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Teaching Two-Eyed Seeing in Education for Sustainable Development: Inspirations from the Science | Environment | Health Pedagogy in Pandemic Times

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Abstract: This conceptual paper starts by outlining six important concerns of Science | Environment | Health (S | E | H), a new pedagogy of science that has been developed during the last decade by a Special Interest Group of the ESERA community. The paper points out that the importance of these six concerns even increased during the SARS-CoV-2 pandemic. They play an essential role in preparing future citizens not only for coping with the pandemic but in general with other great challenges that lie ahead of our world. In this way S | E | H is naturally connected to the UN Sustainable Development Goals, and the paper discusses how S | E | H work in recent years may inspire education for sustainable development. The six concerns are: (1) the question of curricular change, (2) the role of knowledge in S | E | H contexts, (3) the danger of scientism and the tension between individual and political responsibility, (4) decision-making in S | E | H contexts, (5) the challenge of coping with uncertainty, and (6) the question of scientific holism. Structured by these concerns, the paper reviews recent research of the S | E | H community. These findings are reframed by the Two-Eyed Seeing approach that has recently found growing interest in the S | E | H community. This new approach distinguishes between the scientific image and the life-world image on an ontological basis, which helps to disentangle the six concerns and to provide a framework for tackling them in teacher education and educational research—in S | E | H contexts and also in education for sustainable development.

Keywords: education for sustainable development; science education; health education; environmental education; teacher education

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1. Science | Environment | Health Pedagogy: Pertinent in Pandemic Times

Science | Environment | Health (abbreviated as S | E | H) is a new pedagogy of science with the explicit vision of fostering a situation of mutual benefit between the three involved educational fields—science education, environmental education and health education. During the last decade, the S | E | H vision has found growing interest among science educators, which encouraged the foundation in 2014 of the special interest group *Science* | *Environment* | *Health* of the ESERA (European Science Education Research Association) conference. The results of these activities have been progressively presented in two anthologies [1,2], several consensus papers [3–6], and a special issue in the International Journal of Science Education [7]. These publications include a considerable variety of scholars from all over Europe and from the USA, with various research interests and perspectives on science, health, and environmental education. In 2019, Zeyer and Dillon proposed a first, tentative conceptual summary of S | E | H concerns [8].

Although the present paper naturally represents the author's view, it draws from these publications and tries to closely reproduce the work in the group, which of course is still incipient and under continuous development. The second part of the paper also reports new developments, aiming particularly to point out that, in light of the SARS-CoV-2 pandemic, S | E | H concerns have become even more relevant than before, for preparing future citizens not only for coping with a pandemic, but generally for the great challenges

that lie ahead in our world [9]. In this way, S | E | H is closely connected to education for sustainable development. The promotion of the UN Sustainable Development Goals is of great importance to S | E | H. Meanwhile, as will be shown in this paper, S | E | H work may inspire new ways of dealing successfully with pedagogical issues relating to sustainability in school (see also Section 5 in this paper).

Four arguments inspired the engagement of the founders of this new movement and were presented in the first anthology [1]: informed citizenship [9], awakening interest for science [10], promoting scientific literacy [11], and critical approaches to science [12]. In this paper, these will be elaborated in terms of six concerns that have crystallised during the last few years of the special interest group's activity. These concerns are (1) the question of curricular change, (2) the role of knowledge in S | E | H contexts, (3) the tension between individual and political responsibility, (4) decision-making in S | E | H contexts, (5) the challenge of coping with uncertainty, and (6) the question of scientific holism. All six concerns had been thematized and investigated before the beginning of the SARS-CoV-2 pandemic, but we believe that they currently all appear in an even more urgent, pressing light.

It goes without saying that all these points are not idiosyncratic to S | E | H pedagogy but find their counterpart in many other scholarly efforts throughout the scientific world. This paper will occasionally point out important links to other research. However, the connections to other fields are so manifold and interwoven that it remains difficult for a single paper to accomplish an encompassing and systematic overview.

2. Six Concerns of S | E | H Important in Pandemic Times

2.1. Concern 1: Time for Curricular Changes in Science Education?

The science curriculum in many countries does not adequately reflect critical issues about health and the environment. Indeed, the vision for S | E | H at the start of the decade was starkly curriculum driven [13], based on the perception that many students did not learn enough about these two major areas of their lives in their studies of science in school [14]. Young people learn much of what they know about health and environmental issues from the Internet or from their friends, families, and doctors, but not from school [15]. While health and the environment are two central fields in their lifeworld, science seems to be more distant.

