METHODOLOGY FOR INTEGRATED TEACHING OF GENERAL PHYSICS TO CHEMISTRY AND BIOLOGY STUDENTS

Dilfuza BEGMATOVA,
National University of Uzbekistan

Abstract

Introduction. In chemistry and biology degree programs, general physics is frequently taught in isolation from professional subjects, and students who can manipulate equations often fail to apply them to chemical or biological phenomena. **Aim.** The study aims to develop and substantiate a methodological model for integrated teaching of general physics to chemistry and biology students. **Methods.** The research is based on theoretical and methodological modeling: comparative analysis of scientific literature and curricula, systematization of physical laws, selection of professional contexts, construction of illustrative quantitative tasks, and design of an assessment rubric. **Results.** A five-stage integrated teaching algorithm is proposed (selecting a physical law, situating it in a professional context, constructing a model, carrying out an inquiry task, and evaluating the outcome), together with six content-selection criteria and an integration map of general physics topics. The algorithm is illustrated through quantitative tasks on diffusion, osmosis, heat transfer, electrical conductivity of electrolytes and membrane potential, and light absorption. A 12-point rubric for assessing interdisciplinary transfer is presented. The calculations are instructional examples rather than empirical results of a new educational experiment. **Conclusion.** Explicit definition of the physical model and its limits of applicability is a key condition for the scientific validity of integrated tasks; the model provides a basis for future empirical studies of interdisciplinary transfer.

Keywords: general physics; chemistry; biology; interdisciplinary integration; systems analysis; mathematical modeling; professionally oriented instruction; physics education.

1. Introduction

In contemporary natural sciences, the boundaries separating physics, chemistry, and biology are becoming increasingly fluid from a research perspective. Transport of substances across biological membranes, the energetics of chemical reactions, electrical potentials in cells, spectrophotometric analysis, and molecular motion are difficult to explain in depth without physical laws. Nevertheless, in non-physics degree programs, general physics is often studied separately from professional subjects; consequently, students may be able to solve equations while finding it difficult to apply them to chemical or biological situations.

Integrated teaching goes beyond mentioning terms from several disciplines in a single lesson. It explains a phenomenon from the perspectives of at least two disciplines and establishes a verifiable conceptual or quantitative connection between them. The concepts of energy, material flux, gradient, equilibrium, field, and wave in physics can serve as such unifying foundations. The National Research Council framework identifies systems and system models, flows of energy and matter, and cause-and-effect relationships as crosscutting concepts that unite the sciences [8]. As this framework was developed for school education, its application to higher education requires methodological adaptation.

An extensive body of research has developed around introductory physics for the life sciences. Meredith and Redish argue that a physics course meeting the needs of biology students must recognize that the two disciplines see the world differently, and they emphasize building simple quantitative models, connecting equations to physical meaning, and estimation [9]. Redish and Cooke describe the negotiation of "interdisciplinary authenticity" between physicists and biologists and show that the same task may be framed and valued differently by the two communities [10]. Crouch

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 15 Issue: 01 in January-2026
https://www.gejournal.net/index.php/IJSSIR

Copyright (c) 2026 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

and Heller propose restructuring the course around biologically rich contexts in which fundamental physics gives genuine insight into a biological system [11], and the NEXUS/Physics project repurposed an introductory course so that it interacts with the biology and chemistry courses taken by the same students [12]. Research on teaching physics to life-science students further emphasizes the importance of interpreting biological reasoning through physical interactions, integrating concepts from both disciplines in mathematical expressions, and coordinating functional and mechanistic explanations [1].

In the national context, the systems approach to teaching physics to non-physics students has been developed in a series of studies. Methods of teaching molecular physics to biology and chemistry students on the basis of systems analysis [2], the systematization of general physics topics [4], a systems approach to teaching physics to chemistry students [5], and the use of system analysis in solving physical problems [7] have been substantiated. The use of educational technologies in teaching the basics of nanophysics [3] and the integrated teaching of the topic "electromagnetic waves" [6] have also been described.

