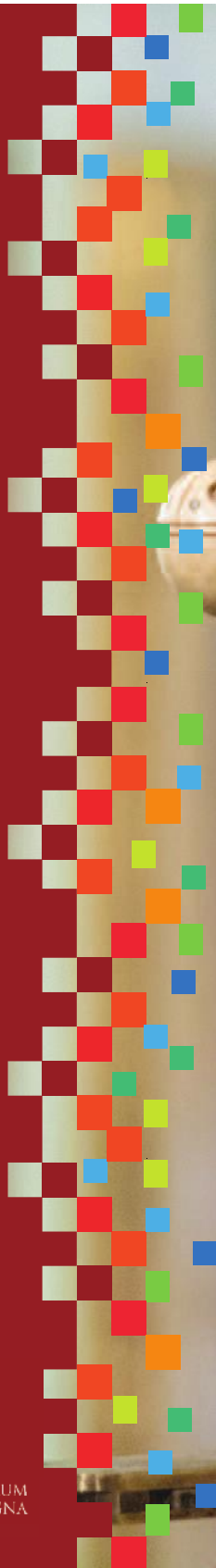




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The Beauty and Pleasure of Understanding: Engaging with Contemporary Challenges Through Science Education (Proceedings of ESERA 2019)

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The Proceedings of ESERA 2019 is an electronic publication for revised and extended papers presented at the ESERA 2019 conference in Bologna, Italy during the 26-30 August, 2019. All papers in the eProceedings correspond to communications submitted and accepted for the ESERA 2019 conference. All proposals to the conference went through a double-blind review process by two or three reviewers prior to being accepted to the conference. A total of 1314 proposals (out of which 65 were symposia) were presented at the conference and in total 238 papers are included in the eProceedings.

The authors were asked to produce updated versions of their papers and take into account the discussion that took place after the presentation and the suggestions received from other participants at the conference. On the whole, the eProceedings presents a comprehensive overview of ongoing studies in Science Education Research in Europe and beyond. This book represents the current interests and areas of emphasis in the ESERA community at the end of 2019.

The eProceedings book contains eighteen parts that represent papers presented across 18 strands at the ESERA 2019 conference. The strand chairs for ESERA 2019

co-edited the corresponding part for each strand 1 to 18. All formats of presentation (single oral, interactive poster, ICT demonstration/workshop and symposium) used during the conference were eligible to be submitted to the eProceedings.

The co-editors carried out a review of the updated versions of the papers that were submitted after the conference at the end of 2019. ESERA, the editors and co-editors do not necessarily endorse or share the ideas and views presented in or implied by the papers included in this book.

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WITHIN THE PROCEEDINGS:

Part 1: Learning science: Conceptual understanding

Part 2: Learning science: Cognitive, affective, and social aspects

Part 3: Science teaching processes

Part 4: Digital resources for science teaching and learning

Part 5: Teaching-Learning Sequences as Innovations for Science Teaching and Learning

Part 6: Nature of science: history, philosophy and sociology of science

Part 7: Discourse and argumentation in science education

Part 8: Scientific literacy and socio scientific issues

Part 9: Environmental, health and outdoor science education

Part 10: Science curriculum and educational policy

Part 11: Evaluation and assessment of student learning and development)

Part 12: Cultural, social and gender issues in science and technology education

Part 13: Pre-service science teacher education

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STORIES ABOUT NATURE AS AESTHETIC EXPERIENCE IN SCIENCE EDUCATION

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In recent decades, constructivist and cognitivist research recognized the important role played by imagination in science education. In particular, the potential of imaginative approaches to attract students to the scientific contents has been highlighted, in addition to the importance of routinely engaging learners' imagination in everyday learning experiences. The function performed by emotions and, in particular, by the feeling of pleasure appears to be less investigated in scientific literature: it is still not clearly defined how it is possible to facilitate learning processes related to the scientific contents by making them more enjoyable.

A branch of research is exploring the possibility of using metaphors and narratives for this purpose: to mobilize the emotional and affective dimension, integrating it with the logical one. This contribution aims to deepen the role that the feeling of pleasure can play in science education experiences in which metaphors and narratives are used systematically.

There is an area in which the feeling of pleasure is intertwined in a paradigmatic way with the knowledge of peculiar elements: in the aesthetic experience, we consider an object (artistic or natural) to be beautiful to the extent that we perceive a feeling of pleasure aroused by it.