In the SARS-CoV-2 pandemic, this alienation has become salient. The pandemic has been an overwhelming experience in the manifest world we all live in, but many citizens apparently have not learned in school how to use scientific knowledge in these critical times, and how to appreciate both the value and the limitations of the scientific endeavor in its context [16,17]. Therefore, in S | E | H, the term *medicine education* has attracted growing interest [18]. In S | E | H, we see medicine education as a pedagogical field that prepares future citizens for patient-centered medicine and shared decision-making (see below). The SARS-CoV-2 pandemic shows that medicine education in this sense could be of high interest and highly innovative but has so far been neglected in schools [4].

Curricular changes are not possible without also changing (science) teacher education. S | E | H is described as a pedagogy because it aims to provide science teachers with an instrument to help them embed new S | E | H curricular elements in a coordinated teaching and learning strategy. Justin Dillon, one of the S | E | H founders, had exactly this in mind when he wrote: "Teachers need a pedagogy based on sound theories of learning and need to find out what students know, design activities to challenge students, provide opportunities for discussion and provide formative feedback. They will need to develop their skills and knowledge and they will need to be able to teach about values and about controversial issues openly" [13] (p. 99).

As already mentioned, the second part of this paper is concerned with science teacher education, on a conceptual as well as a practical level.

2.2. Concern 2: The Role of Knowledge in S | E | H

From the beginning, S | E | H researchers have been particularly interested in the role of knowledge in their new field. Behind this engagement stood the belief that better knowledge would generally entail better health decisions, an aspect that had for decades been neglected, or even disputed, by many health education discourses [19].

In 2004, Keselman and colleagues demonstrated that scientific knowledge could help to identify what they called HIV myths—scientifically wrong beliefs that students firmly articulated before they learned more conceptual scientific knowledge about HIV and AIDS [20]. In the years to come, S | E | H studies investigated students' scientific knowledge in various fields, for example about HPV (Human Papilloma Virus) vaccination [21,22], about menopause and cardiovascular diseases in females [23], about epilepsy and people suffering from this disease [24], and about viruses and antibiotics [25].

The SARS-CoV-2 pandemic reinforced the belief about the importance of correct scientific knowledge. Simon, based on his previous research, provided an update for biology teachers that was designed to "provide a summary of the most important facts related to viruses and offers implications for topics to heed while teaching virology at school" [26], (p. 147). Keselman and her colleagues recently introduced into S | E | H the investigation of fake news—and how it could be neutralized by science education. They see the conceptual understanding of biomedicine as a key factor for laypersons' ability to evaluate the quality of health information resources and health claims, particularly in online settings [27].

2.3. Concern 3: Scientism and Individual and Political Responsibility

For many years, these efforts to improve students' scientific knowledge were undoubtedly important, and even identity-building for S | E | H, although they were critically questioned from the very beginning. As early as 2009, in a comment on an article by Cobern and Loving [28], Zeyer warned of a dangerous and unintended side effect of teachers' impetus to massively influence students' worldview about health and the environment [29]. This could come across, he wrote, as a variant of scientism—the myth that scientific knowledge deserves unquestioned epistemic privilege [28]. Together with colleagues, he pointed out that in contrast to the well-meant intention of these activities, the results may be students' rebellion against science and science education [28], or even a latent environmental depression [29,30]. "Live as long as you can and enjoy life. And that's it . . . " was the ultimate statement made by one of the students interviewed who had been subject to an *eco-scientistic* science education by well-intending teachers.

Since then, the concern about *eco-anxiety* has become much more prominent than when those results were published. A very impressive analysis of climate-anxiety, for example, was recently presented by Dunlop and Rushton [31]. Eco-scientistic approaches have been heavily criticized and more holistic approaches to environmental education have been requested. A compelling example is the bicycle model presented by Cantell et al. [32], which emphasizes the importance of several aspects: knowledge, thinking skills, values, identity, worldview, action, motivation, participation, future orientation, hope and other emotions, and operational barriers. Another example is the 'holistic Agentic Climate-Change Engagement' model (h-ACE), which, based on the bicycle model, aims at tracing learners' journeys towards full engagement with and understanding of climate change education [33].

