REVISTA TÓPICOS
ISSN 2965-6672 | Qualis A2

PHYSICS BEYOND FORMULAS: EXPERIMENTATION AND MULTIPLE REPRESENTATIONS OF LIFE-RELATED PHENOMENA IN BASIC EDUCATION

FÍSICA PARA ALÉM DAS FÓRMULAS: EXPERIMENTAÇÃO E MÚLTIPLAS REPRESENTAÇÕES DE FENÔMENOS RELACIONADOS À VIDA NA EDUCAÇÃO BÁSICA

Ciências Exatas e da Terra, Ciências Humanas • 25/08/2026

REGISTRO DOI: 10.70773/revistatopicos/787612072

Diego Augusto Oliveira Dourado
Flávia Lis Fernandes Medina Melo
Ilmário de Souza Calqueija

ABSTRACT

Physics education can benefit from approaches that integrate experimentation with different forms of knowledge representation, enabling connections among observable phenomena, models, concepts, and mathematical language. This study aimed to analyze how high school students mobilize and represent physics concepts when interpreting life-related phenomena through group-based experimental and representational activities. The study adopted a qualitative, exploratory, field-based approach and involved 29 third-year high school students from a state public school in Delmiro Gouveia, Alagoas, Brazil. The intervention addressed six themes: muscles and levers in the human body; radiation and its effects on the body; photosynthesis and solar energy; breathing and air pressure; density and buoyancy; and motion and mechanical energy. The analysis encompassed experiments, models, posters, photographic records, and explanations produced by the students, focusing on the relationships between phenomena and concepts, experimentation and modeling, and multiple forms of representation and communication. The results showed that physics knowledge was mobilized through different modes of representation, including experimental, visual, verbal, and mathematical representations, whose use varied according to the nature of the phenomena investigated. Connections between physics and biological knowledge were also observed, as was the importance of teacher mediation in supporting the interpretation of phenomena and an understanding of the limitations of models and representations. The findings suggest that integrating experimentation, modeling, and multiple representations can broaden opportunities for interpreting and communicating physics knowledge in basic education, with mathematics understood as one of the languages of physics rather than its sole form of

representation.
Keywords: Physics education; experimentation; basic education; interdisciplinarity.

RESUMO

O ensino de Física pode ser favorecido por propostas que articulem a experimentação a diferentes formas de representação dos conhecimentos, possibilitando relações entre fenômenos observáveis, modelos, conceitos e linguagem matemática. Este estudo teve como objetivo analisar como estudantes do Ensino Médio mobilizam e representam conceitos físicos na interpretação de fenômenos relacionados à vida por meio de atividades experimentais e representacionais desenvolvidas em grupo. A pesquisa, de abordagem qualitativa, caráter exploratório e natureza de campo, foi realizada com 29 estudantes da 3ª série do Ensino Médio de uma escola pública estadual de Delmiro Gouveia, Alagoas, Brasil. A intervenção contemplou seis temáticas: músculos e alavancas do corpo humano; radiações e seus efeitos no corpo; fotossíntese e energia solar; respiração e pressão do ar; densidade e flutuação; e movimento e energia mecânica. Foram analisados experimentos, modelos, cartazes, registros fotográficos e explicações produzidas pelos estudantes, considerando as relações entre fenômeno e conceito, experimentação e modelização e múltiplas formas de representação e comunicação. Os resultados evidenciaram que os conhecimentos físicos foram mobilizados por meio de diferentes linguagens, incluindo representações experimentais, visuais, verbais e matemáticas, cuja utilização variou conforme a natureza dos fenômenos investigados. Também foram observadas articulações entre conhecimentos físicos e biológicos, bem como a importância da mediação docente na interpretação dos fenômenos e na compreensão dos limites dos modelos e

representações. Conclui-se que a integração entre experimentação, modelização e múltiplas representações pode ampliar as possibilidades de interpretação e comunicação dos conhecimentos físicos na Educação Básica, compreendendo a matemática como uma das linguagens da Física, e não como sua única forma de representação.
Palavras-chave: Ensino de Física; experimentação; Educação Básica; interdisciplinaridade.

1. INTRODUCTION

Physics education in basic education involves not only addressing concepts, laws, and mathematical expressions, but also using them to understand natural and everyday phenomena. From this perspective, Duarte (2012) discusses the articulation between concrete experiences and different forms of representation, fostering connections between observable situations and more abstract levels of understanding.

The study of life-related phenomena also provides opportunities to establish connections between physics and biology. In this regard, Sestari, Garcia, and Santarosa (2021), in their analysis of interdisciplinary practices in physics education, identify different ways in which knowledge from distinct fields can be related and discuss the need to distinguish interdisciplinarity from other forms of interaction between disciplines.

