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ARTICLE

THE MARTIN EGER RESEARCH PROGRAM: PRINCIPLES OF PHILOSOPHICAL HERMENEUTICS IN SCIENCE EDUCATION

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ABSTRACT: This text begins with a theoretical research program that seeks to map the tradition of Philosophical Hermeneutics (PH) in Science Education (SE), producing syntheses of works by different authors who assumed the PH in SE. The objective is to present research programs that articulated PH and SE as we tailored our own research program based on them. We started with the research on the work of Martin Eger, one of the pioneers in this discussion in English, who proposed a Philosophy of Science Education (PSE). The justification for this program is that PH provides arguments for understanding the role of language, which contributes to facing the daily challenges of teachers in Natural Sciences teaching and learning. In this text, based on a brief discussion of PH as developed by Hans-Georg Gadamer, we have studied Martin Eger's work. Some of the concepts proposed by Gadamer, such as the hermeneutic circle and the expansion and fusion of horizons, as well as the triple hermeneutics, proposed by Eger, have supported the understanding of the language of Natural Sciences, thus undoing the separation between subject and object; in this way, students, teachers in training, professors and researchers in Education and Science Education, as well as scientists, can be seen as interpreters of the Natural Sciences. By bringing together the work of Natural Sciences and the work of art in a cascade of interpretations throughout the production of scientific knowledge and its learning by students, Eger's academic production provides arguments to understand the very history of Science Teaching, by rescuing paths and reviews. At the same time, it brings inspiration to think about the present.

Keywords: philosophical hermeneutics, Martin Eger, Hans-Georg Gadamer, science education.

O PROGRAMA DE PESQUISA DE MARTIN EGER: PRINCÍPIOS DA HERMENÊUTICA FILOSÓFICA NA EDUCAÇÃO EM CIÊNCIAS

RESUMO: Este texto inicia por um programa de pesquisa teórica que busca mapear a tradição da Hermenêutica Filosófica (HF) na Educação em Ciências (EC) produzindo sínteses de obras de diferentes autores que assumiram a HF na EC. O objetivo é apresentar programas de pesquisa que articularam HF e EC à medida que costuramos nosso próprio programa de pesquisa neles fundamentados. Iniciamos com a pesquisa sobre a obra de Martin Eger, que propôs uma Filosofia da Educação em Ciências (FEC),

sendo um dos pioneiros nesta discussão em língua inglesa. A justificativa para este programa é que a HF traz argumentos para a compreensão do papel da linguagem, o que contribui para o enfrentamento dos desafios cotidianos dos professores no ensino e na aprendizagem das Ciências Naturais. Neste texto, a partir de uma breve discussão sobre a HF desenvolvida por Hans-Georg Gadamer, adentramos no estudo da obra de Martin Eger. Alguns dos conceitos propostos por Gadamer, como do círculo hermenêutico, e da ampliação e fusão de horizontes, assim como o da tripla hermenêutica, proposto por Eger, sustentam a compreensão da linguagem das Ciências Naturais desfazendo a separação entre sujeito e objeto, podendo estudantes, professores em formação, docentes e pesquisadores da Educação e da Educação em Ciências, bem como cientistas, podem ser encarados como intérpretes das Ciências Naturais. Ao aproximar o trabalho das Ciências Naturais e o trabalho da arte, em uma cascata de interpretações ao longo da produção do conhecimento científico e de sua aprendizagem pelos estudantes, a produção acadêmica de Eger traz argumentos para compreendermos a própria história do Ensino de Ciências, resgatando percursos e críticas. Ao mesmo tempo traz inspirações para pensarmos o presente.

Palavras-chave: hermenêutica filosófica, Martin Eger, Hans-Georg Gadamer, educação em ciências.

EL PROGRAMA DE INVESTIGACIÓN MARTIN EGER: PRINCIPIOS DE LA HERMENÉUTICA FILOSÓFICA EN LA EDUCACIÓN CIENTÍFICA

RESUMEN: Este texto inicia un programa de investigación teórica que busca mapear la tradición de la Hermenéutica Filosófica (HF) en la Educación en Ciencias (EC) mediante la producción de síntesis de trabajos de diferentes autores que asumieron la HF en EC. El objetivo es presentar programas de investigación que articulen HF y EC ya que adaptamos nuestro propio programa de investigación basado en ellos. Partimos de la investigación sobre la obra de Martin Eger, quien propuso una Filosofía de la Educación en Ciencias (FEC), siendo uno de los pioneros en esta discusión en inglés. La justificación de este programa es que el HF tiene argumentos para la comprensión del papel del lenguaje, lo que contribuye al enfrentamiento los desafíos cotidianos de los docentes en la enseñanza y aprendizaje de las Ciencias Naturales. En este texto, a partir de una breve discusión sobre la HF desarrollada por Hans-Georg Gadamer, nos adentramos en el estudio de la obra de Martin Eger. Algunos de los conceptos propuestos por Gadamer, como el del círculo hermenêutico y el de la expansión y fusión de horizontes, así como la triple hermenéutica, propuesta por Eger, apoyan la comprensión del lenguaje de las Ciencias Naturales, deshaciendo la separación entre sujeto y objeto; de esta forma, estudiantes, maestros en formación, docentes e investigadores en Educación y Educación en Ciencias, así como científicos pueden ser vistos como intérpretes de las ciencias naturales. Al unir el trabajo de las Ciencias Naturales y el trabajo del arte, en una cascada de interpretaciones a lo largo de la producción del conocimiento científico y su aprendizaje por parte de los estudiantes, la producción académica de Eger trae argumentos para comprender la historia misma de la Enseñanza de las Ciencias, rescatando caminos y revisiones. Al mismo tiempo, trae inspiración para pensar en el presente.

Palabras clave: hermenéutica filosófica, Martin Eger, Hans-Georg Gadamer, educación científica.

INTRODUCTION

Within the scope of Natural Sciences education, the attention of researchers, professors, and students has been focused on ways of teaching and learning scientific concepts. In this scenario, we have a look directed at scientific knowledge and how its epistemological construction takes place in educational spaces. At the same time, the world is experiencing an intense historical movement of denial of science. The anti-vaccination movements reinforce the concern with the way teachers, especially Science teachers, deal with distant interpretations of scientific doing/being scientific. In these studies, the epistemological approach prevails (ACEVEDO-DÍAZ, 2004; CACHAPUZ et al., 2005; ALLCHIN, 2011, MATTHEWS, 2017), and the results show ways to face this problem, which is, in fact, legitimate.