Without doubting the value of such initiatives, some S | E | H researchers would still place a question mark here. Malmberg and his colleagues interpreted similar initiatives in terms of a tension between levels of individual and political responsibility for health and environmental issues. In their view, the individual perspective is (mis-)used in school science for instrumentalizing students, and they coined the term *health- and eco-certified citizens* [34]. The SARS-CoV-2 pandemic seems to cast a sharp light on the failure of the certified citizen approach and on the tension between individual and political responsibility, particularly in health issues.

By the same token, the political scientist Bogner in his recent book diagnoses the *epistemization* of politics. Political disputes, he points out, suddenly mutate to conflicts about scientific knowledge [35]. The question of who is right becomes gradually replaced by the question of who knows better. Political crises and conflicts are interpreted as epistemic problems—problems of knowledge, expertise and competency. To Bogner, the political discussion in the SARS-CoV-2 pandemic so far represents an apotheosis of the tendency to interpret political conflicts and crises as epistemic problems. Very much in line with what has been said above, he calls this a new type of scientism.

2.4. Concern 4: Decision-Making

Thus, in times of the SARS-CoV-2 pandemic, the role of scientific knowledge in decision-making must be seriously revised. Several avenues for doing so have been investigated by S | E | H researchers, for example a new synergic model of *critical thinking* in science education [36], the investigation of *psychological distance* and connectedness to environmental and health issues [37], and the role of attitudes, values and subjective needs in health-related decision-making [38].

One powerful concept to capture the interplay of cognitive and affective factors in S | E | H decision-making may be the *evidence and preference* approach, which is probably the most popular model used today in patient-centered medicine [39,40]. Recently, Zeyer and Arnold [41] described how the evidence and preference approach has been successfully used to structure an education for sustainable development week in teacher education, to prepare future teachers for health issues in their daily work in school.

Indeed, in times of pandemic, the splitting of the responsibility between experts (providers of evidence) and citizens (providers of preference) [42] may inspire new ways of thinking about decision-making in relation to sustainability issues, on the political as well as the individual level.

2.5. Concern 5: Coping with Uncertainty

Complexity has become an important issue in many considerations about future science education [43], in education for sustainable development [44], and particularly so in S | E | H [5]. Here, complexity has been mainly discussed in terms of unpredictability and of the resulting uncertainty. Two strategies have been discussed in S | E | H to support students in coping with complexity, uncertainty, and limited prediction in real-world health and environmental scenarios [45]:

Strategy 1 is awareness of complexity. Most science education curricula encourage a hidden curriculum about science and its power of prediction and control, and they neglect or even avoid complex contexts. In the pandemic, the lack of complexity awareness may well have been one reason for the deception and frustration some people experienced when predictions were wrong, and control was flawed.

Strategy 2 is adaption. If prediction and control in complex systems are limited, then adaption may be a second and complementary strategy for coping with uncertainty. Adaption implies a different role for scientific knowledge. It may not be used to predict, but to interpret, i.e., to make sense out of situations [46]. In S | E | H contexts, a good strategy may be to combine a predictive control approach with an interpretative adaptive approach, sometimes also called *adaptive staging* [47].

An interpretative approach in complex S | E | H contexts may be supported by using a narrative instead of a descriptive approach to science education, as has been proposed by Fuchs. Narratives in S | E | H may be a discursive way to bridge the gap (mentioned in Section 2.1) between the manifest life-world view of health and the environment and the scientific view, and so foster interpretative and adaptive processes [48].

The SARS-CoV-2 pandemic has clearly shown the importance of a complexity approach to science education and education for sustainable development. Only citizens who have been trained to negotiate both the predictive and the interpretative use of science in complex contexts were able to navigate in radical uncertainty without losing their

trust in science. In the beginning of the pandemic, understanding as prediction often failed [49], experts often caused bewilderment, and goals were not achieved. Nevertheless, understanding as interpretation was probably much more helpful than frustrated people noticed [50], because their focus was much more on understanding as prediction. Conversely, later in the pandemic, when a powerful vaccination was at hand, fighting about interpretative priority made less sense, and a predictive focus could have been much wiser. Informed citizens become aware of the need to switch from one point of view to the other [51].