Analysis of the literature reveals a research gap. Most international studies concern courses for biology and pre-medical students, whereas a general physics course taught simultaneously, or in parallel, to chemistry and biology students requires a common physical core with differentiated professional contexts. Moreover, explicit criteria for selecting integrated content and instruments for assessing interdisciplinary transfer are rarely formulated. From this perspective, the same physical law should be retained in general physics for chemistry and biology students, while the disciplinary context and experimental task should differ.

Research aim. To develop a scientific and methodological model for selecting and teaching general physics content through interdisciplinary integration for chemistry and biology students, and to substantiate it through representative physical processes.

Research questions. (1) Which physical concepts are professionally relevant to both chemistry and biology? (2) How should an effective assignment linking a physical law to a professional process be designed? (3) How can interdisciplinary transfer be assessed?

The **novelty** of the study lies in a five-stage algorithm in which the professional example is treated as an essential stage in constructing and testing the physical model rather than as a supplementary application, in a set of paired chemical and biological tasks built on a single physical law, and in an analytic rubric that makes interdisciplinary transfer a separately assessed outcome.

2. Materials and Methods

2.1. Research design

This study is based on theoretical and methodological modeling. Its main methods include comparative analysis of scientific and curricular content, systematization of physical laws, selection of professional contexts, illustrative calculations, and the design of an assessment rubric. No new student sample or educational experiment data were used. The study therefore belongs to the class of design-oriented methodological research whose product is a model and a set of instructional materials ready for subsequent empirical testing.

2.2. Sources and procedure of content analysis

The materials analyzed included the general physics syllabi of chemistry and biology bachelor programs, standard university textbooks of general physics, physical chemistry, and biophysics, and peer-reviewed publications on introductory physics for life-science students [1, 9–12] and on the systems approach in physics teaching [2–7]. The analysis was conducted in three steps. First, the sections of the general physics course (mechanics, molecular physics and thermodynamics, electricity and magnetism, optics, atomic and nuclear physics) were listed. Second, for each section, the

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 15 Issue: 01 in January-2026
https://www.gejournal.net/index.php/IJSSIR
Copyright (c) 2026 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

processes from chemistry and biology courses in which the corresponding physical law plays an explanatory role were identified. Third, the identified pairs were compared and those that allow a single quantitative model to be applied in both disciplines were selected.

2.3. Criteria for selecting integrated content

The following criteria are proposed for selecting content for interdisciplinary integration:
(a) fundamental importance of the physical law within the general physics course;
(b) practical relevance of the law to chemistry and/or biology;
(c) alignment with students' prior knowledge in mathematics and natural sciences;
(d) possibility of quantitatively estimating parameters with realistic data;
(e) feasibility of laboratory or virtual verification;
(f) explicit consideration of the limits of model applicability.

A topic was included in the integration map if it satisfied at least criteria (a), (b), (d), and (f); criteria (c) and (e) were used to determine the place of the topic in the course sequence and the format of the inquiry task.

2.4. Integrated teaching algorithm

An integrated instructional unit is designed in five interconnected stages (Figure 1):
I — identifying the fundamental law and its conditions of applicability;
II — defining the chemical or biological problem;
III — constructing a physical model through idealization, variables, and equations;
IV — conducting calculations, laboratory work, or a virtual experiment;
V — interpreting the outcome in disciplinary terms, evaluating the limitations of the model, and transferring knowledge to a new situation.

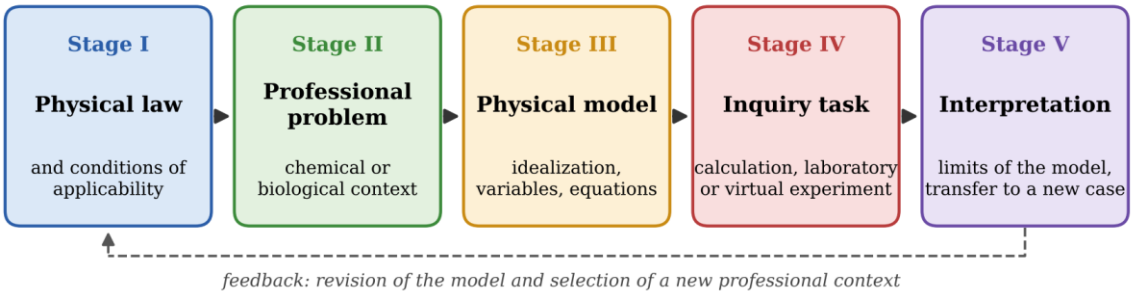


Figure 1. Five-stage algorithm of an integrated instructional unit

The algorithm is cyclic: the interpretation stage may reveal that the model is too idealized for the professional situation, which returns the learner to stage III (refinement of the model) or to stage II (selection of a different context).