Experimentation provides a means of connecting theoretical knowledge with observable situations. Batista, Fusinato, and Blini (2009) highlight the contributions of experimentation to the teaching and learning process and to student engagement in classroom activities.

However, experimental activities should not be understood merely as the manipulation of materials; rather, they should be articulated with discussions of the knowledge involved (Alves & Stachak, 2005). Along these lines, Séré, Coelho, and Nunes (2003) emphasize the connections that experimentation can establish between what is observed and the knowledge used to interpret it.

Simple experiments using readily available materials also offer possibilities for physics education in basic education (Quirino & Lavarda, 2001; Silva & Leal, 2017). Other studies have demonstrated ways of contextualizing physics knowledge: Silva and Assis (2012) addressed concepts of modern physics through a low-cost experimental activity, while Carvalho et al. (2025) and Caldeira (2026) present approaches that establish connections between physics and biological knowledge.

Despite these possibilities, conducting experimental activities does not, in itself, ensure that students will connect what they observe with physics concepts and the different ways in which these concepts can be represented. Accordingly, this study is motivated by the need to understand how experimentation and multiple forms of representation can contribute to the interpretation and communication of physics knowledge related to life-related phenomena, with mathematics understood as one of the languages of physics, articulated with experimental, visual, and verbal representations.

Against this background, the following research question was formulated: How can experimental and representational activities related to life-related phenomena support high school students in mobilizing and communicating physics concepts?

Thus, the overall aim of this study was to analyze how high school students mobilize and represent physics concepts when interpreting life-related phenomena through group-based experimental activities. Specifically, the study sought to identify the relationships established between the phenomena and physics concepts; analyze experiments, models, posters, and mathematical expressions as different forms of knowledge representation; examine how these representations were mobilized in communicating the explanations developed by the students; and identify the potential and limitations observed during the activities.

2. METHODOLOGY

The study was conducted at the Luiz Augusto Azevedo de Menezes State School, a full-time public school within the state education system, located in the municipality of Delmiro Gouveia, Alagoas, Brazil. Twenty-nine students from 3rd-year Class B of Brazilian High School participated in the activities, including 17 female and 12 male students. The class exhibited a heterogeneous profile in terms of participation and engagement in the activities: some students showed greater ease in communicating and expressing their ideas, whereas others participated more reservedly. Overall, greater engagement was observed when the proposed tasks involved hands-on activities, material production, and teamwork.

The study adopted a qualitative approach, as it sought to understand the students' productions, explanations, and forms of representation mobilized throughout the pedagogical intervention. According to Minayo (2014), qualitative research enables the understanding of meanings, relationships, and processes within the context under investigation, while Lüdke and André (2013) emphasize the importance of context in the study of educational phenomena.

Regarding its objectives, the study was exploratory in nature, as it sought to broaden the understanding of the possibilities and limitations of an experimental and representational approach to physics education. According to Gil (2010), exploratory research allows for closer engagement with the research problem and contributes to a deeper examination of its different aspects. In terms of procedures, the study was characterized as field research, conducted in the school setting where the pedagogical intervention took place, allowing the activities to be directly monitored and data to be produced within the context under investigation (Vergara, 2013).

The intervention was conducted between September and November 2025 by one of the authors, who was the teacher responsible for the class. Approximately eight 60-minute lessons were used, totaling about eight hours of activities. This period encompassed the initial problematization and organization of the groups, the development of the experimental activities, the preparation of the students' productions, and the discussion of the physics concepts involved.

The intervention was organized around six themes related to phenomena associated with life and everyday situations: (a) muscles and levers in the human body; (b) radiation and its effects on the human body; (c) photosynthesis and solar energy; (d) respiration and air pressure; (e) density and buoyancy; and (f) motion and mechanical energy.

The students were divided into six groups, each responsible for one of the themes. Although the interpretation of the phenomena from a physics perspective constituted the main focus of the activities, connections with biological knowledge were established whenever they contributed to understanding the phenomena under investigation. In such cases, knowledge from both fields was mobilized in an integrated manner, giving the intervention an interdisciplinary dimension.

The instructional sequence began with the problematization of the themes and the organization of the groups. Subsequently, the students conducted research, discussed the concepts involved, and planned their productions. The activities were organized according to the specific characteristics of each theme and involved the preparation of explanatory posters and the development of experiments, models, or hands-on activities related to the phenomena under investigation. Throughout the lessons, the teacher monitored the groups, clarified questions, and posed questions aimed at supporting the interpretation of the phenomena and the construction of explanations.