2.6. Concern 6: Reductionism and Holism

The call for more holism has been prominent during these pandemic times, particularly in the form of fact/value holism in literature influenced by feminism [52]. Many S | E | H authors have used the terms holism and holistic in their publications. One example is a group of S | E | H researchers in Spain that has, for many years, worked on citizen education in environmental health. The authors write:

> "At present, problems related to the environment have led to a situation of planetary emergency. And it is necessary to generate interdisciplinary solutions with a holistic vision of the management of problems resulting from relations between the environment and society . . . " [53] (p. 108)

Another group of S | E | H researchers intend to introduce a holistic perspective into science education in terms of "authenticity". They hope that meta-organism science will help learners deal with holistic implications for health, nutrition, biodiversity loss, ecosystem sustainability, and implement " . . . a more holistic view because it reveals just how interconnected and interdependent organisms are" [54] (p. 24). A new S | E | H pedagogy, they point out, should put the interconnection and dependence of all living entities and the environment at the center of consideration, and cases from metaorganism research would then serve to challenge traditional views of organisms as separate entities.

3. A New S | E | H Focus: Two-Eyed Seeing

Particularly through this last concern of holism, the concept of *Two-Eyed Seeing* has recently become of growing interest in S | E | H research [6]. The following ideas are fairly new, and here they are sketched out briefly. They seem to cast a new light on the six concerns and may open new avenues for practice, development and research in S | E | H, and in education for sustainable development.

The metaphor of Two-Eyed Seeing was shared by Canadian science educators from their work with Aboriginal students [55]. They used it for phenomenologically describing the way they aimed to work with both the scientific perspective and the perspective of traditional ecological knowledge. An important point I want to make here is that conceptual similarities can be drawn with Sellars's *stereoscopic image* [56], which conceptualizes, as its name indicates, two images of the world.

One is the scientific image, which is an outside image that is analytical, objective, and non-social. It is things-oriented and conceives the world in terms of moving matter. For example, in this image, humans are complex systems that function according to natural laws and are accessible to systematic investigation.

The other image, referred to as the life-world image (close to Sellars's manifest image), is an internal image of people living together in the world. This image is people-oriented. It is holistic, personal, social, and contextual, and it conceives the world in terms of community-building persons. Humans, in particular, are perceptive, with freedom of belief and intention, able to be accessed by empathy and understanding.

Two-Eyed Seeing, or the stereoscopic view, means that finding one's way around in the world needs both images, simultaneously, complementary, and supplementally. Neither one is better, truer, or more fundamental than the other. This tension is not easy to hold, and most people end up by favouring one of the two images, often unconsciously [6].

The crucial question is how to switch between the two images without reducing one to the other, and how to ultimately see "truly" stereoscopically a more encompassing picture of the world. We call the "eye switch" from the life-world image to the scientific image *scientific reductionism*, and the "eye switch" from the scientific image to the life-world image *scientific holism* (Figure 1).