In an expansion of this theoretical-conceptual scenario well characterized in Science Education (SE), we point out in this text, the theoretical tradition of Philosophical Hermeneutics (PH). Education and SE researchers have deepened this approach, starting from an ontological perspective influenced by PH (BORDA, 2007; GINEV, 2013; MAGRINI, 2014; SCHULZ, 2014; LEIVISKÄ, 2016; DEWAR, 2016), and thus join to efforts to understand the challenges of the SE field. We have allied with them in the production of knowledge in the Brazilian context, where this approach is also less frequent in SE (SOUSA and GALIAZZI, 2017a; 2018a; 2019; SANTOS; FORATO; SILVA, 2021).

PH developed by the German philosopher Hans-Georg Gadamer (1900-2002) deals with understanding the world through interpretation. Within this process of understanding (self, others, things, phenomena), a non-enlightenment humanism is based, in which the human being is not the center, but is immersed in the centrality of language as a way of accessing the world. It is based on the concepts of "formation" (*Bildung*), *Sensus communis*, judgment, and taste (GADAMER, [1960] 2015), raising indissoluble ethical questions imbued in these concepts.

In the frightening current social landscape, we have questioned humanity daily in living in a society concerning the existence of oneself and others. PH, based on the understanding of language, inspires us to open up classroom inventions toward the humanism proposed by Gadamer. We understand that the (self)understanding access to the world from art, through the game in aesthetic experiences, the historical tradition, and the language of/in dialogue, as proposed by Gadamer ([1960] 2015), can bring contributions to some of the challenges in SE (SOUSA; GALIAZZI, 2017a; 2018a; 2019; SOUSA, 2021).

The objective of this text is to present the beginning of a theoretical research program on the tradition of the application[1] of PH in SE with the synthesis of the programmatic work of Martin Eger. Unless better judgment, the application of PH in SE in English was initiated by Martin Eger (1936-2002), a physicist/physics teacher directly influenced by Gadamer's production. It seems interesting to clarify that we are Chemistry professors and that the encounter with PH and Phenomenology happened through immersion in the understanding of Discursive Textual Analysis (MORAES, 2003; MORAES and GALIAZZI, 2016; GALIAZZI and SOUSA, 2021a; 2021b; 2020; 2019; SOUSA and GALIAZZI, 2016; 2017b; 2018b), a methodology for analyzing qualitative research.

We started with the research of the scientific production of Martin Eger (1992, 1993a, 1993b, 1995, 1997, 1999). To situate the author's thinking, we present, in general terms, aspects of PH understood as bridges to the relationship with SE, emphasizing the concept of the *hermeneutic circle*. Then, we delve into the texts of Martin Eger and his proposition of a Philosophy of Science Education (PSE).

PHILOSOPHICAL HERMENEUTICS

As we will show from the historical tradition of Martin Eger's scientific production in the next sections, the word hermeneutics can sound strange or unknown to many of those involved with the study of Natural Sciences, whether scientists or teachers and even more to Science students. This is

[1] Complementary to understanding and interpretation, Gadamer introduces the concept of "application". For him, the search for knowledge is never neutral or impartial, being always related to the concerns of a specific individual search. Therefore, the person is always applying understanding to himself, and because of this, all understanding is ultimately self-understanding (LAWN; KEANE, 2011).

because hermeneutics has been oriented more directly towards the interpretation of texts from the Human Sciences than from the Natural Sciences. The broad designation "hermeneutics" emerged in the 17th century, understood as the science or art of interpretation (GRONDIN, 1999). Its origin is attributed to the theologian Johann Conrad Dannhauer (1603-1666), who used the term hermeneutics in the title of his work *Hermeneutica sacra sive methodus exponendarum sacrarum litterarum*, from 1654 (GRONDIN, 2012).

Although the historical location of the term hermeneutics is dated to the 17th century, the idea of the art of interpretation (Greek verb *hermeneuein*) goes back a long way, from the Greek Stoics to Patristics in the Middle Ages. "Wherever, in a way, methodological indications of interpretation were offered, one can speak of hermeneutics in the broadest sense of the word" (GRONDIN, 1999, p. 23-24). From the Renaissance, theological hermeneutics, profane hermeneutics, and legal hermeneutics emerged. All were intended to prevent arbitrariness in the interpretation of their respective texts.

Gadamer elaborates on his philosophical position influenced by previous philosophers, both those of the hermeneutic tradition (Schleiermacher, Droysen, and Dilthey, for example) and those of the phenomenological tradition (Husserl, Heidegger, etc.).

The work *Truth and Method: fundamental traits of a Philosophical Hermeneutics* (TM) (GADAMER, [1960] 2015) shows Gadamer's concern with the problem of understanding, that is, with how something/someone comes to be understood. When dealing with the phenomenon of understanding, Gadamer ([1960] 2015) bases his philosophical position on different interpretations: the interpretation of art/aesthetics, the interpretation of historical traditions, and the interpretation of language in dialogue. The hermeneutic illustrates, based on them, our ways of interpreting the world, which have repercussions on our ways of being with things and with people. For him, the way of interpreting is ontological, because, when dealing with the world, we carry experience, the baggage of our existence, that is, we deal with the world with our pre-understandings and our pre-judgments. Gadamer calls this the "horizon", which is what we can "achieve", what we "see", which can be expanded based on new experiences with the world, from which we do not emerge unscathed, as we are affected by them. When this happens, we have an expansion of horizons or even a fusion of horizons: an initial horizon that merges with the available horizons to be experienced. This characterization of the way we interpret/understand, Gadamer, following Heidegger, conceptualizes as a hermeneutic circle.

For Grondin (2016), the hermeneutic circle is one of the fundamental doctrines of hermeneutic theory. It starts from the idea that, when we seek to understand something, we carry our pre-understandings as anticipation. However, it is in the strangeness of what we seek to understand that we enter this non-addicted circular movement, as we never return to the starting point without changing along the way.

> Hermeneutical thinkers such as Heidegger, Bultmann, Ricœur, and Gadamer see the hermeneutical circle more from what it constitutes as an inescapable element of understanding: as finite and historical beings, we understand why we are guided by anticipations, expectations, and questions (GRONDIN, 2016, p. 299).

Our quest for understanding, guided by these anticipations, leads us to want to broaden the horizons of a phenomenon. However, we need to be aware of our historical finitude, which needs to analyze the parts to understand the whole. In the analysis of the parts, it is necessary to be aware of the whole, since the sum of the parts of a phenomenon does not account for the phenomenon, which is interpretively more complex. That is why the hermeneutic circle exposes our finitude. However, it is the search for entry into circles of understanding that makes it possible to expand horizons, which are always incomplete. This makes up our existence in the world, that is, our way of being in the world with things, phenomena, and people.