The students' productions varied according to the phenomenon investigated by each group. For the theme of muscles and levers in the human body, a poster was produced relating bodily structures and movements to the concepts of force, lever classes, and torque. The group responsible for radiation produced a poster addressing aspects of electromagnetic waves, frequency, energy, and the effects of radiation on living organisms, including historical events related to the topic. For photosynthesis and solar energy, the poster was associated with a hands-on activity involving different conditions of light exposure, allowing relationships between light and energy transformations to be discussed.

For respiration and air pressure, the students constructed a model of the respiratory system using a bottle and balloons, accompanied by an explanatory poster, to represent relationships between changes in volume and air pressure. The group responsible for density and buoyancy developed an experimental activity involving the behavior of different materials in a liquid medium, allowing concepts of mass, volume, density, and buoyant force to be addressed. Finally, for motion and mechanical energy, the students produced a poster and an experimental setup using accessible materials to address motion and different forms and transformations of mechanical energy.

The experimental activities were conducted predominantly with simple and accessible materials. The experiments and models were used as resources for observation, problematization, modeling, and discussion of the phenomena, without intending to reproduce the full complexity of the natural or biological processes under investigation. The posters, in turn, enabled the groups to organize and communicate the knowledge they mobilized through texts, images, diagrams, concepts, and, when relevant, mathematical expressions associated with the respective themes.

Data were produced in the school setting throughout the development of the activities. The sources of evidence included direct observation, the materials produced by the groups—particularly posters, experiments, and models—the explanations provided by the students during classroom discussions, and photographic records of the activities.

The analysis of the evidence was guided by three interconnected qualitative dimensions. The first, relationship between phenomenon and concept, focused on the physics concepts mobilized by the students to interpret the phenomena under investigation, including their connections with biological knowledge when relevant. The second, experimentation and modeling, addressed the use of experiments and models as resources for observation, problematization, and interpretation of the phenomena, while also considering the limitations of these representations. The third, multiple forms of representation and communication, examined the use of posters, drawings, diagrams, verbal explanations, and mathematical expressions to organize and communicate the physics concepts mobilized by the groups.

These three dimensions were defined in accordance with the research question and the objectives of the study and guided the analysis and interpretation of the evidence produced during the intervention. The analysis considered, in an integrated manner, classroom observations, group productions, students' explanations, and photographic records, seeking to identify convergences, specific features, and relationships across the different sources of evidence. The dimensions were not used to classify or compare group performance, but rather to organize the qualitative interpretation of the evidence.

The analysis was descriptive and interpretive, seeking to understand the relationships among the phenomena investigated, the physics concepts involved, and the different forms used by the students to represent and communicate them. Throughout this process, experimental, visual, verbal, and mathematical forms of representation were considered in an integrated manner, as were connections between physics and biological knowledge whenever they contributed to the construction of the students' explanations.

3. RESULTS AND DISCUSSION

The activities carried out revealed different possibilities for addressing physics knowledge through phenomena related to life and everyday situations. Although the six groups investigated different topics, their work shared common elements, including research, poster development, hands-on activities, and the use of drawings, models, and explanations. Mathematical relationships were also present in some of the activities, integrated with the other resources used to interpret and communicate the knowledge addressed.