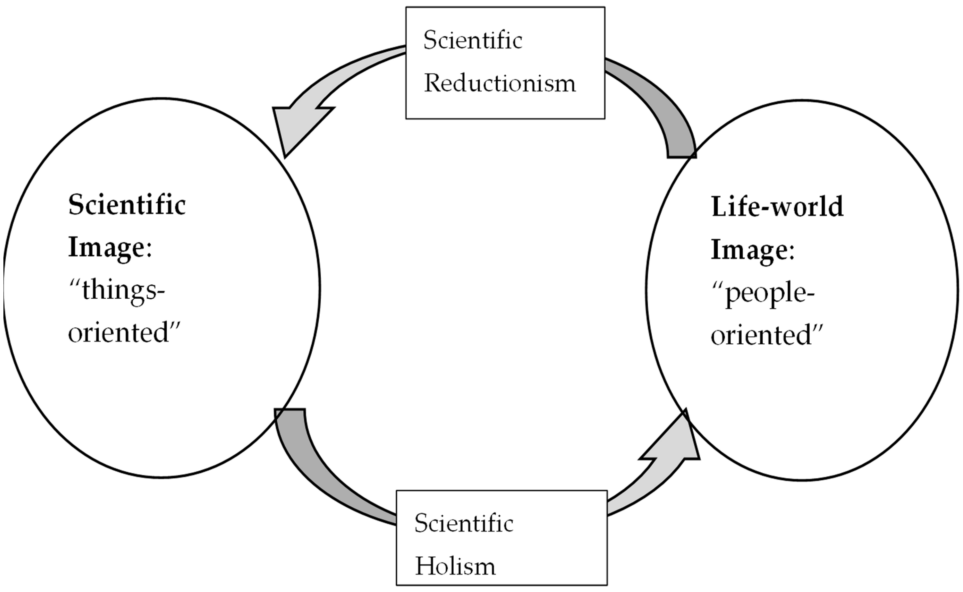

Figure 1. The ontological framework of Two-Eyed Seeing.

Two-Eyed Seeing may thus be understood as a perpetual circulation through Figure 1 with a repeated "eye switch" between the life-world image and the scientific image.

It is interesting to conceptualize the six aspects of S | E | H in pandemic times in the framework of Two-Eyed Seeing (Table 1).

Table 1. Concerns in Section 2, and the Two-Eyed-Seeing.

Concerns	Life-World Image	Scientific Image
(1) Time for curricular changes?	Environment, Health, Medicine	Science
(2) The role of knowledge	Values	Facts
(3) Scientism and responsibility	"ought"	"is"
(4) Decision-making	Preference	Evidence
(5) Coping with uncertainty	Interpretation and adaption	Prediction and control
(6) Holism	Sensing persons	Moving matter

Of course, Table 1 should not be overinterpreted. It is a rough conceptualization of the six concerns of S | E | H in terms of Two-Eyed Seeing. Nevertheless, it can be observed that the introduction of the two images does not complicate the situation unduly, but, on the contrary, points out an inner structure of S | E | H concerns, in terms of a repeated duality between the two involved images. It is particularly helpful to consider this duality on an ontological level, by following Sellars [56]. The life-world image is people-oriented, i.e., its basic ontological entities are "sensing persons", while the scientific image is basically things-oriented, i.e., it consists of "moving matter" [57]. For example, from this point of view, the vague description of health and environment as being closer to the students' lives and science as being one step removed (see Section 2) now makes well-defined sense. In the life-world image, health and illness, as well as "the environment", are health and illness of

sensing persons and their environment. In the scientific image, they are a feature of living systems, built of physical, chemical, and biological particles and parts. In addition, values in the life-world image are "my" values", "your" values, or "our" values, while facts are defined within the scientific image. Further, the duality of "is" and "ought", also called the naturalistic fallacy, is here framed in terms of the two images, as already Sellars suggested in his writings [56].

The duality of prediction and control on the one hand, and interpretation and adaption on the other, is underlined by the complementary character of the two images. The scientific image allows for understanding as prediction, while in the life-world image, understanding as interpretation and sense-making are central. As in all these antitheses, the opposition here is not strict, and the borders are blurry. But in principle, it results directly from the two different ontologies. The temporo-spatial arrangement of moving matter can be predicted and controlled by science, while values and beliefs always refer to persons and communities, who have the *freedom* to hold these beliefs and share these values, or not to do so.

Lastly, the evidence and preference approach (see Section 2.4) also offers compelling synergies with Two-Eyed Seeing. Shared decision-making literally mirrors Two-Eyed Seeing by splitting the responsibility between experts and citizens. As representants of the scientific image, experts share evidence, and as representants of the life-world image, citizens are asked to interpret it, to reflect on their preferences, and to find or defer a decision.

4. Two-Eyed Seeing in Teacher Education: A First Pilot

The idea for the conceptual use of Two-Eyed Seeing in science education is new and is driven by the experience of how urgent the six concerns of S | E | H have become in times of pandemic. It seems that this framework could be useful not only in a new S | E | H pedagogy, but also in education for sustainable development when the role of science in sustainability is of interest. The framework requires discussion and further development. This paper concludes with a short description of a pilot project in science teacher education that has only just begun, and with the presentation of some very preliminary results.

The pilot was part of an introductory course for science teacher students offered at a Swiss university of teacher education. In this course, the students in groups prepared short teaching sequences, called *miniatures*. They performed these miniatures with their colleagues as "their students". These short teaching sequences were analyzed and discussed in the course, and we used them for introducing and fleshing out important didactic principles. This year, for the first time, Two-Eyed Seeing was used as the basic framework for this intervention, i.e., we used Figure 1 and Table 1 of this paper for the preparation, performance and discussion of the miniatures.