Although Gadamer did not elaborate on a Philosophy of Education, several authors have sought to carry out this approximation. Martin Eger was one of the pioneers in proposing articulation between PH and SE.

MARTIN EGER: A RESEARCH PROGRAM IN THE PHILOSOPHY OF SCIENCE EDUCATION

The concern with the low performance of students in science learning has a long-standing. According to the understanding of Martin Eger (1992), PH would provide elements to deal with difficulties in Science classrooms related to low student performance. In this context, he presented a theoretical research program to articulate PH and SE.

Martin Eger (1936-2002) was a theoretical physicist and during his career was a Professor of Physics at the College of Staten Island at the City University of New York. Philosopher, he developed many courses and articles on Philosophy that influenced his way of teaching Physics. As a reader of Jürgen Habermas and Gadamer, he extended the thought of these philosophers to SE, especially due to the way PH proposes the interpretation of concepts and propositions based on preconceptions about a topic. Eger (1992a) understood that PH could be applied to the Natural Sciences in the same way as to the Human Sciences. He emphasized that, methodologically, PH applied not only to those who were scientists but also to students in general, extending Gadamer's notion of dialogue to interpretation in SE (SHIMONY, 2008).

In the 1990s, the journal *Science & Education* began to be published, which, over 30 years, has gathered contributions to the History, Philosophy, and Sociology of Science and Mathematics. In the first volume of the journal, Eger (1992) announced the theoretical research program in the Philosophy of Education in Science in the article *Hermeneutics and Science Education* – a program later claimed as a field of research by Roland M. Schulz (2010). Next, we will highlight the deepening of the initial proposition.

Philosophical Hermeneutics as an Approach to the Natural Sciences: Part I[2]

Eger (1992) presents his research program, which was deepened in two articles: *Hermeneutics as an Approach to Science: Part I* (EGER, 1993a) and *Hermeneutics as an Approach to Science: Part II* (1993b), to be detailed below. Some ideas were reinforced in these two works, characterizing entry into the hermeneutic circle with a greater level of depth.

From his activity as a Physics teacher and experience in dealing with the meanings attributed by students to scientific concepts in teaching, the author presents the ontological character of PH in activities of scientists that, from his point of view, were neglected both in the Philosophy of Science (PS) and in education. For his argument, the author brought excerpts from the biography of Barbara McClintock, Nobel Prize in Physiology and Medicine in 1983, for whom it is necessary to get rid of pre-understandings and listen to what the phenomena have to say. It seems strange to us to think that it is possible to get rid of pre-understandings, but, relying on Husserlian Phenomenology in particular, we understand that it is interesting that we are attentive to how the phenomenon appears at first, making an effort to suspend our pre-understandings.

As previously mentioned, to substantiate the importance of the rapprochement between PH and the Natural Sciences, Eger (1993a) maintained that both PH and PS began to show similarities, to the point that it was considered by some scientists that the Sciences could be thought of as a form of hermeneutics. This articulation explicitly appeared in the works of philosophers of science, especially in *Revolutions and reconstructions in the Philosophy of Science* (HESSE, 1980), *The construction of reality* (AIRBIB, HESSE, 1986), and *Hermeneutics and the analysis of complex biological systems* (STENT, 1985). Patrick Aidan Heelan also presented this articulation in the works *Hermeneutics of experimental science in the Context of the life-world* (1977), *Space, perception, and Philosophy of Science* (1983), and *A Heideggerian Meditation on Science and Art* (1988), but he found resistance in the consolidated thought of many other philosophers of science, scientists, and philosophers, such as Habermas (1984) and Gadamer ([1960] 2015), who kept the place of hermeneutics restricted to the Human Sciences.

Another argument was the ontological characteristic of PH. In this case, Eger (1993a), addressing education, argued that PH allowed formulating basic questions, considering the relationship between the student and the science phenomena studied. He also pointed out that PH could provide understanding for areas that at the time were emerging with intense controversy such as constructivism, with clear diffusion in the field of SE.

[2] The subheadings of the article's sections are translations of the titles given to Eger's articles.

Defending his position, Eger (1993a, 1993b) emphasized that, in SE, a student encounters, before nature, the historically elaborated language. This refers to Gadamer ([1960] 2015) and his sentence that everything you know it is because there is language. At a time when the constructivist movement was receiving criticism (MATTHEWS, 2000), Eger (1993a, 1993b) perceived PH arguments to understand its contributions, due to its ontological approach, and, at the same time, its limits. This, for example, is in the treatment given by researchers and professors to conceptual change, misconceptions, and other movements for overcoming preconceptions. As he claimed, he was a friendly critic of constructivism.

If PH seemed to provide strong arguments for this path of approximation, Eger (1993a) warned about some dangers. The first, was an excessive shift towards language, neglecting the study of nature and creating possibilities for relativism that pointed to the production of knowledge in the Natural Sciences as being nothing more than human constructions. Thus, this study was restricted to constructed worlds, not the world itself. In Gadamer ([1960] 2015) and Habermas (1984), citing two renowned philosophers, the criticism of objectivism, fundamentalism, and the great narratives of science as drivers of progress in a certain way produced their devaluation, accused not only by these philosophers by its modes of prediction and control, by its alienated objectivity and susceptible to domination. Eger (1993a) sided with these criticisms.

With this discursive shift, there was – and remains to this day – a strong critique of the distance between the production of Natural Sciences and technologies, considering their consequences for human beings and the world. At SE, the Science, Technology, and Society (STS) approach is an example that questions who appropriates and benefits from Science and Technology, questioning the instrumental mode of work in Science teaching (HURD, 1975; AIKENHEAD; RYAN, 1992; SANTOS; MORTIMER, 2000; AULER, 2018). Also, examples are the movements in defense of the environment, very present in Environmental Education (LOUREIRO; LIMA, 2012; LOUREIRO, 2014; ZAMBAM; CALLONI, 2019).

In a way, Eger (1993a) pondered that precisely the separation of Natural Sciences from their relevance for human beings and the world produced an emptying of students' interest because they did not perceive reasons for their study. Hence we are confronted, at all levels of education, from Basic Education to Higher Education, with a small number of students in careers linked to Science. In Basic Education, there is a strong lack of interest in these areas, although it seems to us that this emptying is not due to the social and political character alerted by movements that criticize Science.