In this regard, the more pleasant stories about nature are to read, the more effective they are in terms of educational effectiveness.

Stories need to be not only clear, precise, explanatory; stories need in fact not only to be understood, but also aesthetically enjoyed.

By taking "The Winter Story" as example (Fuchs, 2011), the paper focuses on the characters that make stories enjoyable. The pleasure of the text is indeed an essential ingredient in the narrative understanding of natural phenomena: the presence of metaphors, personifications, of a "grammar of stories", meaning the elements that are involved in the cognitive value of the narration.

Keywords: Aesthetic Experience, Science Education, Evaluation.

AESTHETIC PLEASURE AND SCIENCE EDUCATION

Aesthetic experience, pleasure and beauty

The Aesthetic experience's foundational characteristics have been recently discussed in the scientific literature (Desideri, 2018, p.13), where it has been defined "an experience with the characteristics of a dense, memorable and joyful synthesis, an experience that comes from the fusion of perceiver and perceived previous to their distinction. It is an experience without a subject and without an object". Such definition finds strong roots in the philosophical tradition, as the meaning of *aesthetic experience* oscillates between three main different aspects: the feeling of something radically "close", immediately present; a sort of intuition, the possibility of grasping something indeterminate, yet essential; the experience of beauty, which generates a feeling of specific pleasure. A particularly relevant resonance with the latter element can be traced in Kant's analysis of the aesthetic experience, as he discussed the *feeling of the beautiful* expressed in the *judgment of taste* (Kant, 1952). The judgment of taste, in Kant, is defined as a reflection based on the "free agreement" between the object and the need for finality of the intellect, which arouses a feeling of delight. The object of the feeling of beauty appears to be "made for" the needs of the subject, and oriented to arouse aesthetic emotions and a sense of harmony. Kant established a connection between pleasure and beauty, specifically declined in two definitions proposed in his analytic of the beautiful. In the former, Kant affirms "the beautiful is that which, apart from a concept, pleases universally". In this case, the judgement of taste belongs to the subjective experience, which appears individual and non-objective. Nonetheless, it demands consent and sharing, as it implies the claim of a common validity, related to a common sense that all men share. Universality can therefore be conceived as subjective, since it refers to a common sentiment of the judging subjects that resides in them. For this very reason, it remains without proof. However, universality itself becomes the foundation of shared meanings: taste can be formed, educated, it can be an index of a cultural identity. In the second definition, Kant states "the beautiful is that which, apart from a concept, is cognized as object of a necessary delight". In this case, beauty is not an element determined by a concept, but an evidence perceived by the subject. However, in order to happen, the recognition of beauty needs to be connected with pleasure aroused by beauty itself. In other words, the feeling of beauty exists only if the object in question is considered as a source of pleasure. Considering the elements underlined, it is possible to claim that Kant's view suggests that the experience of beauty and pleasure can be considered as the oscillation between a sense of intimacy and, at the same time, a sense of distance from the object. As proposed by Givone (2003), we can call it an experience of "enchantment".

Intimacy and distance of the beautiful

Intimacy and distance are both relevant elements to be taken into account in the analysis of the role played by pleasure in the experience of beauty. Regarding *intimacy* we can affirm, following Kant (1952), that beauty is the object of a free and immediate feeling: the judgment

on beauty is neither conditioned by other judgments on the object nor the result of a deductive argument. Instead, the beautiful appears to be experienced on the basis of the needs of the subject. For example, a beautiful natural landscape may seem to be formed in order to allow a subject to admire and appreciate it. Moreover, the regularity of a composition of shapes and lines, or the logic in the proportions of a portrait or a statue, can generate a feeling of correspondence with a subject's need for harmony. For Bergson (2001), the sense of beauty can be identified in the arousing of a peculiar psychic state in the subject, meaning the identification of a high degree of continuity with our own experiences. On the other hand, *distance* plays a relevant role in the experience of beauty, given how it appears as something we cannot completely explain as a defined concept. It comprehends irreducible elements, almost showing an autonomous subjectivity. For example, in Leonardo's Mona Lisa we can recognize the technique of the composition, but the smile remains an ineffable and indeterminate aspect. Similarly, a beautiful musical composition that follows a regular trend draws attention on the details that determine its variations, or the pleasure in the sense of grace is generated by a movement that looks regular and free at once, as something that cannot be determined by a preceding calculation. Given these elements we can affirm that pleasure, in the experience of beauty, can be considered as the immediate contact with something intimate and, at the same time, a feeling fostered by the search for something, which cannot be immediately grasped.