To give two examples, one student group started with the physics of pressure as the scientific image. They decided to use blood pressure as their example in the context of the life-world image.

Another group began with the personal experience of one student who had recently broken his leg when skiing. This was the life-world image they used as a starting point, and they decided to use the student's X-ray image to discuss X-rays in the scientific image context.

The data of this pilot require careful evaluation. However, at this stage, with due caution, four preliminary insights can be presented:

(1) Most of the groups chose issues of good health and wellbeing, i.e., the third learning objective of education for sustainable development, for the life-world image. In this way issues of education for sustainable development came naturally into these student teachers' training, and the scientific aspects of these issues were spontaneously and naturally integrated.

(2) "Closing the loop" became a standard formula in students' preparation activities to describe the challenge of getting both images into the miniature. Without their feeling

pressure to do so, Figure 1 motivated students to integrate a full round of Two-Eyed Seeing into their performances.

(3) In all three stages of the miniature—preparation, performance, and discussion—the students had to switch between two different roles. When it came to scientific reduction in the Two-Eyed Seeing cycle (Figure 1), the students (as teachers in the miniature) conceived themselves in an expert role, i.e., their responsibility and identification was towards the scientific image. We use Figure 2 to symbolize this situation. The teacher, the small figure between the two images, points towards the scientific image.

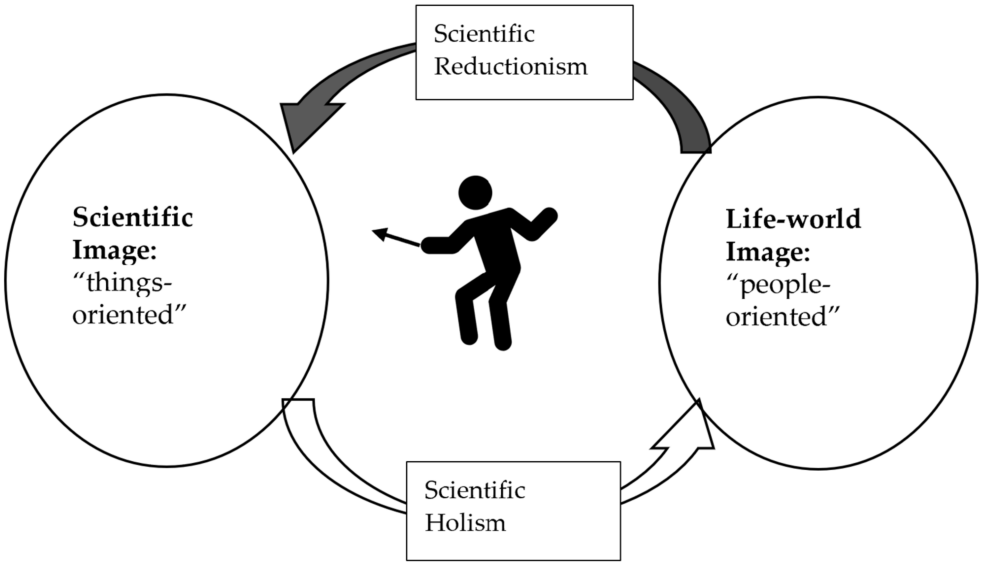

Figure 2. Scientific reductionism: The teacher in the expert role, looking to the scientific image.

In contrast, in the case of scientific holism, the students (in their role as teachers in the miniature) had a hermeneutic/empathic role. They felt responsible towards the life-world of their audience. They conceived their task as helping the students to interpret scientific facts and evidence in terms of their life-world contexts and of their preferences. Figure 3 turned out to be helpful to symbolize this second role.