If hermeneutics relativized the meanings of the Sciences, attributing them adjectives that pointed out their detestable character (remember some manifestations of our students) and little enlightenment about the world, Eger (1993a), in the opposite movement, pondered that PH could also show that science is about a common world in which we all live. Thinking about the current days, in which we live the negation of science and its devaluation, would not we be experiencing an excessive displacement towards language, in which science has been attacked by speeches emptied of knowledge produced by it? In this sense, we could cite the global anti-vaccination movement or science denialism – shown, for example, in the sad Brazilian context, amid the pandemic triggered by the SARS-COV-2 virus, with the incentive to distribute Covid kits, with a prescription of hydroxychloroquine, its ineffectiveness in the treatment of the disease having already been proven, and the attack on drug regulatory bodies, such as the National Health Surveillance Agency (ANVISA- *Agência Nacional de Vigilância Sanitária*).

What Eger (1993a) considered most distinctive for the articulation of PH with the Natural Sciences (NS) is the hermeneutic approach, developed by Martin Heidegger and later continued by Gadamer, due to its ontological character. This character, according to the author under study, is what will give PH arguments to counteract the criticism it receives for its subjectivism and relativism.

In TM, Gadamer ([1960] 2015) already affirms the universal character of hermeneutics and that interpretation and understanding are not separate cognitive actions in a subject. Understanding is always an interpretation that itself makes explicit a form of understanding. Eger states (1993a, p. 12): "For the interpreter, however, it is to enter the hermeneutic circle, to project and keep moving between the text and the projected preconceptions". Therefore, when the author refers to a text, it should be clarified that he is not referring only to expressions in a language, but to all objects that can trigger

hermeneutic attention. In the context of Science, graphs, models and experiments can be considered texts, as well as nature, in a metaphorical sense.

In presenting the ontological characteristic of PH, Eger (1993a) stresses that knowledge is not in the interpreter, on the one hand, and in the text, on the other, with its meanings. The text provides, within a broad range, many potential meanings. This idea contradicts notions that there is a fixed and unique meaning conveyed by the text, even though there is something in the text to be interpreted. If what the interpreter projects onto what is in the text proves to be adequate and the interpreter is open to listening, then a meeting of the meanings of the interpreter and the text takes place; Gadamer ([1960] 2015) refers to this phenomenon by stating that the text speaks to the interpreter. Eger (1993a) is inspired by PH to state that not only the text speaks, but also natural things, such as trees, molecules, or stars. In other words, interpretation is not an invention. There are also messages in what is being interpreted.

This hermeneutic way of thinking about the appropriation of meanings from texts and phenomena is in a different direction from what is normally found in Science Education. In general, there is the researcher as a producer of knowledge, the texts and teachers as transmitters, and, at the other end, the student as a receptacle of this knowledge. Such a way of thinking about the production of knowledge in Science or teaching has been heavily criticized by movements such as constructivism, which the author will detail his criticisms in the work that follows.

Philosophical Hermeneutics as an Approach to the Natural Sciences: Part II

Continuing the discussion on the proposition of a hermeneutic-phenomenological investigation of the Natural Sciences – and, in this text, the *phenomenological* expression is added to *hermeneutics* –, Eger (1993b) argues that the language of the Natural Sciences, and we could say its languages in the different Sciences, need a double hermeneutic, paying attention to the role of the interpreter, bringing again the particularity of the teaching of Natural Sciences. Based on examples from Physics, Eger shows that hermeneutics is present at all levels and stages of Natural Sciences. At the end of the text, he associates the nature of the interpretative mode with the creative mode, approaching Gadamer's description of the interpretation of art.

By including Phenomenology in his proposal, Eger (1993b) describes it as a movement in Philosophy and Science in reaction to the growth of abstraction, the mechanical interpretation of nature, and the fragmentation of disciplines, which emptied science and knowledge produced by it. On the contrary, this philosophy proposes an approximation of the phenomena, avoiding as much as possible the abstraction and imposition of theoretical constructs, based on the subject's experience. The return to things was an effort to preserve the totality of experiences, whatever they were, from Husserl, who coined Phenomenology. For this, he proposed the analysis of phenomena from different angles, which would make the subject perceive them. The purpose of this analysis was to remove the preconceptions inherent in every point of view, preserving all the particular and distinct views obtained that, together, constituted the object under study.

Hermeneutics, as a conscious self-interpretation, becomes important for Phenomenology, since, for each of the selected points of view, in each specific context, an interpretation of the phenomenon within that context is possible. This way of interpreting decidedly distances from hypothetical-deductive analysis because, let us remember, Phenomenology intended to remain close to things. The subject interprets the meaning of the thing from a point of view in such a context, related to its foundations and horizons. A subject does not postulate pure concepts of how things are to be understood.

Language is fundamentally inserted in PH as proposed by Gadamer ([1960] 2015), because, with its multiple possibilities of meanings, it has, however, its freedom limited in the language of common use and even more in the specific languages of the Natural Sciences. On the other hand, language offers analogical metaphorical descriptions. In this sense, thinking that not all contexts can be physically or visually inserted in the analysis, language – and only language – offers this function. For this, Gadamer focuses on analyzing the structure of the game and on games to expose certain experiences. He later transfers this description to the context of art and then considers the historical context.

By considering that all sciences are positioned on a continuum concerning the role of hermeneutics, Habermas, bringing the argument of the double hermeneutics proposed by Giddens, will affirm that all scientists need to interpret what they observe, but that, in the Human Sciences, there is a world pre-interpreted by language, and the scientist of these sciences needs, before interpreting, to know this specific language. This world cannot be found as the world of natural phenomena.

Eger's (1993b) argument, however, is that all sciences, not just the human ones, have a double hermeneutics because they all deal with language. This particular language, like all others, needs to be interpreted. Habermas' argument reinforces the separation between Human Sciences and Natural Sciences. There is a mistake in Habermas's interpretation, according to Eger (idem), as he assumes that the scientist of the Natural Sciences is direct with the phenomenon. We know, however, that the scientist always first finds the language of that particular science in which his research is inserted. Eger (idem) reinforces that, in this sense, a scientist is always and above all a student and asks if we do not also have, in this way, in the Natural Sciences, the hermeneutic duo.

