a bounded dialogue with an artificial intelligence tool, verification against physical principles and a subsequent unaided explanation. An ultrasound example demonstrates how a plausible answer can contain a conceptual error that dimensional analysis alone does not detect. Assessment addresses model selection, quantitative reasoning, verification and transfer to a changed problem. The article provides a practical design for supervised use of artificial intelligence, with attention to multilingual learning, equitable access and protection of educational data. Its contribution is methodological; no original student intervention data or measured effects on achievement are reported.

Keywords: biophysics education; artificial intelligence; generative AI; medical education; formative feedback; independent reasoning.

Introduction

Biophysics connects physical laws with biological processes and medical measurement. Students must explain how variables interact, translate between equations and physiological meaning, and recognize the limits of simplified models. These demands are evident in the study of blood flow, membrane electrical properties, diffusion, optics and ultrasound. A correct numerical answer alone does not demonstrate that a learner has selected an appropriate model or understood the conditions under which it applies.

Generative artificial intelligence (AI), particularly systems based on large language models, can produce explanations and questions in response to a student's request. Educational commentary identifies opportunities for adapting learning materials and supporting interaction, alongside problems of reliability, bias and dependence [1]. In medical education, demonstrations have shown both useful conversational responses and fabricated references [2]. These observations make verification a central

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

instructional requirement. The fluent presentation of an explanation provides insufficient evidence of its scientific accuracy.

A distinction must therefore be made between completing an assisted task and acquiring an independently usable skill. Recent studies of structured AI tutoring and unrestricted assistance report different learning outcomes in their respective settings [3,4]. Medical biophysics needs a teaching design that preserves students' responsibility for choosing equations, checking units and interpreting results. The aim of this article is to develop such a design and identify observable evidence for its evaluation. The guiding question is how AI assistance can be incorporated into biophysics lessons while keeping the learner's own physical reasoning visible.

Methods

This article combines a focused narrative synthesis with instructional design. Targeted searches of publisher websites and bibliographic records were conducted on 15 October 2026 using combinations of "AI tutoring," "physics education," "generative AI learning," "medical education" and "biophysics teaching." Sources were selected purposively for their relevance to learning outcomes, scientific reliability or educational implementation. The evidence base comprises two educational trials, one medical examination benchmark study, two scholarly commentaries and UNESCO guidance, supplemented by a physics textbook for the ultrasound example [1–7]. This is not an exhaustive systematic review.

Each source was considered in terms of its setting, type of evidence, outcome and applicability to undergraduate medical biophysics. Empirical findings were distinguished from demonstrations and recommendations. The resulting principles were translated into a lesson sequence, verification tasks and assessment criteria. No students were recruited, no institutional experiment was performed and no achievement dataset was analyzed. Accordingly, the Results section presents a synthesis and a proposed instructional method. The numerical example is an illustrative calculation, and the assessment scheme requires validation before use for consequential decisions.

Results

Evidence informing the teaching approach

Kestin and colleagues conducted a randomized controlled study in an undergraduate physics course involving 194 students. A custom AI tutor designed around pedagogical principles produced greater immediate learning than the active classroom condition in the studied lessons [3]. This finding concerns a deliberately designed instructional system; it does not establish that an unrestricted chatbot or every AI-supported activity will have the same effect. Its relevance to biophysics lies in the possibility of structuring assistance around the learning process rather than simply supplying solutions.

Bastani and colleagues studied AI assistance in high-school mathematics. Students using the unrestricted interface performed better during assisted practice but worse on subsequent unassisted assessment than the control group. A tutor with safeguards largely mitigated this negative effect, while its unassisted performance was statistically indistinguishable from the control condition [4]. The

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

setting differs from medical education, but the result supports a design requirement for the proposed biophysics lessons: evaluate what students can explain after assistance is withdrawn.