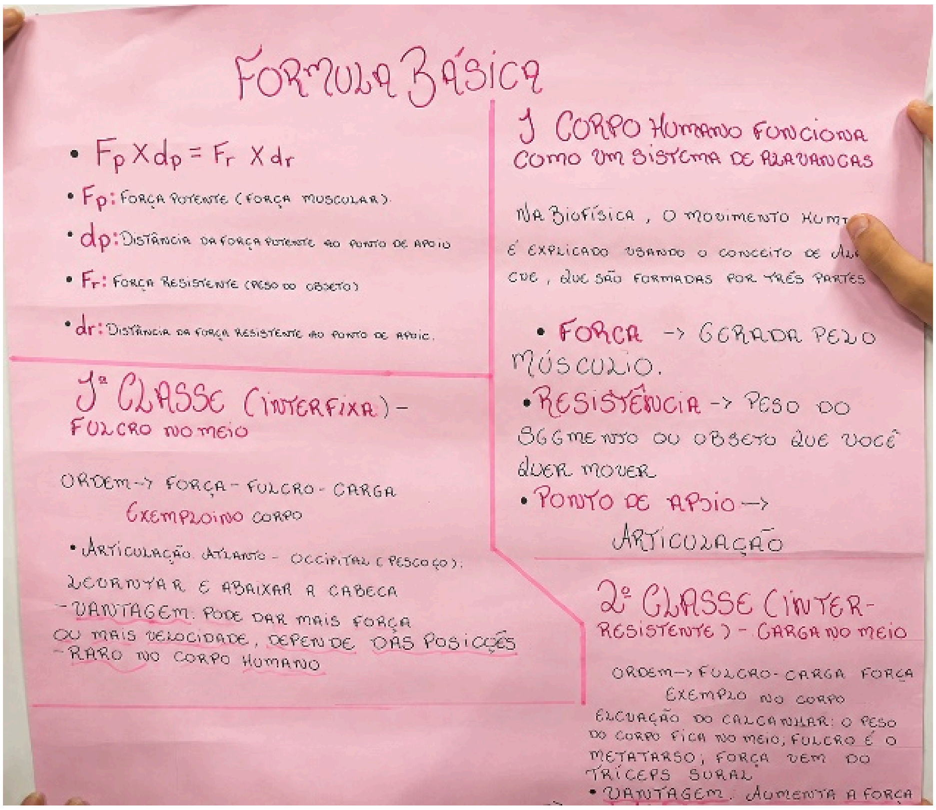
The analysis sought to understand how these different resources were mobilized by the students in interpreting and communicating physics knowledge. From this perspective, Séré, Coelho, and Nunes (2003) highlight that experimentation can foster connections between what is observed and the knowledge used to interpret phenomena. Araújo and Abib (2003), in turn, show that experimental activities in physics education can encompass different approaches and purposes, including activities related to everyday situations.

However, the performance of hands-on activities was not considered, in isolation, as evidence of conceptual understanding. Bassoli (2014) draws attention to the different meanings that practical activities may assume in science education, cautioning against automatically associating their implementation with learning. Accordingly, the analysis considered the groups' work, the explanations they provided, the experiments and models they developed, and the connections they established with the physics concepts addressed.

3.1. Muscles And Levers: Physics In The Interpretation Of Body Movements

In the topic of muscles and levers in the human body, the group used knowledge of mechanics to interpret body movements and structures. The poster included elements such as muscular force, resistance, and fulcrum, as well as examples related to the different classes of levers and the joints of the human body.

Figure 1. Representations used by the students to address levers in the human body.



Source: Authors' collection (2025).

The physics concepts in the students' work were related to bodily situations through explanations, examples, and representations presented on the poster. A mathematical relationship associated with lever equilibrium was also included, together with the other resources used by the group. Thus, the physics concepts were presented in connection with movements and structures of the human body.

In this case, the mathematical relationship did not appear in isolation but was integrated with the representations and bodily examples used by the group, helping to connect the formalization of physics concepts with the situations analyzed.

This connection between concrete situations and physics knowledge is consistent with Duarte (2012), who discusses the importance of establishing relationships among experiences, models, and different forms of representation in physics education.

In the case analyzed, body movements provided situations through which concepts of mechanics could be contextualized.

The activity also enabled connections between physics and biology, as mechanical concepts were used to interpret movements and structures of the human body. Physics knowledge therefore assumed an explanatory role in addressing a life-related phenomenon.

3.2. Breathing And Air Pressure: Experimentation And Modeling

In the topic of breathing and air pressure, the group used a model constructed from a bottle and balloons to represent certain aspects of pulmonary ventilation. Manipulating the model made it possible to observe changes in the balloons and discuss relationships between changes in volume and air pressure.

Figure 2. Representations used by the students to address breathing and air pressure.

Source: Authors' collection (2025).

The poster included a drawing of the model, explanations of how it worked, and a mathematical relationship between pressure and volume. These elements constituted different resources used by the group to represent and communicate aspects of the phenomenon under investigation. The hands-on activity provided a situation that could be manipulated and observed, while the poster enabled the students to organize the knowledge discussed.