2.5. Construction of quantitative tasks

For each selected topic, a pair of tasks was constructed: one oriented to a chemical process and one to a biological process, both resting on the same physical equation. Input data were chosen within the ranges given in standard reference sources so that the results have realistic orders of magnitude. The following constants were used: $R = 8.314\ J \cdot mol^{-1} \cdot K^{-1}$, $F = 96485\ C \cdot mol^{-1}$. Results were rounded to two or three significant figures. The values obtained are instructional examples and are not presented as experimental measurements.

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 15 Issue: 01 in January-2026
https://www.gejournal.net/index.php/IJSSIR
Copyright (c) 2026 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

2.6. Design of the assessment instrument

The assessment instrument was designed as an analytic rubric. Its dimensions were derived from the stages of the algorithm and from the competences emphasized in the literature: conceptual understanding, modeling, transfer, and experimentation [9, 11]. For each dimension, four performance levels (0–3 points) were described in observable terms. Content validity of the rubric is to be established through expert review by physics, chemistry, and biology lecturers, and its reliability through inter-rater agreement in a subsequent study (see Section 4).

3. Results

3.1. Integration map of general physics topics

Content analysis made it possible to identify the points at which general physics topics intersect with chemical and biological processes. The resulting integration map is presented in Table 1. For each topic, the table shows the chemical process, the biological process, and the type of integrated activity through which the connection is established.

Points of integration between general physics topics and chemistry and biology

Table 1

Physics topic	Chemical process	Biological process	Integrated activity
Diffusion (Fick's law)	Mixing of solutions	Transport of substances across membranes	Calculate the concentration gradient and flux
Osmosis (van 't Hoff law)	Colligative properties of solutions	Water balance and turgor of cells	Estimate osmotic pressure
Thermodynamics and heat transfer	Reaction enthalpy, calorimetry	Heat balance of the organism	Model energy exchange
Electric current	Conductivity of electrolytes	Ion channels and membrane potential	Compare charge carriers
Optics	Spectrophotometry	Pigments and biomolecules	Interpret absorption spectra

3.2. Diffusion

In chemistry, diffusion refers to the mixing of substances driven by concentration differences; in biology, it is one mechanism of substance transport through membranes and tissues. For a one-dimensional steady-state process, Fick's first law is:

$$J = -D\,(dc/dx), \quad \dot{N} = JA, \tag{1}$$

where J is the molar diffusive flux density ($mol \cdot m^{-2} \cdot s^{-1}$), D is the diffusion coefficient (m^2/s), c is the concentration (mol/m^3), and A is the area through which transport occurs (m^2).

Consider the following example: a porous layer of thickness $L = 1.0 \cdot 10^{-4}$ m separates regions with a concentration difference $\Delta c = 2.0$ mol/m^3; $D = 1.0 \cdot 10^{-9}$ m^2/s and $A = 1.0 \cdot 10^{-3}$ m^2. Assuming an approximately constant concentration gradient:

$$|J| = D\Delta c/L = 2.0 \cdot 10^{-5}\ mol \cdot m^{-2} \cdot s^{-1}; \quad |\dot{N}| = 2.0 \cdot 10^{-8}\ mol/s. \tag{2}$$

The characteristic time needed for diffusion over a distance L is estimated as:

$$t \approx L^2/(2D). \tag{3}$$

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 15 Issue: 01 in January-2026
https://www.gejournal.net/index.php/IJSSIR

Copyright (c) 2026 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

For $L = 1.0 \cdot 10^{-4}$ m, $t \approx 5$ s, whereas for $L = 1.0 \cdot 10^{-3}$ m the time increases to about 500 s, and for L = 1 cm to about 14 hours. Chemistry students analyze the effects of solution concentration and the diffusion coefficient, for example, why stirring is required to prepare a homogeneous solution in a reasonable time. Biology students examine how barrier thickness and surface area affect substance transport and why diffusion alone is sufficient within a cell but insufficient for multicellular organisms, which need circulatory and conducting systems. The same physical equation applies in both contexts. In actual biological membranes, however, selective permeability, channels, active transport, and partition coefficients may make the simple Fickian model insufficient.