Kung and colleagues evaluated a language model on medical licensing examination questions [5]. Such performance describes the system's responses, not the learning gains of students who use it. Similarly, demonstrations of generated quizzes and simulated dialogue are evidence of possible functionality, rather than proof of educational effectiveness [2]. Taken together, these sources justify separating the quality of AI output, the quality of the student's submitted work and the student's independent understanding.

Matching AI functions to biophysics learning tasks

The proposed method assigns AI a limited role within a task selected by the teacher. Conversational tools can provide staged hints, feedback tools can compare an explanation with an explicit rubric, and coding assistants can help draft simple simulations. In each case, the teacher verifies the material before classroom use and students retain responsibility for the physical interpretation. Table 1 illustrates how the same principle applies across several topics.

Table 1. Proposed AI functions and verification tasks in biophysics

Topic	Proposed AI function	Required student verification
Fluid flow	Generate hints about changing vessel radius in an ideal tube model.	Check the fourth-power relation and identify the quantities held constant.
Membrane electricity	Comment on an explanation of a passive resistance–capacitance model.	Relate resistance and capacitance to the time constant; state model limitations.
Ultrasound	Ask questions about pulse travel and echo timing.	Draw the outward and return paths and calculate depth independently.
Optical absorption	Suggest variations of a concentration calculation.	Check units, the reference signal and assumptions of the absorption model.

A lesson sequence that preserves independent reasoning

Before accessing AI, students write the known quantities, identify the unknown and make an initial prediction. The teacher collects this short response so that later revisions can be traced to an identifiable misconception. Students then request a hint about the reasoning step that caused difficulty. A suitable teacher-written instruction is: "Ask me to justify my choice of physical model. Give one hint at a time and wait for my response before providing the next step." This instruction defines the intended interaction; it does not guarantee that every system will follow it.

Verification follows the dialogue. Students compare the proposed equation with an approved course source, check dimensions and units, reconstruct the numerical calculation with a calculator, and examine whether the answer is plausible. A second answer from the same model is not an independent

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

check. If the AI generates code for a simulation, the code must first reproduce a teacher-verified example and an appropriate limiting case. An attractive graph cannot substitute for checking the equation that produced it.

The student then submits a brief account of the original reasoning, the useful or incorrect advice received, and the justification for the final solution. The lesson ends with a related problem completed without AI. This final task changes a numerical value, the representation or an assumption so that students must apply the principle again. The comparison between the initial and final explanations provides information about reasoning; the dialogue record helps the teacher understand how assistance was used.

An ultrasound example of scientific verification

Consider an illustrative pulse–echo task in a uniform medium. The assumed sound speed is 1540 m/s, and the measured interval between pulse emission and echo return is 130 μs. Ultrasound ranging uses the outward and return travel of the pulse [7]. If d is the distance to the reflector, c the sound speed and t the total travel time, the appropriate relation is:

$$d = \frac{c\,t}{2} = \frac{1540 \times 130 \times 10^{-6}}{2}\ m = 0.1001\ m \approx 10.0\ cm$$

A teacher-prepared incorrect solution might multiply speed by time and report 20.02 cm as the reflector depth. This deliberately constructed error is an instructional example, not a recorded response from a tested AI system. Both the correct and incorrect calculations have units of length, so dimensional consistency alone cannot distinguish them. The student must draw the two segments of the pulse path and explain why the measured time corresponds to twice the reflector distance.

The subsequent task can ask how the estimated depth changes if the assumed sound speed is too high while the measured time remains fixed. The student should infer an overestimate of depth and explain the proportional dependence. Discussion then addresses the idealization of uniform propagation and the difference between a mathematical estimate and a clinical interpretation. The learning objective is the ability to verify the underlying model, including an error that may remain hidden in a fluent explanation.