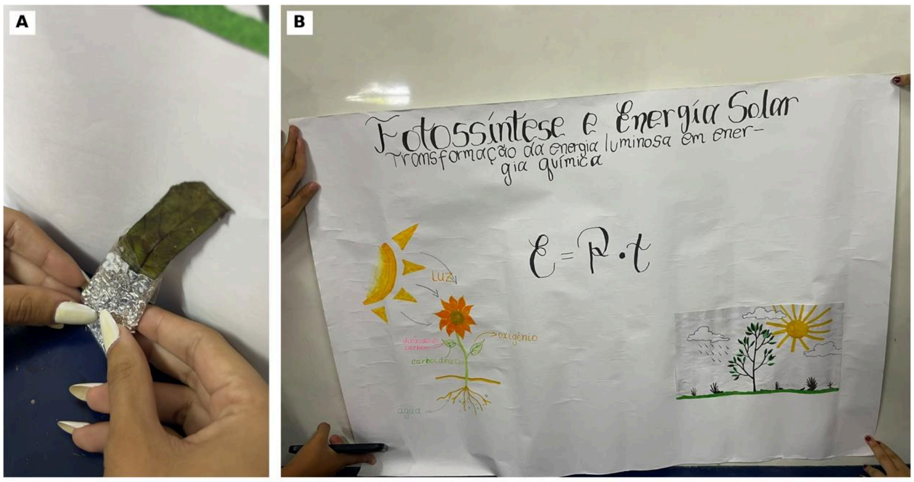
This result is consistent with the perspective of Séré, Coelho, and Nunes (2003), according to whom experimentation can contribute to establishing connections between observable situations and the knowledge used to interpret them. In this case, the value of the activity lay not only in how the model worked, but also in the physical relationships that could be discussed through it.

However, the model used constitutes a simplified representation and does not fully reproduce the anatomical and physiological complexity of human breathing. This limitation reinforces the importance of teacher mediation in discussing what the model is able to represent, an aspect consistent with Bassoli's (2014) considerations regarding hands-on activities in science education.

3.3. Photosynthesis And Solar Energy: Light, Energy, And Interpretation Of The Phenomenon

In the topic of photosynthesis and solar energy, the group addressed the role of light and the energy transformations associated with the photosynthetic process. The poster included drawings, explanations of light exposure, and references to the transformation of light energy, while the hands-on activity involved a leaf subjected to different lighting conditions.

Figure 3. Student productions related to the topic of photosynthesis and solar energy: (A) hands-on activity involving light exposure; (B) poster developed by the group.



Source: Authors' collection (2025).

This activity presented an important characteristic: not all aspects of the phenomenon under investigation could be directly observed. Although it was possible to explore a situation related to light availability, the energy transformation associated with photosynthesis depends on scientific knowledge that extends beyond what can be directly perceived. Thus, the activity made it possible to establish connections between an observable situation and the knowledge used to interpret it.

This characteristic is consistent with Duarte's (2012) discussion of the need to establish connections between concrete experiences and more abstract levels of understanding. In this case, the hands-on activity served as a starting point for discussion, while drawings, texts, and explanations contributed to representing aspects of the phenomenon that were not directly observable.

The poster also included a mathematical relationship involving energy, power, and time. This relationship constituted one of the elements used by the group to address the topic, without, in itself, representing the complexity of the photosynthetic process. Its inclusion alongside drawings and explanations demonstrates the use of different resources in organizing the students' work.

The connection between energy and biological phenomena is also found in Maciel (2019), who developed an interdisciplinary approach integrating physics and biology to address energy in the human body. Caldeira (2026), in turn, presents possibilities for articulating physics and biological knowledge through contextualized and experimental activities. Although these studies address different phenomena, they demonstrate possibilities for using life-related situations to contextualize physics knowledge.

3.4. Radiation: Physics, Organisms, And Contextualization

In the topic of radiation and its effects on organisms, the group addressed knowledge related to electromagnetic waves, frequency, and energy, establishing connections with possible effects of radiation on living organisms. The poster also included references to the Cesium-137 accident and the Chernobyl disaster, broadening the discussion to historical situations related to the topic.

The students' work combined texts, drawings, symbols, a mathematical relationship between energy and frequency, and references to historical events. The combination of these elements made it possible to connect physics knowledge with situations used to contextualize the topic, broadening the approach beyond the isolated presentation of concepts.

Silva and Assis (2012), in addressing modern physics content through a low-cost experimental activity, highlight possibilities for connecting physics concepts with technological applications and everyday situations. This perspective is consistent with the work analyzed here, in which knowledge related to radiation was associated with contexts that contributed to its interpretation.

Carvalho et al. (2025) also present a connection between physics and biology by addressing knowledge related to light, electromagnetic waves, and carbon-14 dating in the interpretation of biological and evolutionary phenomena. Despite the differences between the approaches, these studies demonstrate possibilities for articulating physics knowledge related to radiation with phenomena addressed in other areas of the natural sciences.

3.5. Motion, Mechanical Energy, And Buoyancy

In the topic of motion and mechanical energy, the group developed a poster and an experimental setup using readily available materials. The students' work addressed different forms of mechanical energy through drawings, examples, explanations, and mathematical relationships associated with the situations represented.