Beauty, aesthetic pleasure and cognition

In order to understand the strict relation that connects beauty, pleasure and cognition, we can once again refer to Kant's understanding of the aesthetic pleasure. In his view, the aesthetic pleasure corresponds to the experience of beauty and, at the same time, the aesthetic pleasure maintains a strong connection with the "understanding". When he defines the aesthetic experience, Kant used in fact the expression "free play" between the cognitive power of imagination and understanding (1952). Drawing on this premise, it is possible to recognize a "free agreement" between the object and the intellect in the judgement of taste. Such judgment is in fact a-conceptual but, at the same time, it is not entirely independent from the intellect. In other words, imagination functions in a rule-governed way, but without being governed by any rule in particular (Ginsborg, 2019). This peculiarity explains the mediating role played by the judgement of taste between the sensible dimension and the conceptual one. The experience of beauty shows an "originating" aspect, as it lays the foundation for knowledge itself. It invites to renew acquired rules, to identify affinities between different contexts, to give shape to new aspects of reality, to desire and anticipate hidden configurations of the world.

THE KANTIAN RELATIONSHIP BETWEEN THE AESTHETIC PLEASURE AND THE COGNITIVE ACTIVITY OF JUDGING FINDS SUPPORT IN RYLE AND GALLIE'S DEFINITION OF PLEASURE (1954). IN THEIR VIEW, PLEASURE IS A PECULIAR STATE THAT OSCILLATES BETWEEN EMOTIONS AND COGNITIVE FACULTIES. IN THE SAME VEIN, LEVINSON AND MATRAVERS (2005) STATED THAT THE AESTHETIC PLEASURE REQUIRES THE ATTENTION OF THE SUBJECT FIRSTLY ON THE CONTENT OF THE OBJECT, SECONDLY ON ITS MEANING, AND FINALLY ON ITS FORM.

By referring to the distinction previously made between the categories of intimacy and discontinuity, we can state that the aesthetic experience establishes a special continuity between our faculties and, at the same time, it rises a clear discontinuity in the ordinary flow of experience.

Aesthetic pleasure and Science Education

The strict connection, or even partial correspondence, between aesthetic pleasure and cognitive processes entails relevant consequences not only for reflections related to the Aesthetic field, but also for other ones, such as pedagogy (Contini, 2019; Manera, 2019) and Science Education. In regard with the former, Egan (1990) - drawing on Vygotsky's conception of imagination (Vygotsky, 2004) - has defined imagination as an ability that allows to think in terms of possibilities (Egan, 1990). As for the latter, Wickman (2006) has argued, drawing on empirical data, that the processes of understanding and learning scientific contents show more relevant results when is connected to aesthetic experiences. Jakobson and Wickman (2008), by analyzing the use made by primary school children of the category of pleasing/displeasing, have highlighted its relevant role in engaging children in learning science. Milne (2010) argued that a careful exploration of all the qualities inherent in sense experience helps to generate a sense of wonder and interest in science. Finally, Stapleton (2018), Caiman and Lundegård (2018) have provided evidences of the importance of the role played by imagination in learning scientific contents. Drawing on these studies, we can state that educators should put more efforts in providing aesthetic experiences when presenting scientific contents. As argued by Hadzigeorgiou (2016, p. 53), activities that include the use of narrative in science education enhance "the aesthetic experience of pleasure". Similarly, Egan (2019) underlined the narratives' potential to involve students in everyday classroom activities and attract them to the world of science. In regard with the most relevant elements that narratives need to present in order to be effective, some Authors (Altman, 2008; Klassen, 2009) have underlined the importance of including elements such as metaphors, narrative coherence, characterization, conflicts, problems' resolution, and elements challenging previous knowledge. With particular regard to metaphorical devices, an innovative line of research (Fuchs, Contini, Dumont, Landini and Corni, 2019) recently explored how metaphors give formal content to stories of forces of nature, and how - at the same time - stories inform about the meaning of the metaphors in narrative, arousing a feeling of pleasure. By analyzing the example of the Winter Story (stories of forces of nature), and how - at the same time - stories inform about the meaning of the metaphors in narrative, arousing a feeling of pleasure.