Eger (1993b), to argue about the pertinence of PH in the Natural Sciences, discusses the experiments, equipment, theories, and models that are part of the scientist's profession, whose perception is expanded by them, which function as an artificial body. The scientist incorporates these artifacts and theories, and this becomes that scientist's way of being – be it the microscope, which, as narrated by Bárbara McClintock, sees the chromosomes, be it the astronauts' clothes, which allow them to go to space, or those of divers, to go to the bottom of the sea. What Eger addresses here is the scientist's activity, in which the tools also bring understanding to them. In some cases, the interpretations can even be surpassed by other tools, as is the case with microscopes, which, with new technologies, allow other interpretations of the phenomena, expanding horizons. Thus, the scientist learns to live with these artifacts, and to this, the author once again associates the idea of the student who has to learn to deal with them, which, in a way, calls into question the objectivity and the relationship between the subject and the object. The author asks:

> When we talk about the language of science, the apparatus of experiments, and the mastery of these instruments, are we talking about the researcher alone or the investigated as well? (Idem, p. 308)

His answer was: When we think of the astronaut's clothing, the clothing incorporates knowledge of what will be investigated, for example, a suit designed to be used on the Moon has to take into account gravity, pressure, temperature variation, surface consistency, solar radiation; that is, incorporating a lot of knowledge into that scientist's activity, clothing becomes essential to develop it. To go to the Moon, for example, solving problems related to clothing was paramount at the beginning of the study; once resolved, this problem becomes secondary. Thus, all arguments that maintain the separation between the subject and object of study become suspect, and so does the same categorical separation between the mode of study and the mode of research. In summary, recalling Eger's (1992, 1993a, 1993b) concern with education, he again brings PH closer to ways of learning, whether of the scientist or the student. That is, it is not possible to separate the subject who learns, who teaches, and who researches, from the culturally produced tools. The separation between subject and object often defended in science finds opposition in PH and Eger's thought.

Another point that Eger (1993b) deepens in this text is the old argument of considering the Natural Sciences as reading the book of nature. The metaphor of the book allows Eger to again confront Habermas' argument of the double hermeneutics, as we can wonder if the language of the book of nature is there in nature, as Galileo thought, or if it is brought into the book first by the writer and then by the reader, as part of his interpretive effort. For a student, the language is in the book. For the scientist, part of this language will still be created from the results of his research. So, thinking that the student and scientist are in front of the same book, it seems that it is not the same book being read by the student and the teacher.

From this perspective, one might think that there are two books: one on the phenomenon to be interpreted and a secondary one on the interpretations of phenomena. The first book we can call the Book of Nature; the second, is from the science book – and it is quite clear that what we learn about nature comes from the second book. This is also true for scientists. In this metaphor, therefore, the

separation remains between, on the one hand, who writes and, on the other, who reads these books, that is, the scientist or the student.

Eger (1993b) did not agree with this explanation and, to show that reading a science book also requires interpretation by the reader, details two historical facts with Heinrich Hertz and Richard Feynman. They reinterpreted existing theories. They were reading science books: Hertz, the book on electromagnetism; and Feyman, The Quantum Mechanics Book. To understand these theories, each one reinterpreted the theory exposed in the book.

The theoretical research program proposed by Eger (1993b) was based on the following argument:

> I argue and try to show that the process of science involves a cascade of interpretations, from the highest level to the way of the teacher and the student in their various levels of education. Interpretation, I maintain, is a fundamental and pervasive event that potentially intertwines research and education, and it is for this reason that subdividing science into creative and educational modes is problematic and inappropriate. (Idem, p. 314)

To defend this argument, Eger (1993b) proposed the extension of PH to the Natural Sciences, although, initially, Gadamer was opposed to how science considered only the knowledge produced by a method to be true. Surprisingly, the approximation component between PH and SE is perhaps the art.

In the first part of the book *Truth and Method*, Gadamer ([1960] 2015) makes a phenomenological description of art, especially performance art, as a model for similar descriptions of history, language, and the Social Sciences, to expose the interpretive encounter between the human being and the cultural cognitive objects that are created. In the performing arts, this encounter is easier to see. Gadamer's treatment of interpretation in art is the same that needs to be emphasized in science. For this, it is necessary to consider art and science not from their differences, but in the way of being of the two and their appropriation. In both art and science, interpretations occur at all levels, even if they are not perceived, and the author will maintain his argument that, as in art, the encounter with science depends on interpretation. Recently, this same idea was reinforced by other authors, in an attempt to highlight the limitation of the pragmatic and instrumental character in SE towards a hermeneutic experience (FERRARO, 2017; TOSCANO; QUAY, 2021).

Not only did Gadamer emphasize the ontological aspect of the art object. Roman Ingarden, a student of Husserl, was another author to highlight this role. And this is the direction that Eger (1993b) points out for the meaning of the work of science to exist for those who find it and want to appropriate the knowledge produced by it – a generic student. He clarifies, when he talks about work, that he does not refer to the encounter with electrons, atoms, genes, or black holes, but with what is written in the science book about electrons, atoms, molecules, and many other concepts immersed in the language. That is, what meaning do these texts assume for those who encounter them?

But what is the play *Julio Caesar*, by Shakespeare, or the musical composition *The Four Seasons*, by Vivaldi? asks Eger (1993b). Just the script? Of course not. The performance composes these art objects, the performance is interpretive, and the script can be interpreted differently by each of the participants, art directors, actors, and audiences – from creation to appropriation, there is a "cascade of interpretations". First, the script of the play can be the interpretation of real facts by the author; then, the director proposes a general interpretation for the staging, which is followed by interpretations by the actors, resulting in a concrete performance. Finally, the entire audience interprets the performance.

As in any cascade, stated Eger (1993b), we see in this description a sequence of movements alternated by a sequence of stabilizations, and realizations. What the author points out is that, phenomenologically, all interpretations of an art object are present in the performance. Unlike art objects, the normal way of interpreting things is restricted to their stable structures. The spectrum of possible answers to the question of being is generated when different weights are assigned to different levels of the cascade. On the more objective side of the spectrum, one might insist that all artwork is the script; or; at the other extreme, that it is the reader, spectator, or listener who determines what is a work or a work of art. The cascade of interpretations and the spectrum of points of view define the dimension of objectivity in the ontology of art. The being of the work can reside in the schematic formation of the

script that is provided or resides entirely in the perception of those who contemplate the art object, whatever it is.

Gadamer ([1960] 2015) avoided the distinction between subject and object and, therefore, focuses on the concept of play, as he argues that the distinction between subject and object disappears when the player becomes part of the play. Someone might say that it is not just the player who plays, but that the play is who plays the player. When someone enters the play, they forget about themselves and are forced to act as the play demands.

The being of the play *Julio Caesar*, then, is certainly in the script, together with the whole set of possible interpretations, that is, the script surrounded by its potential presentations, by possible performances. In phenomenological language, Julius Caesar is not a set of symbols that can be read, but an intentional object constituted by the entire cascade of interpretive perceptions – which is not arbitrary, because all of them are part of the interaction play with the script, it imposes broad and powerful criteria. This is the essence and distinctive feature of Gadamer's and Ingarden's theories of art, according to Eger (1993b).