The students' work demonstrates the combined use of different resources. The poster organized concepts, examples, drawings, and relationships associated with different forms of energy, while the experimental setup provided a hands-on situation related to the content studied. Thus, physics knowledge was addressed through a combination of explanation, representation, and hands-on activity.

The use of readily available materials is consistent with approaches that highlight the feasibility of simple, low-cost experiments in physics education (Duarte, 2012; Quirino & Lavarda, 2001; Silva & Leal, 2017). Such approaches are particularly relevant in school contexts where specific laboratory equipment is not always available. The potential of these resources, however, is related to the opportunities they provide for observation, problematization, and discussion of the concepts involved.

In the topic of density and buoyancy, the group investigated situations involving the sinking and floating of different materials in a liquid medium, mobilizing concepts of mass, volume, density, and buoyant force.

In this activity, the behavior of the objects could be directly observed, but interpreting it required physics knowledge related to the properties of the materials and their interactions with the liquid medium. Observation therefore constituted the starting point for discussing the concepts involved, but did not, in itself, provide a physical explanation of the phenomenon, reinforcing the importance of articulating experimental evidence with conceptual knowledge.

3.6. Multiple Forms Of Representation And Connections Between Physics And Biology

The joint analysis of the six topics showed that the students used different resources to organize and communicate the knowledge addressed. Posters, drawings, texts, models, experiments, examples, and verbal explanations appeared in different combinations according to the characteristics of each topic. Mathematical relationships were also present in some of the students' work, integrated with this broader set of resources.

This diversity is consistent with the analysis by Araújo and Abib (2003), who identify different approaches and purposes for experimental activities in physics education. In the present study, there was no single way of addressing the phenomena: some activities favored observation and the manipulation of models, while others relied more extensively on drawings, texts, and explanations to communicate the knowledge investigated. Table 1 summarizes the main physics concepts and resources used by the groups.

Table 1. Summary of the physics concepts and resources used in the activities.

Topic	Physics concepts addressed	Main resources used
Muscles and levers	Force, resistance, fulcrum, and levers	Poster, body-related examples, drawings, explanations, and mathematical relation
Breathing and air pressure	Pressure, volume, and air behavior	Model, drawing, poster, observation, explanations, and mathematical relation

Photosynthesis and solar energy	Light, energy, and energy transformations	Hands-on activity, drawings, poster, explanations, and mathematical relation
Radiation and its effects on organisms	Electromagnetic waves, frequency, and energy	Poster, texts, drawings, historical contextualization, and mathematical relation
Motion and mechanical energy	Motion and forms of mechanical energy	Experimental setup, poster, drawings, examples, and mathematical relations
Density and buoyancy	Mass, volume, density, and buoyant force	Experiment, observation, and explanations

Source: Prepared by the authors (2025).

The activities also enabled connections between Physics and Biology, particularly in the topics of muscles and levers, breathing, photosynthesis, and radiation. However, the presence of content from both areas was not considered sufficient, in itself, to characterize interdisciplinarity. Sestari, Garcia, and Santarosa (2021) emphasize the need to distinguish interdisciplinarity from other forms of interaction between disciplines, while Cardoso et al. (2008) highlight the importance of interconnecting the knowledge involved.

In the present study, this articulation became more evident when physics knowledge effectively contributed to the interpretation of life-related phenomena, such as the use of Mechanics to discuss body movements, pressure–volume relationships in the study of breathing, and knowledge of light, energy, and radiation in biological phenomena.

This perspective is consistent with Valgas et al. (2024), who connected Physics and Biology through bioelectricity; Carvalho et al. (2025), who addressed phenomena involving light and radiation; Bocchi (2017), who explored physics concepts related to the human senses; and Maciel (2019), who used energy as a connecting element between Physics and Biology. Although these studies differ in their objectives and procedures, they reinforce the potential for contextualizing physics knowledge through life-related phenomena.

3.7. Between Phenomena, Representations, And Physics Concepts

Taken together, the students' productions revealed different ways of mobilizing physics knowledge in the interpretation of the phenomena investigated. The potentialities of the proposal included the exploration of phenomena related to life and everyday situations, the use of accessible materials, students' participation in producing the materials, and the connections established between physics and biological knowledge. The limitations identified included the simplified nature of certain models, the impossibility of directly observing some processes, and the need for teacher mediation to relate the situations investigated to the concepts involved.

In this sense, thinking about Physics "beyond formulas" means broadening the ways in which physics knowledge can be approached without restricting it to mathematical formalization. Mathematical relationships were present in some of the students' productions and were integrated with experiments, models, drawings, posters, texts, and explanations of the phenomena. The results thus reveal different ways of mobilizing, representing, and communicating physics knowledge, without considering the completion of the activities, in itself, as evidence of conceptual learning.