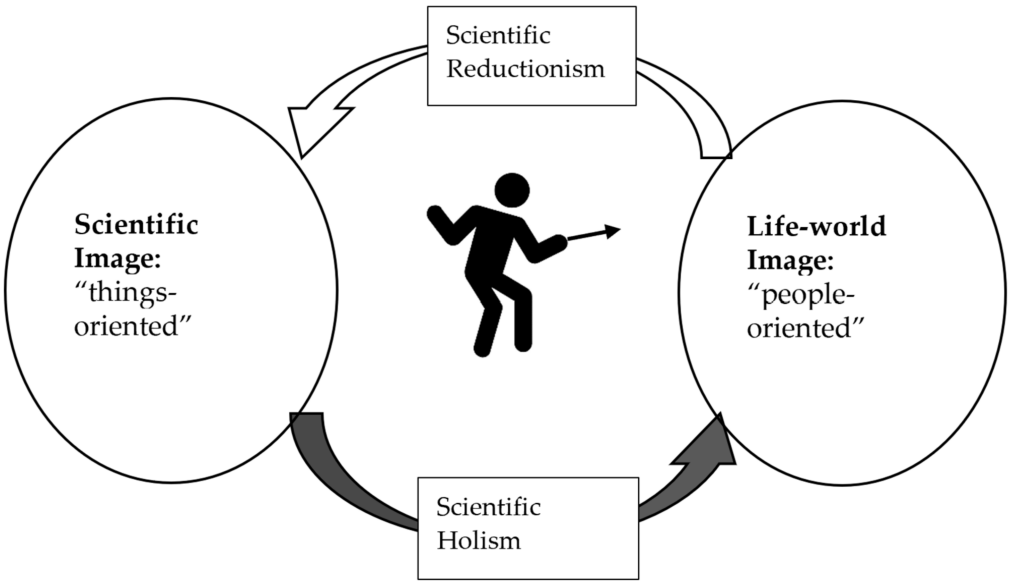

Figure 3. Scientific Holism: The teacher in the empathic/hermeneutic role, looking to the life-world image.

The switch between the two eyes in order "to close the loop", and the required switch by the teacher between the two roles (expert and hermeneutic), proved to be challenging but fruitful. It turned out that the ontological point of view was helpful. In the blood pressure example, physical pressure and the measurement of blood pressure was an issue of moving matter (see Table 1), while the blood pressure was "my blood pressure" or "the blood pressure of elderly people", etc. Similarly, in the X-ray example, the broken leg was "your leg", and the X-ray was "my X-ray", i.e., both entities related to sensing persons. In the scientific image, X-rays were moving photons and the X-ray of the broken leg was a photographic positive of an exposure with high energy photons.

It appears that for our students, the holistic eye-switch and, in conjunction, the teacher's hermeneutic role were more difficult to handle, probably because the expert role is more conventional for a science teacher, and because they had usually experienced their own science teachers in this role.

5. Conclusions and Outlook

This anecdotal report of a pilot study is presented because it marks a new phase in the development of the S | E | H pedagogy. It suggests that Two-Eyed Seeing provides not only an interesting theoretical framework for conceptual considerations of S | E | H. It promises also to be useful for practical applications in the field of science teaching, be it in the development of new teaching–learning content, or in the retrospective analysis of teaching sequences. In this sense, the concept will also be helpful in teacher education. It can provide us with a practical tool for the implementation of the findings of the last 10 years in S | E | H pedagogy. Furthermore, Two-Eyed Seeing could also become a useful research tool in the field.

In this way, we hope to consolidate the theoretical framework of S | E | H, which is at present still tentative and incipient. We assume that Two-Eyed Seeing, applied in suitable research designs, will ground the six concerns in empirical results. Table 1 and Figures 1–3 are good examples of how Two-Eyed Seeing can disentangle the theoretical building blocks of S | E | H, a challenge that until today hindered straightforward realization in research and development. It is assumed that empirical results will confirm or correct the assumptions in Table 1 and Figures 1–3.

The framework offers development potential not just for S | E | H in a narrow sense, but also in related fields such as socio-scientific issues [58] or education for sustainable development [59]. As the pilot showed, in the preparation phase of the miniatures, when Two-Eyed Seeing was consistently applied, sustainability topics were immediately upcoming. Sustainability issues can be perceived as elements of the life-world image as well as of the scientific image and, in both cases, provide a valuable starting point for the application of Two-Eyed Seeing.

Also, Two-Eyed Seeing has recently been referred to by the *healthy planet movement*, presenting another link to an important sustainability movement that could be worthwhile to be established more concisely [60].

In this way, the concept of Two-Eyed Seeing not only marks a keystone of a long-term conceptual journey in S | E | H, but also opens a new field for research and development at the intersection of a whole range of current trends in education for sustainable development.

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