Inquiry task. How does the flux change when the layer thickness doubles? Plot the model prediction and identify limitations of applying it to a biological membrane.

3.3. Osmosis

The topic of osmosis reveals the relationship among physical pressure, solution concentration, and cell volume. For an ideal dilute solution and a semipermeable membrane, the van ’t Hoff equation is:

$$\pi = icRT, \tag{4}$$

where π is osmotic pressure, i is the van ’t Hoff factor, c is molar concentration (mol/m^3), R is the universal gas constant, and T is absolute temperature. For nonideal solutions, activity and the osmotic coefficient must be considered.

Chemical task. For an idealized solution of a nondissociating solute at a concentration of 0.10 mol/L and T = 298 K, c = 100 mol/m^3:

$$\pi = 100 \cdot 8.314 \cdot 298 \approx 2.48 \cdot 10^5 \text{ Pa} \approx 2.48 \text{ bar}. \tag{5}$$

Biological task. For a physiological NaCl solution (0.15 mol/L) at body temperature T = 310 K and an ideal value i = 2, the estimate is $\pi \approx 300 \cdot 8.314 \cdot 310 \approx 7.7 \cdot 10^5$ Pa. Taking into account the osmotic coefficient (about 0.93 for this concentration), the value decreases to approximately $7.2 \cdot 10^5$ Pa. Comparing this solution with distilled water allows students to explain hemolysis of erythrocytes in a hypotonic medium and plasmolysis of plant cells in a hypertonic one.

Chemistry students evaluate concentration units and solution ideality, while biology students explain the relationship between differences in osmotic pressure and water transport in cells. An important methodological point is that the high calculated osmotic pressure does not, on its own, predict the actual state of a cell without accounting for membrane mechanics, the cell wall, and regulatory processes.

3.4. Heat transfer and thermochemistry

Heat transfer by conduction through a flat layer is described by Fourier’s law, and the heat released or absorbed in a calorimeter by the heat balance equation:

$$P = kA\Delta T/L, \quad Q = mc_p\Delta T, \tag{6}$$

where P is the heat flow (W), k is thermal conductivity (W·m^{-1}·K^{-1}), L is layer thickness, m is mass, and c_p is specific heat capacity.

Chemical task. When 50 mL of 1.0 mol/L HCl is mixed with 50 mL of 1.0 mol/L NaOH, the temperature rises by $\Delta T = 6.8$ K. Taking $m \approx 100$ g and $c_p \approx 4.18$ J·g^{-1}·K^{-1}, $Q \approx 2.84$ kJ; dividing by n = 0.050 mol gives a molar enthalpy of neutralization of about −57 kJ/mol, which is close to the reference value.

Biological task. Heat conducted from the body core through a subcutaneous tissue layer with $k \approx 0.2$ W·m^{-1}·K^{-1}, L = 1.0 cm, A = 1.5 m^2, and $\Delta T = 3$ K is $P \approx 90$ W, which is comparable to the metabolic heat production of an adult at rest. Students conclude that thermoregulation cannot be

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 15 Issue: 01 in January-2026
https://www.gejournal.net/index.php/IJSSIR
Copyright (c) 2026 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

explained by conduction alone: convective heat transport by blood flow, evaporation, and radiation must be included.

3.5. Electrical conductivity and membrane potential

Conduction of electric current in electrolytes is carried by ions. The resistance of a conductometric cell and the molar conductivity are related to specific conductivity κ by:

$$R = (L/A)/\kappa, \quad \Lambda_m = \kappa/c. \tag{7}$$

Chemical task. For a 0.010 mol/L KCl solution at 25 °C, $\kappa \approx 0.141$ S/m. In a cell with a constant $L/A = 100\ m^{-1}$, $R \approx 708\ \Omega$ and $\Lambda_m \approx 1.41 \cdot 10^{-2}\ S \cdot m^2 \cdot mol^{-1}$. Students explain why conductivity is used to monitor titrations.