These theories imply that the spectator, listener, or whoever contemplates a work of art becomes part of the broader set in which the boundary with the object is diffused. Or, in other words, each interpretation enters the circle of understanding – the hermeneutic circle –, which is a play between itself and the formal script of the work; and this also implies that the boundary between the interpreter and what he interprets is neither sharp nor immutable. A second implication is that a work of art is always incomplete. If art is a kind of play with a certain structure, then the material object, such as the script or the canvas, cannot be considered an instance of art. What is considered receptive interpretation in contrast to recognized creative interpretations is part of the play and therefore part of the being of art.

With this background, how does Eger (1993b) articulate PH with SE? The first approach is to mirror PH and call it a work of science in comparison to a work of art, which can be an experiment, a law, a model, a theory, etc. that will be written in the Book of Science. What happens when these works are read? Although the author has brought many examples of renowned physicists, he has turned to think about ontological issues of who will read this science book – especially students.

The first implication of this comparison with the work of art is that, likewise, the experiment or theory that is written in the book does not consist of the thing itself. What is written is just the script. This script, depending on the context, can give rise to different interpretations, and it will be all these interpretations that will constitute the essence of the science work. This, according to the author, is valid for an experiment, and every time it is carried out, it is perfected, modified, and can be expanded to theoretical works, and models even if there is no action as there is in the experiment.

In this sense, Eger (1993b) brings an important element of PH when describing Einstein's reinterpretation of Lorenz's theory, and many students may think that this pre-existing theory did not explain the phenomena that the theory of relativity would explain. The important point that Eger (1993b) emphasizes is how the Natural Sciences have been taught, with emphasis on knowledge considered to be the most current, without considering the tradition of this knowledge. What Einstein achieved was to reinterpret, placing all the phenomena explained by Lorenz's theory in a simpler and unified theory, discarding the concept of ether. In doing so, Einstein provides yet another example of the contribution of an explanation from PH to the science textbook. What he did was question preconceptions about time and others that were in previous theories.

For knowledge to be recognized, it needs to be considered valid and then, in the context of justification, it needs to be presented rationally. That is, it is necessary to move from the context of "discovery" to the context of justification, and all previous interpretations constitute the essence of the work of science. The science book is being written forgetting some of these interpretations, replacing them with broader and more adequate interpretations, and the book becomes a place of understanding for readers and students, that is, another step in the cascade of interpretations.

For the scientists' ideas to be understood, there must also be an effort to explain them to other audiences, and the science book is digested, and books about science book appear with the intention that they are read and understood, but this may give rise to different interpretations, some better than others. Eger (1993b) compares the view of science with the view of art: in the first, the

researcher, the teacher, and the student, all participate in the being of science, by interpreting differently, at each step of the cascade of interpretations, the phenomena of that science.

Advances in the hermeneutic-phenomenological approach in Natural Sciences

As we tried to show so far, the hermeneutic-phenomenological approach in the Natural Sciences has a special interest in the interpretive phases of these sciences and the cognitive and social circumstances, whether they are divergent or convergent, pointing to the importance of the hermeneutic circle in research. In another work, Eger (1997) pursued his objective by comparing it with social constructivism in the Natural Sciences and its specific language. In contrast to the language of the hermeneutic-phenomenological approach, the author argued about the advantage of the latter. In addition, the article intended to show the pre-understandings and pre-judgments of science embedded in each of the approaches, as we will show below.

PH and Constructivist Sociology, according to Eger (1997), have in common the criticism of several central characteristics of the analytical view of Science: the small role given to interpretation, how objectivity is portrayed, and the claim of universality of the knowledge produced. Both hermeneutics and sociologists are convinced that the construction is broader than the analytic philosophy of science allows. In this text, Eger (idem) discusses the issue of interpretation for both approaches.

Based on the double hermeneutics of Anthony Giddens and Jürgen Habermas, Eger (1997) presents three stages of interpretation, a triple hermeneutics. In stage 0, interpretation is limited to the received heritage or tradition of science as a whole in two actions: a) reading the science book and b) practicing routine science procedures. In stage 1, interpretation is at the level of research experiments: a) interpretation of data and b) interpretation of phenomena according to advanced theories, which can also happen by interpreting theory through experimentation. Eger (1997) adds to these two stages a third, stage 2, in which interpretation extends to advanced theories in alternative ways.

Remembering, Giddens and Habermas argued that the Natural Sciences were limited to stage 1, while, in the Human Sciences, it would also be necessary to interpret the language of the people studied in stage 1, hence the name double hermeneutics. Eger (1997) opposes this restriction, as stated in previous works. Although natural science objects – from atoms to stars – do not speak, there is a more advanced level of language learning problem, which he called stage 2. It is clear that stage 1 has received the most attention, and it is where Natural Sciences become a reading of the book of nature, requiring interpretations between theory and observation and also interpretations between theories, requiring a dialogue about the meaning of theoretical language within a scientific community.

According to Eger (1997), perhaps the greatest contribution of hermeneutics has been to draw attention to the role of interpretation in the observation stage of a phenomenon, an aspect that was known to exist, but to which little attention was paid, that is, the importance of recognizing the phenomenon. As Polanyi's writings began in the 1950s, and later with Kuhn's writings, hermeneutic and phenomenological treatments began to appear, such as the contributions of scientists such as Mary Hesse (1980), Marjorie Grene (1986), and Joseph Rouse (1987).

At that moment, however, competing with the emergence of hermeneutic thought, although influenced by it, sociologists and anthropologists of science appeared with their detailed studies and with more radical conclusions than those of the hermeneutics that began in the sciences, in which they discussed the mechanism of negotiation in the production of scientific knowledge. Eger (1997) opposes the proposed term, even though it is part of the hermeneutic vocabulary because its use in hermeneutics was quite different from that in Constructivist Sociology. Negotiation, in this view, is associated with other terms: experimenter regression, black box, and undoing or deconstruction of science. These are terms close to another philosophy, other than hermeneutics, in addition to another position about science.

Continuing with the description of the word negotiation based on its usual meanings, Eger (1997) discusses that, for a negotiation to take place, there must be opposing interests between the negotiators. He discusses how the word negotiation had been used by constructivist sociologists, with negotiations being channeled to social interests, becoming unscientific negotiation tactics, used to produce certified knowledge, which in the end had become invisible. With a set of descriptions of

scientific facts made by constructivist sociologists showing the negotiations carried out by scientists, whether negotiations to get money or to negotiate conflicting results obtained by different experiments, Eger (1997) criticizes constructivism.