Fostering aesthetic pleasure in storytelling trough continuity and discontinuity

Drawing on the discussed ambivalence of the aesthetic experience in terms of intimacy-continuity and distance-discontinuity, we argue that certain narrative elements are particularly effective in order to promote aesthetic pleasure.

With regard to the sense of continuity, we refer an example where metaphors of personification are used, as often happens in science stories for children that present scientific contents. A first explanation lies in the fact that personification can foster empathy, even in the specific terms of an *embodied simulation* (Gallese & Fredberg, 2007). Secondly, we argue that metaphors establish two kinds of continuity. On the one hand, we find continuity among different

concepts, because metaphors condense many information in a single semantic element. On the other, we experience the continuity of our faculties, since metaphors bind pleasure and learning by making the latter faster. Thirdly, in order to understand metaphors we need to activate our imagination, as they require to go beyond the objective similarities immediately recognized (Johnson, 1981).

Concerning the sense of discontinuity, a first explanatory example can be found in the narrative scheme of the reversal. In Aristoteles' *Poetics* (1962), the reversal schema constituted the basis of the cathartic experience and the condition of a complex narrative plot. In relevant twentieth-century studies on narratives it was considered as an essential element for the construction of a narrative (Bruner, 1992). More recently, (Passalacqua & Pinzola, 2016), narrative has been studied for its relevant communicative function. A second relevant element related to the importance of the sense of discontinuity can be traced in metaphor. The effect of discontinuity in metaphor is related to its cognitive power, since metaphors tend to organize experience in an innovative way, which cannot be anticipated and determined by any prepared concept. Thirdly, a link between metaphor, discontinuity and pleasure can be related to the fact that the process of metaphors' understanding can trigger a rewarding cognitive research for elements that were not previously determined (Forceville, 1996).

Narrative and personification of scientific facts: the example of the Winter Story

A relevant example of a narrative realized in order to present macroscopic physical science and, more specifically, the concepts of heat and cold can be found in the *Winter Story* (Fuchs, 2010), here summarized.

As the last of the warmth of late Fall left the plain surrounding Little Hollow, cold found its way into the area and spread out. [...] The cold of winter knew a good place where it could do its job of making everything and everybody cold [...] It could flow into the hollow where the town had been built. It could collect there and it knew it would not be driven out so easily by a little bit of wind [...] The people of Little Hollow [...] knew that the cold would find its way into their homes if they were not careful to close windows and doors. The cold could even sneak in through tiny cracks between walls and windows, so the people had learned to build their homes well to make it hard for cold to flow in. [...] At times when much cold had collected in their town, the fires in the furnaces had to work very hard to fight the cold. The people in their homes made sure that the heat produced by the furnaces would always balance the cold so that their homes felt comfortably warm.

From a first analysis, we can notice that through the conceptual metaphor of "cold as a fluid substance", we necessarily and ordinarily think of the cold (Fuchs, 2013, p. 16). Furthermore, the metaphors proposed in the story are the same that are used in the formal scientific description of such phenomena. The expressions "[...] the cold would find a way to enter their homes" and "[...] the people had learned to build their homes well to make it hard for cold to flow in", are at the same time used ordinarily and scientifically correct (Fuchs, 2006).

From a deeper analysis, we can notice that the metaphoric projections elicited by the story lead to a process of personification. The projection frames cold in terms of a force of Nature, meaning a *powerful agent*. In this personification, the cold performs actions, behaves like an

agent who has the power to affect reality. If the cold is framed as an agent, we can conceive natural scenes in which it lives adventures and interacts with objects in the world. By acting as a force of nature, cold creates an event that takes place over time and changes things in the world. In this personification, the cold performs actions, behaves like an agent who has the power to affect reality. Acting as a force of nature, it therefore creates an event that takes place over time and changes things in the world. This is the kind of event we call a “story”. In our view, the supported ambivalence of aesthetic experience requires that personification makes the phenomenon "familiar", but for the “estrangement” effect, it must also be evident that we have the encounter between diverse meanings. For example, in this case, rather than saying "the cold gathered in one place", we could speak of a "cold army" as a "collective" agent, separated from the semantic domain of natural phenomena; in this way we could favor the already present sense of confrontation, battle, strategy, without losing scientific coherence. This could also distribute the personification on other "agents": for example, the wind in the phrase "It could accumulate there and knew that it would not be chased away so easily from a little wind as it could happen on the plain".