Biological task. When ions are distributed unequally across a selectively permeable membrane, an equilibrium potential arises, described by the Nernst equation:

$$E = (RT/zF)\ \ln(c_{out}/c_{in}). \tag{8}$$

For K^+ ions with $c_{out} = 5$ mmol/L, $c_{in} = 140$ mmol/L, and T = 310 K, $E_K \approx -89$ mV. The measured resting potential of many cells (about −70 mV) differs from this value because the membrane is also permeable to Na^+ and Cl^-; this leads students to the idea of a weighted model (the Goldman–Hodgkin–Katz equation). The membrane can additionally be represented as an RC circuit: with a specific capacitance of about 1 μF/cm^2 and a specific resistance of about 10 kΩ·cm^2, the time constant $\tau = RC \approx 10$ ms. Here, the main methodological point is that Ohm's law describes the ionic current but does not explain the origin of the membrane potential.

3.6. Light absorption

Absorption of light by a solution is described by the Bouguer–Lambert–Beer law:

$$A = \lg(I_0/I) = \varepsilon l c, \tag{9}$$

where A is absorbance, ε is the molar absorption coefficient, l is the optical path length, and c is concentration.

Chemical task. NADH has $\varepsilon \approx 6220\ L \cdot mol^{-1} \cdot cm^{-1}$ at 340 nm. For a measured absorbance A = 0.311 in a 1.0 cm cuvette, $c \approx 5.0 \cdot 10^{-5}$ mol/L, and the transmittance is $T = 10^{-A} \approx 0.49$. Students construct a calibration line and determine the range of its linearity.

Biological task. In an enzymatic assay, the decrease of NADH absorbance at a rate of 0.062 min^{-1} corresponds to a reaction rate of about $1.0 \cdot 10^{-5}\ mol \cdot L^{-1} \cdot min^{-1}$. The model is limited to dilute, non-scattering solutions: in cell suspensions, light scattering and instrumental stray light at high absorbance cause deviations from linearity.

Summary of paired integrated tasks

Table 2

Physical law	Chemical task: result	Biological task: result	Key limitation
Fick's law	Flux $2.0 \cdot 10^{-8}$ mol/s; mixing time	Diffusion time 5 s (0.1 mm) vs. 14 h (1 cm)	Channels, active transport
Van 't Hoff law	$\pi \approx 2.48$ bar (0.10 mol/L)	$\pi \approx 7.2 \cdot 10^5$ Pa (0.15 mol/L NaCl)	Non-ideality, membrane mechanics
Heat balance, Fourier's law	$\Delta H \approx -57$ kJ/mol	P ≈ 90 W through tissue layer	Heat losses, blood convection
Ohm's law, Nernst equation	$R \approx 708\ \Omega$, $\Lambda_m \approx 141$ S·cm^2/mol	$E_K \approx -89$ mV; $\tau \approx 10$ ms	Multi-ion permeability
Beer–Lambert law	$c \approx 5.0 \cdot 10^{-5}$ mol/L	Rate ≈ 10 μmol·L^{-1}·min^{-1}	Scattering, high absorbance

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 15 Issue: 01 in January-2026
https://www.gejournal.net/index.php/IJSSIR

Copyright (c) 2026 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

3.7. Organization of an integrated class

Based on the algorithm, a sample sequence for an 80-minute integrated class was developed (Table 3). This allocation of time is advisory and should be adapted to the curriculum.

Sample structure of an 80-minute integrated class

Table 3

Stage	Time, min	Activity of the lecturer	Activity of students
Introduction of a professional problem	10	Presents a chemical or biological situation	Formulate the question in physical terms
Analysis of the physical law	15	Clarifies the law and its boundary conditions	Identify variables and assumptions
Calculation or simulation	20	Provides data, consults	Solve paired tasks in groups
Group experiment and interpretation	20	Organizes measurements	Compare model and data
Transfer and reflection	15	Offers a new situation	Apply the model, assess its limits

3.8. Framework and rubric for assessing integrated knowledge

Four dimensions are distinguished for assessing integrated knowledge (Figure 2).