The solar neutrinos episode was brought to show that there were several types of negotiation, far from the negotiation for meanings, as found, for example, in Lemke (1990). At the beginning of research to detect solar neutrinos, several negotiations were made to continue the research, although the results were disappointing. Over time, however, scientists have worked hard, and knowledge about solar neutrinos has expanded. One of the results obtained was that, when trying to study the phenomenon more deeply, another unexpected phenomenon occurred. Eger (idem) used the word "see" neutrinos deliberately because this is one of the achievements of hermeneutic phenomenology in having asked the question about the role of tools in understanding phenomena and having produced a plausible answer. According to this theory, it is possible to see or perceive a phenomenon through instruments because the instruments become part of the subject and form an extension of their perceptive systems, that is, they are incorporated into the subject (embodiment).

Constructivist Sociology developed a concept parallel to embodiment – the black box –, with an entirely different and negative connotation, according to which scientists would be dismantling science, often negotiating crucial parts of the theory. Again, Eger (1997) disagreed with this interpretation of science disassembly, stating that the phenomenon does not behave as expected, so there is no negotiation with models that will modify it. Thus, the meaning that emerges from thinking with hermeneutics is that it was understood that the problem is deeper than what had been thought, which means that one could be facing an entirely new phenomenon and that, if neutrinos have mass, there will be a fundamental change in particle physics and cosmology, because the mass of neutrinos will need to be accounted for in the missing mass of the universe – another puzzle, claimed Eger (1997), which at first had nothing to do with the initial project.

Resuming the discussion about neutrinos, Eger (1997, p. 97) says:

> We started with the structure of the sun as our object of investigation while neutrinos are the medium that carries the information. We rely on our pre-understandings of these particles and the tools and practices. In the course of interpretation, however, we found pre-understandings that failed and neutrinos became part of the object of investigation. To understand the structure of the sun, we need to understand neutrinos but to understand neutrinos we need to understand the structure of the sun. We are in the circle.

Eger (1997) considers the hermeneutic circle as the movement of going back and forth in thought, from a part of the object under investigation to the whole, and each new understanding of one of the parts modifies the whole and vice versa. Eger (idem), however, considers the hermeneutic circle in a broader view from Gadamer, in a dialogical and ontological version, in which the circle is between the global pre-understanding of the subject's world and the object's response - again, the latter modifying the former and vice versa. The adaptation made of the hermeneutic circle to the Natural Sciences results in a movement of attenuation of the limits of separation between the subject and the object. Movement is away from the subject when progress in investigation results in the object becoming incorporated into the subject's apparatus, becoming transparent and, in effect, part of the subject's sensory system. The movement occurs towards the subject when the answers to the problem from the object cause the experimenter to turn to himself and question his senses. Thus, they weaken the clear separation between subject and object, as proposed by Gadamer ([1960] 2015).

Language and the double hermeneutics in the Natural Sciences

To present the body of work discussed at the 1st International Seminar on Hermeneutics and Natural Sciences, organized by the Hungarian Academy of Sciences, held in Veszprém, from 4 to 9 September 1993, where Martin Eger gave a lecture, Føllestal (1999) describes Eger's work as an orientation for the discussion of science for SE, proposing this shift to education, so that science can be learned based on the propositions of PH.

According to Føllestal (idem), Eger (1999) argues against a clear boundary between the Natural Sciences and the Human Sciences, contrary to Taylor, Dreyfus, Giddens, and Habermas, for whom the Social Sciences are distinguished from the Natural Sciences due to double hermeneutics. According to these authors, someone finds in the Social Sciences a native language that must be interpreted, and, therefore, it is necessary to mediate between the investigator's language and the native language. Eger (1999) opposes this and argues that, in Natural Sciences, there is triple hermeneutics: (1) to understand Sciences, one finds the language and practices of existing science, and one must enter that culture. As stated by Polanyi, one must learn to read X-rays, which is much more than learning how to interpret old data; (2) one must, then, learn to construct theories. The data cannot be taken for granted by those who argue against hermeneutics in science. The data must fit the theory; (3) finally, there is the matter of interpreting theories to understand them. We present more details of this work by Eger (1999) below.

Eger (1999) bases on the "hermeneutic circle" because this concept can link the interpretation of texts to the Natural Sciences, as we have shown in the author's different works. In more than one of his articles, he exemplified how we proceed to read a text considered difficult, in which we read a part and design the whole and, after reading the whole, we return to the parts, as Gadamer (2000) argues about this movement from the word to the concept and from the concept to the word, back and forth, which leads to the fusion of horizons or, as expressed by Eger (idem), to the convergence of interpretations. If Gadamer approaches the interpretation of texts, Eger inserts the concrete objects of study in this approach. This movement gives PH a way of understanding described by Eger (idem) in three stages: a first interpretation, followed by the reinterpretation of the interpretation, accompanied by a shift from the epistemological to the ontological focus. In this aspect, Eger (idem) noticed similarities with PS, especially with Kuhn's paradigms, and with the preponderant constructivist theories in Science Education at that time. We repeat here the similarity that Eger (1993b, p. 8) presents between the thought of Kuhn and Gadamer:

> The anomaly only appears against a background provided by the paradigm, the more precise and comprehensive the paradigm is, the more sensitive an indicator it provides for anomaly and therefore of an occasion for a paradigm shift (KUHN, 1970, p. 65).
>
> The important thing is to be aware of one's prejudices so that the text presents in all its novelty and thus can assert its truth against its pre-meanings (GADAMER, 1975, p. 238).

Eger (1993b) highlights, in both authors, the presence of thoughts about preconceptions that will trigger the process of understanding through movement in the hermeneutic circle and stresses that preconceptions were also identified as present in all phases of research, since what was pointed out by Popper in PS. However, it is the ontological turn developed by Heidegger and followed by Gadamer that will be distinctive in Eger's (1999) thought, as we will detail below.

Eger (1999) resumes his argument that hermeneutics is a characteristic not only of the Human Sciences but also extends to the Natural Sciences. His opposition to Habermas and Giddens is because they contribute to maintaining the separation between Human Sciences and Natural Sciences by proposing the double hermeneutic argument only for the first. Scientists, when they enter into a new project, always find a language of that specific science in which the project is inserted – a language that is not necessarily the language of previous projects.