4. CONCLUSIONS

The study showed that the interpretation of life-related phenomena in Physics education can be supported by the articulation of different forms of representation. The research question was addressed by identifying that experiments, models, visual representations, verbal explanations, and mathematical expressions can play complementary roles in the mobilization and communication of physics knowledge, particularly when associated with the problematization of phenomena and teacher mediation.

Thinking about Physics “beyond formulas” does not mean diminishing the importance of mathematical language, but rather recognizing it as one of the ways of representing and communicating physics knowledge. From this perspective, mathematical formalization can be integrated with observation, experimentation, modeling, and other forms of representation, thereby broadening the possibilities for interpreting phenomena in the school context.

The exploration of life-related phenomena also enabled connections between physics and biological knowledge, provided that these relationships effectively contributed to the interpretation of the phenomena investigated. The proposal thus highlights possibilities for developing contextualized approaches to Physics education while preserving the conceptual specificities of the field and valuing different ways of constructing and communicating explanations.

As a limitation, the study was conducted with a single class and within a specific school context, which does not allow for generalizations or isolated claims regarding effects on students' conceptual learning. Future studies may extend the investigation to other contexts and incorporate instruments that allow for a more in-depth analysis of the relationships among experimentation, multiple representations, and the learning of physics concepts.

REFERENCES

ALVES, Vagner Camarini; STACHAK, Marilei. A importância de aulas experimentais no processo ensino-aprendizagem em Física: "eletricidade". In: SIMPÓSIO NACIONAL DE ENSINO DE FÍSICA, 16., 2005, Rio de Janeiro. **Anais do XVI Simpósio Nacional de Ensino de Física.** Rio de Janeiro: Sociedade Brasileira de Física, 2005. p. 1-4.

ARAÚJO, Mauro Sérgio Teixeira de; ABIB, Maria Lúcia Vital dos Santos. Atividades experimentais no ensino de Física: diferentes enfoques, diferentes finalidades. **Revista Brasileira de Ensino de Física,** São Paulo, v. 25, n. 2, p. 176-194, 2003. DOI: 10.1590/S0102-47442003000200007.

BASSOLI, Fernanda. Atividades práticas e o ensino-aprendizagem de ciência(s): mitos, tendências e distorções. **Ciência & Educação,** Bauru, v. 20, n. 3, p. 579-593, 2014. DOI: 10.1590/1516-73132014000300005.

BATISTA, Michel Corci; FUSINATO, Polônia Altoé; BLINI, Ricardo Brugnolle. Reflexões sobre a importância da experimentação no ensino de Física. **Acta Scientiarum. Human and Social Sciences,** Maringá, v. 31, n. 1, p. 43-49, 2009. DOI: 10.4025/actascihumansoc.v31i1.380.

BOCCHI, José Antônio Afonso da Costa. **Interdisciplinaridade entre Física e Biologia promovendo a compreensão de conceitos físicos.** 2017. Dissertação (Mestrado Profissional em Ensino de Física) – Instituto de Física, Universidade Federal do Rio Grande do Sul, Porto Alegre, 2017.

CALDEIRA, Claudio Geraldo Rocha. Interdisciplinaridade entre Física e Biologia para fins de aferição do conteúdo Termologia por meio da contextualização e o uso de metodologias alternativas. **Rebena – Revista Brasileira de Ensino e Aprendizagem,** v. 14, p. 421-444, 2026. DOI: 10.5281/zenodo.18487388.

CARDOSO, Fernanda Serpa; THIENGO, Angela Maura de Almeida; GONÇALVES, Maria Helena Dias; SILVA, Nilza Ribeiro da; RODRIGUES, Carlos Rangel; NÓBREGA, Ana Lúcia; CASTRO, Helena Carla. Interdisciplinaridade: fatos a considerar. **Revista Brasileira de Ensino de Ciência e Tecnologia,** v. 1, n. 1, p. 22-37, jan./abr. 2008. DOI: 10.3895/S1982-873X2008000100002.

CARVALHO, Samuel Fernandes; LOPES, Renata Porto Souza; RIBEIRO, Sulamita Santos; SOUZA, Aline Meira; RAMOS, Sandra Cristina; MENEZES, Marcia de Oliveira. A interdisciplinaridade entre Física e Biologia: o espalhamento Rayleigh e a datação por carbono-14. **Rebena – Revista Brasileira de Ensino e Aprendizagem,** v. 10, p. 290-301, 2025.