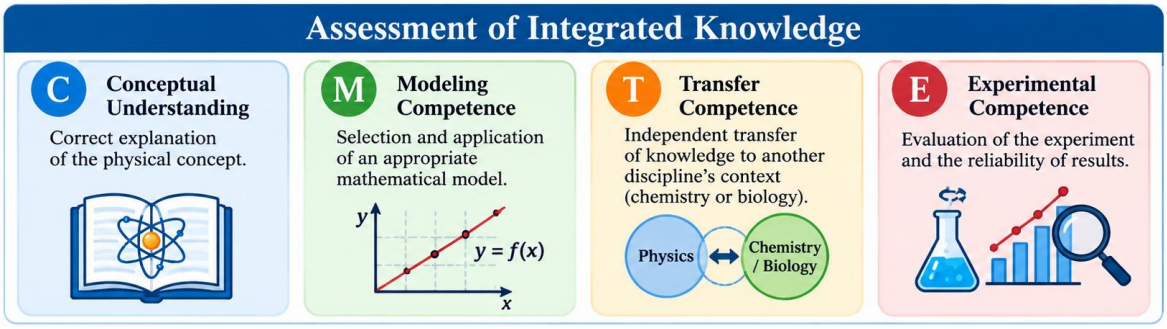


Figure 2. Framework for assessing integrated knowledge

Each dimension is rated using an expert rubric on a scale from 0 to 3 points, yielding a total score from 0 to 12 (Table 4). This scale is a preliminary methodological proposal and should not be presented as a standardized test until its validity and inter-rater agreement have been established.

Proposed analytic rubric for assessing integrated assignments

Table 4

Criterion	0 points	1 point	2 points	3 points
C: conceptual understanding	Incorrect explanation	Names the concept	Explains the law	Justifies conditions and limitations
M: modeling	No model	Selects a formula	Calculates correctly	Analyzes parameters and errors

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 15 Issue: 01 in January-2026
https://www.gejournal.net/index.php/IJSSIR
Copyright (c) 2026 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

Criterion	0 points	1 point	2 points	3 points
T: interdisciplinary transfer	Cannot establish a connection	Gives an example	Applies to a professional situation	Independently solves a new situation
E: experimentation	No interpretation	Records measurements	Compares results	Evaluates uncertainty and limitations

4. Discussion

The proposed model preserves the fundamental nature of physics while taking account of the disciplinary learning needs of chemistry and biology students. Its theoretical distinction is that the professional example is not treated as a supplementary application but as an essential stage in constructing and testing a physical model. This position is consistent with the view that biological examples added superficially to a traditional course are insufficient and that the course should be restructured around contexts in which physics gives genuine insight [9, 11]. The model also extends this line of research: instead of separate courses for different audiences, it offers paired tasks in which a single law serves both chemistry and biology, so that the common physical core and the disciplinary differences become visible simultaneously.

The results of Section 3 answer the research questions as follows. Regarding the first question, the concepts of gradient and flux, energy balance, potential and charge transport, and interaction of radiation with matter proved to be professionally relevant to both disciplines; they correspond to the crosscutting concepts of the NRC framework [8]. Regarding the second question, an effective assignment includes an explicit model, realistic data, a paired disciplinary interpretation, and a mandatory discussion of the limits of applicability. Regarding the third question, transfer can be operationalized as a separate rubric dimension evaluated on a new, previously unseen situation.

At the same time, interdisciplinary integration should not erase distinctions between disciplines. For example, equating the simple Fick's law model with biological membrane transport, or explaining all electrical properties of a membrane solely through Ohm's law, may lead to methodological errors. Physicists tend to reason from a few fundamental principles and idealized systems, while biologists value the complexity, structure, and function of real organisms [10]. Therefore, the idealizations and limits of applicability must be discussed in every assignment. In the proposed tasks, this function is performed by the "key limitation" column (Table 2), which turns the gap between the model and reality into a subject of discussion.

Potential educational benefits—including stronger professional motivation, more meaningful understanding of formulas, and improved transfer of knowledge—remain theoretical expectations. Empirical confirmation requires a study using assessment instruments with demonstrated validity and reliability. A limitation of the present study is that the proposed model has not been claimed to have undergone experimental testing with a particular university sample.