In this text, Eger (1999) addresses his understanding of the contribution of hermeneutics to SE more intensely when he argues, based on his experience as a physicist and professor of Physics, that what we have in the Sciences is a triple hermeneutics, in stages 0 and 1, as proposed by Habermas and Giddens, and going further, with stage 2, which is when the theories produced in stage 1 need to be understood. In this sense, the languages of each specific science cannot be compared to a common language that needs to be learned by students. Here, it is necessary to pay attention to his opposition to the double hermeneutics proposed by Habermas:

> My view is that we have in Physics, for example, not just a double hermeneutic, but a triple hermeneutic – three distinct phases in which interpretation is necessary and practice: in experimental data collection, Habermas' stage zero, which he denies for the Natural Sciences;

> then, in building medium and high-level theories, recognized by Habermas as stage 1 and finally in the interpretation of established theories with the effort to understand them. This phase – which I call stage 2 (to follow the terminology of Giddens and Habermas) – is rarely discussed. (EGER, idem, p. 267).

He continues, in his argument, saying that objects do not have their language. When scientists produce a theoretical language appropriate to a phenomenon, this is hermeneutic stage 1. When the same scientist is just learning the accepted language, this is the domain of education, and then stage 2. To approximate the study of the language of science and the study of natural phenomena, it is necessary to approach the formation of the subject and the interpretation to reach the object, for that, it is necessary to enter the language, which requires time.

Eger (1999) explains what it would be like for a beginner to get into the language of Science, first doing a kind of probe, connecting the specific words. Would not it be similar to stage 0 proposed by Habermas? And if this is clear, we need to pay attention to the proposition of stage 2, in which attention to students is inserted. Moving on to SE, it leaves the metaphor of science as an extension of the body behind and returns to a much older metaphor – the Natural Sciences as reading the book of nature. He explains that in science different modes of reading are perceived. Scientists use devices to "see" through them the phenomenon under study and then "read" the book of nature and occasionally add words to this book. One could also think that, in another place, below this floor where the scientists are (remember the cascade of interpretations that Eger refers to in another text), students and other scientists are surrounded by books, trying to read a theoretical language already established. Thus, it seems that two books are being read: the book of nature and the book of scientists – an extensive, time-consuming, and collective work. If we admit that reading the book of nature is an interpretive way of reading, which is a consensus, reading the second book does not seem to be different.

Understanding scientific results, after they have been established or verified, or constructed, is the domain of education, teaching, and the popularization of science. The metaphor of these two books, however, also shows a separation between the Natural Sciences and their construction of interpretations of nature (or phenomena) and the study of the Natural Sciences as the reception of these interpretations. On the one hand, there is the writing of this science book and, on the other, its reading. The belief that interpretation is only a part of writing the science book, not reading it, rests on the belief that although the raw data of nature need to be interpreted, once the results are turned into textbooks, interpretations ceased (EGER, 1999).

Eger (1999) goes on to present examples of "reading" the second book that showed important interpretations for science. He brought up the example of Hertz interpreting Newton's theory differently and Feynman's reinterpretation of quantum mechanics, with his assertion until the end of his life that no one understood quantum theory. By detailing these examples, Eger (1999) intended to show that interpretation is something that happens when in contact with the Book of Natural Sciences, not only with the book of nature, and what the interpretations of Hertz, Feyman, and Einstein brought resulted in new words for the book of Natural Sciences.

When thinking about students, this problem of interpretation certainly occurs at all levels of education (let us remember again the cascade of interpretations of the author's previous texts). Moving toward the end of this text, Eger (1999) again expresses the certainty that it is no longer necessary to question or doubt hermeneutics in the Natural Sciences. The proposed challenge is that more historical, philosophical, and sociological studies would be needed to deepen the understanding, whether of hermeneutics in the Natural Sciences or of the Natural Sciences in the Human Sciences.

The challenge essentially remains in assuming that the language of the Natural Sciences is about beings such as stars, atoms, and others exclusively, instead of being about the interaction of stars and atoms with human beings. Many times, one still hears hermeneutics stating that the objects of the Natural Sciences are meaningless. We bring a part of Eger's argument that seemed poetic and prophetic to us, so we ask for permission to transcribe it:

> But if, as I believe the language of the Natural Sciences includes these relations, implicitly or explicitly, the study of scientific languages is more than the study of atoms or stars and their invariances of point of view. It is also a study of the understanding we have of our relationship

> as human beings with these and other ways of being. This can be seen, as I am suggesting, in all activities (developed by scientists not only by students) where the various languages of the Natural Sciences remain as objects of study (EGER, 1999, p. 277).

BY SYNTHESIS

We detail the theoretical research program in the Philosophy of Science Education developed by Martin Eger. Martin Eger's contributions in English seem undeniable in terms of what we can call the principles of a hermeneutic SE, or even phenomenological and hermeneutic SE, based on the influence of Gadamer. In addition to the repercussions of his work, Eger departed from some Gadamerian concepts to question the hegemonic SE at the time, presenting other possibilities for SE.

In short, Eger emphasized: i. the approximation of doing scientific work and studying/learning science; ii. valuing the perceptive and experiential experiences of those who seek to access/learn science; iii. the primacy of reading science texts as a way of accessing science through language in Science teaching; iv. encouraging the interpretation/translation of Science texts as a way of understanding the world; v. the need to resort to the historical traditions of science as a means of self-understanding; vi. the claim that science teaching experiences are more aesthetic – as concerning works of art – than pragmatic and instrumental; vii. those involved in the pedagogical action are interpreters in the search for consensus around the ontological phenomena that they intend to understand. These and other points lead to the constitution of curricula, educational practices, interpersonal relationships, development of values, routines, spaces and school times, teacher education, and the education of those who educates teachers, necessarily distinct, built from phenomenological and hermeneutic assumptions.

Research productions in Brazil around the articulation carried out by Eger are incipient, in addition to those produced by the research groups of the authors of this article. Based on Eger's program and the articulation between PH and SE, we have developed our research program that has been deepened and expanded to interpret the contemporaneity of Science Education (SOUSA; GALIAZZI, 2017a; 2018a; GALIAZZI; SOUSA, 2019; CARMO; SOUSA, 2022; CARMO; SOUSA; GALIAZZI, 2022). This reinforces advances in the approach initiated by Eger in the 1990s, which have yielded fruits to scientific production in the Brazilian context as well.

This text sought to open space for dialogue about what the author defended, betting on its relevance and emergence. We went to the SE tradition to seek influences on how we perceive, interpret, and understand and thus access the Sciences that help us to interpret the world. Our educational paths also signal a historical movement of rapprochement between the Human Sciences and the Natural Sciences that the PH allowed us to perceive, the result of many derivations of Eger's initial program, which deserves to be carried forward in his proposition of a Philosophy of Science Education.

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CONFLICT OF INTEREST DECLARATION

The authors declare that there is no conflict of interest with this article.

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