Assessing understanding after AI assistance

Four proposed assessment domains are model selection, calculation with units, verification of an external answer, and transfer to a changed problem. Each domain can receive 0 points for absent or incorrect reasoning, 1 point for a partially correct explanation, and 2 points for a correct independently justified explanation, yielding a total of 8 points. Teachers should develop topic-specific examples for each level and review agreement between assessors. These criteria are a proposed formative rubric and have not been validated.

Immediate assessment should include an unaided explanation, while a parallel task approximately two weeks later could assess retention. AI-assisted assignment quality and unaided performance should be recorded separately. The ability to identify and repair a flawed solution is particularly relevant because

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

verification is an explicit learning objective. Satisfaction and perceived usefulness may inform lesson improvement, but they cannot replace a measure of what the student can do independently.

Discussion

The proposed contribution is a method for making the use of AI observable and assessable within a biophysics lesson. The teacher specifies the physical concept and acceptable evidence, the student records an initial attempt, and AI assistance is followed by verification and independent transfer. This design responds to the distinction between successful task completion and learning identified in the reviewed studies [3,4]. Its effectiveness in medical biophysics remains a question for empirical evaluation.

Scientific control begins with preparation. Before using generated explanations or questions, the teacher checks definitions, equations, units, numerical solutions and the correspondence between questions and intended outcomes. Generated references must be located and read before they are accepted as evidence. For a tool that retrieves course materials, the supplied materials should be accurate and permitted for that use, and students should inspect the cited passage. Access to reference material can support checking, but does not establish that every generated claim follows from that material.

UNESCO guidance emphasizes human agency, institutional validation, privacy and equitable access [6]. In a medical teaching context, these principles support using fictional cases and avoiding identifiable patient or student information in external systems. A comparable route using printed prompts and instructor feedback should be available when access is unequal. For students studying through Uzbek, Russian and English, teachers can prepare a checked glossary and ask learners to retain standard symbols and units when translating explanations. Translation quality and conceptual understanding should be assessed separately.

A future evaluation could compare the proposed approach with teacher-guided practice covering the same content for the same duration. Baseline mathematical preparation should be measured, the primary outcome should be predefined as unaided transfer performance, and sample size should follow a stated analysis and power plan. If intact classes are allocated, analysis must account for clustering. The study should record tool version, prompt instructions, teacher involvement and access conditions so that changes in technology are not confused with differences in pedagogy.

The present synthesis has limitations. Its sources were selected purposively and include evidence from general physics and school mathematics rather than direct trials in medical biophysics. Commentary and policy guidance establish considerations for design, not effect estimates. The illustrative ultrasound task tests one kind of reasoning, and the assessment rubric requires piloting. No claim can therefore be made that this approach improves local examination scores or clinical competence. Its immediate value is a specified teaching procedure that can be examined, adapted and tested.

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

Conclusion

AI tools can be incorporated into biophysics teaching through clearly bounded assistance, independent verification and assessment after assistance is withdrawn. The proposed method connects generated explanations and feedback with the student's own model selection, calculation and interpretation. The ultrasound example shows why verification must examine physical meaning as well as numerical accuracy and units. Teachers should retain responsibility for scientific quality and assessment, while implementation should address language, access and data protection. Future research should determine whether this design improves unaided transfer and retention among medical students.