DUARTE, Sergio Eduardo. Física para o Ensino Médio usando simulações e experimentos de baixo custo: um exemplo abordando dinâmica da rotação. **Caderno Brasileiro de Ensino de Física,** Florianópolis, v. 29, n. esp. 1, p. 525-542, set. 2012. DOI: 10.5007/2175-7941.2012v29nesp1p525.

GIL, Antonio Carlos. **Como elaborar projetos de pesquisa.** 5. ed. São Paulo: Atlas, 2010.

LÜDKE, Menga; ANDRÉ, Marli E. D. A. **Pesquisa em educação: abordagens qualitativas.** 2. ed. Rio de Janeiro: E.P.U., 2013.

MACIEL, Tamirys Adriane Mendes. **Uma abordagem interdisciplinar de Física e Biologia como estratégia para o estudo de energia no corpo humano.** 2019. Projeto de dissertação (Mestrado em Ensino de Ciências e Matemática) – Instituto de Ciências Exatas, Universidade Federal do Amazonas, Manaus, 2019.

MINAYO, Maria Cecília de Souza. **O desafio do conhecimento: pesquisa qualitativa em saúde.** 14. ed. São Paulo: Hucitec, 2014.

QUIRINO, Welber Gianini; LAVARDA, Francisco Carlos. Projeto experimentos de Física para o Ensino Médio com materiais do dia-a-dia. **Caderno Catarinense de Ensino de Física,** Florianópolis, v. 18, n. 1, p. 117-122, abr. 2001.

SÉRÉ, Marie-Geneviève; COELHO, Suzana Maria; NUNES, António Dias. O papel da experimentação no ensino da Física. **Caderno Brasileiro de Ensino de Física,** Florianópolis, v. 20, n. 1, p. 30-42, abr. 2003.

SESTARI, Fabiane Beatriz; GARCIA, Isabel Krey; SANTAROSA, Maria Cecília Pereira. Ações interdisciplinares no ensino de Física: pressupostos teóricos e revisão da literatura. **Caderno Brasileiro de Ensino de Física,** Florianópolis, v. 38, n. 2, p. 883-913, ago. 2021. DOI: 10.5007/2175-7941.2021.e67750.

SILVA, José Carlos Xavier; LEAL, Carlos Eduardo dos Santos. Proposta de laboratório de Física de baixo custo para escolas da rede pública de Ensino Médio. **Revista Brasileira de Ensino de Física,** v. 39, n. 1, e1401, 2017. DOI: 10.1590/1806-9126-RBEF-2016-0167.

SILVA, Luciene Fernanda da; ASSIS, Alice. Física Moderna no Ensino Médio: um experimento para abordar o efeito fotoelétrico. **Caderno Brasileiro de Ensino de Física,** Florianópolis, v. 29, n. 2, p. 313-324, ago. 2012. DOI: 10.5007/2175-7941.2012v29n2p313.

VALGAS, Artur Antunes Navarro; GONÇALVES, Tatiane Alves; ROSA, Andrea Pires da; KOHLER, Fabiane; AMARAL, Lisandra Catalan do. Bioeletricidade: uma aplicação no ensino de Física e Biologia. **Journal of Education, Science and Health,** v. 4, n. 3, p. 1-13, jul./set. 2024. DOI: 10.52832/jesh.v4i3.454.

VERGARA, Sylvia Constant. **Projetos e relatórios de pesquisa em administração.** 14. ed. São Paulo: Atlas, 2013.

---

[1] PhD in Science Education from the Universidade Federal do Rio Grande do Sul (UFRGS). Degree in Sciences with a specialization in Biology from the Universidade do Estado da Bahia (UNEB) and degree in Physics from Centro Universitário FAVENI – UNIFAVENI. Full Professor at Centro de Ensino Superior do Vale do São Fran cisco – CESVASF. E-mail: acesse o artigo original para visualizar o e-mail. ORCID: https://orcid.org/0000-0002-0472-7421

[2] Specialist in Biotechnology from the Universidade Estadual de Maringá (UEM). Specialist in Clinical Analysis from Faculdade de Tecnologia e Ciência (FTC) and degree in Sciences with a specialization in Biology from the Universidade do Estado da Bahia

(UNEB). E-mail: acesse o artigo original para visualizar o e-mail.
ORCID: https://orcid.org/0009-0005-5333-1318

[3] Specialist in Biotechnology from the Universidade Estadual de Maringá (UEM) and degree in Sciences with a specialization in Biology from the Universidade do Estado da Bahia (UNEB). E-mail: acesse o artigo original para visualizar o e-mail. ORCID: https://orcid.org/0009-0008-3597-213X