Beauty in narrative about Darwin’s evolution theory

It is possible to emphasize the importance of narrative’s aesthetic experience in learning processes that involve scientific concepts by referring to an example related to Darwin’s evolution theory.

In this case, the narrative strategy and the personification can help on the one hand to make the evolutionary logic intelligible and familiar, on the other to generate wonder. For example, the spontaneous instinct of bees could be focused in the construction of the perfect hexagons of their hives, as if they were conscious architects. In the evolutionary history of the whale, the unexpected majesty of the contemporary animal could be compared with the less pleasant and significant aspect of its ancestors.

The same ambivalence emerge in narrative schemes related with the evolution. They favor identification (sense of continuity) and, at the same time, exceed expectations (sense of discontinuity). For example, stories of marginalization and redemption, in which an apparent defect becomes an evolutionary resource.

Aesthetic pleasure in stories about evolution and natural selection

To synthesize the aforementioned aspects, we could conceive a narrative about the evolution of a whale, inspired by the book “When the wales walked” (Dixon, 2018). We know that in the skeleton of a whale it is possible to observe tiny hind limbs and pelvic bones disconnected from the rest of the skeleton. These bones demonstrate the connection of cetaceans with ancestors who lived on Earth. If a whale were to discover the existence of these “vestiges”, the story could become a journey aimed to investigate his own past. In such fictional time travel, the whale could meet its own ancestors, who could exhibit and speak about some of their determining features as members of a specie. This element can encourage identification as an aspect of continuity: for example, if the story is addressed to children, they could be stimulated to reflect on their roots and origins, especially in multicultural contexts. At the end of the journey, we could imagine that the whale "encountered" its own species and learned to look at

their qualities from a different perspective (e.g., it could see some of its defects as resources), thus declining the aspect of surprise-discontinuity. Furthermore, the encounters with the ancestors taking place during the journey should favor two main elements. On the hand, the idea of continuity with the past (e.g., by highlighting the similarity of some distant ancestors' qualities). On the other hand, the awareness that there are ruptures and discontinuities (e.g., an odd feature that becomes an evolutionary advantage, setting the conditions for a renewal of the species).

The beauty of the phenomenon

We claim that closeness and difference can be thought of as immediately blended in the experience of a primary perception of the object. The primary perception conceived in the phenomenological approach is careful to all the qualities of sensory experience before the intervention of the cognitive filter. In fact, it includes conceptual schemes, and meanings already acquired. By referring to Merleau Ponty, Dahlin (2001) states that the *presence* of the subject when the object is constituted is the characteristic of a radical insight and the condition of a "profound, convincing and satisfying" learning. This perceptive experience appears as "nascent *logos* (intended meaning, order, knowledge)" and condition of objectivity itself.

Conclusive remarks

By referring to the Kantian tradition, we have argued that a strict connection exists between aesthetic pleasure and cognitive processes. Drawing on scientific literature, we have shown how science-learning shows more relevant results when is connected to aesthetic experiences. This connection entails relevant consequences for Science Education. Teachers and educators should in fact put more efforts in providing aesthetic experiences when presenting scientific contents. Our argument is that a viable way to enhance the aesthetic experience of pleasure in Science Education is the use of narrative. Through the analysis of aesthetic experiences' ambivalence, in terms of intimacy-continuity and distance-discontinuity, we argued that certain narrative elements such as metaphors of personification and the reversal scheme, are particularly effective in promoting aesthetic pleasure. To be effective, narratives need as well to possess elements such as coherence, characterization, conflicts, problems' resolution, and elements challenging previous knowledge. By analyzing the example of the "Winter Story", we have shown how metaphors give formal content to stories of forces of nature, and how such stories inform about the meaning of the metaphors in narrative, arousing a feeling of pleasure. Finally, by proposing various examples, we have argued that it is possible to emphasize the importance of narrative's aesthetic experiences in learning processes that involve concepts related to the evolution theory.

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