References

1. Rustamov M. M. Virtual laboratoriyalar, simulyatsiyalar va elektron o‘quv resurslaridan foydalanish mexanizmlari // Ta’lim, tarbiya va innovatsiyalar jurnali. – 2025. – T. 2, № 2. – B. 41–46.
2. Rustamov M. M. Tibbiyotda axborot texnologiyalari fanining zamonaviy o‘qitish talablari // Ta’lim, tarbiya va innovatsiyalar jurnali. – 2025. – T. 2, № 2. – B. 47–50.
3. Rustamov M. M. Tibbiy ta’limda raqamli ta’lim muhitidan samarali foydalanishning innovatsion yondashuvlari // Ta’lim, tarbiya va innovatsiyalar jurnali. – 2025. – T. 2, № 2. – B. 51–54.
4. Rustamov M. M. Tibbiy ta’limda innovatsion ta’lim metodlari va ta’lim vositalaridan foydalanishning afzalliklari (Axborot texnologiyalari va jarayonlarni matematik modellashtirish faniga tadbiqi misolida) // O‘zMU xabarlari. – 2024. – T. 1, № 1.5.1. – B. 197–199. – DOI: 10.69617/nuuz.v1i1.5.1.4783.
5. Rustamov M. M. Enhancing medical education through virtual reality: innovative methods and practices // Лучшие интеллектуальные исследования. – 2024. – T. 16, № 3. – P. 70–73.
6. Rustamov M. M. Use of modern methods in teaching “Information technology” in medical education // Science and Innovation. – 2023. – Vol. 2, № A7. – P. 30–33. – DOI: 10.5281/zenodo.8134893.
7. Rustamov M. M. Improving the methodology of teaching the subject “Information technologies and modeling of technological processes” in an innovative educational environment // Science and Innovation. – 2023. – Vol. 2, № B7. – P. 58–61. – DOI: 10.5281/zenodo.8151780.
8. Rustamov M. M. Enhance students’ knowledge and skills with multimedia tools in an innovative educational environment // Science and Innovation. – 2023. – Vol. 2, № B10. – P. 43–45.
9. Rustamov M. M. Comparative analysis of the use of modern and traditional methods of education in higher education // Periodica Journal of Modern Philosophy, Social Sciences and Humanities. – 2023. – Vol. 20. – P. 1–3.
10. Use of new innovative methods in teaching the science of information technologies and modeling of technological processes / M. M. Rustamov, A. A. Ismanova, Sh. A. Gulamov [et al.] // Journal of Survey in Fisheries Sciences. – 2023. – Vol. 10, № 2S. – P. 1458–1463.
11. Teshaboyeva G. M. Biofizika fanini o‘qitishda zamonaviy pedagogik dasturiy vositalardan foydalanish // Ustozlar uchun. – 2025. – № 83, 1-qism. – B. 88–91.
12. Teshaboyeva G. M. Biofizika fanida simulyatsion va VR texnologiyalaridan foydalanish // Ustozlar uchun. – 2025. – № 83, 1-qism. – B. 92–94.

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

13. Teshaboyeva G. M. Biofizika fanini STEAM yondashuvi asosida o‘qitish // Образование, наука и инновационные идеи в мире. – 2025. – № 80, 2-qism. – B. 53–57.
14. Teshaboeva G. M., Ermatov Sh. A. Features of semiconductor lasers // Eurasian Journal of Medical and Natural Sciences. – 2023. – Vol. 3, № 4. – P. 169–175. – DOI: 10.5281/zenodo.7816302.
15. Teshaboeva G. M., Ermatov Sh. A. Tunnel effect in the field of laser radiation // Eurasian Journal of Medical and Natural Sciences. – 2022. – Vol. 2, № 2. – P. 150–153. – DOI: 10.5281/zenodo.6344797.
16. Tusmatov T. G‘. Raqamlashtirilgan ta’lim muhiti sharoitida biofizika fanini o‘qitishda virtual laboratoriya texnologiyalarining samaradorligini baholash // Образование, наука и инновационные идеи в мире. – 2025. – № 82, 2-qism. – B. 85–91.
17. Tusmatov T. G‘. Improving the methodology of teaching biophysics through the creation of an artificial intelligence-based analytical environment // Modern Education and Development. – 2026. – № 45, 1-qism. – P. 455–460.
18. Tusmatov T., G‘ulomov Sh. Klinik injiniring bo‘yicha virtual laboratoriya tashkil etishning ilmiy-metodik asoslari // Жамият ва инновациялар. – 2026. – T. 7, № 6/S. – B. 185–191. – DOI: 10.47689/2181-1415-vol7-iss6/S-pp185-191.