To evaluate the effectiveness of the methodology in future research, parallel experimental and control groups may complete pretests, posttests, and interdisciplinary transfer tasks. An ANCOVA controlling for baseline scores or a multilevel model accounting for clustering of students within groups, together with effect sizes and confidence intervals, would be appropriate. The hypothesis is that the group taught using the integrated approach will obtain higher scores on interdisciplinary transfer. This hypothesis has not yet been tested.

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 15 Issue: 01 in January-2026
https://www.gejournal.net/index.php/IJSSIR
Copyright (c) 2026 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

5. Conclusion

The methodological foundation for integrated teaching of general physics in chemistry and biology programs is the systematic linking of physical laws with discipline-specific processes. The study proposes a five-stage teaching algorithm, six content-selection criteria, an integration map of general physics topics, paired interdisciplinary quantitative assignments on diffusion, osmosis, heat transfer, electrical conductivity and membrane potential, and light absorption, a sample structure of an integrated class, and an analytic assessment rubric. Explicitly defining the physical model and its limits of applicability is identified as a key requirement for the scientific validity of an integrated task. The model can serve as a theoretical and methodological basis for evaluating interdisciplinary transfer and modeling competence in future educational research.

References

1. Gouvea, J. S., & Simon, M. R. (2019). Bridging the gaps: How students seek disciplinary coherence in introductory physics for life science. Physical Review Physics Education Research, 15, 020142. https://doi.org/10.1103/PhysRevPhysEducRes.15.020142
2. Begmatova, D. A. (2024). Methods of teaching molecular physics topics to biology and chemistry students based on systems analysis. American Journal of Social Science, 2(5), 118–123.
3. Begmatova, D. A., Eshkuvatov, H., Abdullayev, N., … Suvonova, O., & Ishtayev, J. (2024). Use of educational technologies in teaching the basics of nanophysics, nanomaterials and nanotechnologies. Results in Optics, 16, 100717.
4. Begmatova, D. A., & Zaxidova, M. A. (2024). Methodology of teaching general physics topics based on systems analysis. Fan va jamiyat [Science and Society], (6), 108. Nukus.
5. Begmatova, D. A., Iskandarov, A., Yakubova, B., & Suvonova, O. (2025). Methodology for teaching physics to chemistry students based on a systems approach. NamDU Ilmiy axborotnomasi [Namangan State University Scientific Bulletin], (8), 617.
6. Xolboyev, Y., Tursunmetov, K., Tajiboyeva, X., Begmatova, D., Abdullayev, N., Sodiqova, S., & Nomozova, D. (2025). Methodology of teaching the topic of “electromagnetic waves” in a systematized and integrated way. Results in Optics, 100889.
7. Begmatova, D. A., & Abdullayev, N. (2020). Method of system analysis in solving physical problems. Journal of Critical Reviews.
8. National Research Council. (2012). A framework for K-12 science education: Practices, crosscutting concepts, and core ideas. Washington, DC: The National Academies Press. https://doi.org/10.17226/13165
9. Meredith, D. C., & Redish, E. F. (2013). Reinventing physics for life-sciences majors. Physics Today, 66(7), 38–43. https://doi.org/10.1063/PT.3.2046
10. Redish, E. F., & Cooke, T. J. (2013). Learning each other’s ropes: Negotiating interdisciplinary authenticity. CBE—Life Sciences Education, 12(2), 175–186. https://doi.org/10.1187/cbe.12-09-0147
11. Crouch, C. H., & Heller, K. (2014). Introductory physics in biological context: An approach to improve introductory physics for life science students. American Journal of Physics, 82(5), 378–386. https://doi.org/10.1119/1.4870079
12. Redish, E. F., et al. (2014). NEXUS/Physics: An interdisciplinary repurposing of physics for biologists. American Journal of Physics, 82(5), 368. https://doi.org/10.1119/1.4870386

ISSN 2277-3630 (online), Published by International journal of Social Sciences & Interdisciplinary Research., under Volume: 15 Issue: 01 in January-2026
https://www.gejournal.net/index.php/IJSSIR

Copyright (c) 2026 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY). To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/