Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 2178-5198
ISSN on-line: 2178-5201
Doi: 10.4025/actascieduc.v39i2.30440

Hanna Arendt and the distinction between knowing and thinking: reflections for science teaching

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ABSTRACT. Theoretical contributions are proposed for the formation of science teachers from the distinction between knowledge and thought presented by Hanna Arendt. For the author, the action of knowing, accomplished by science, seeks truths, while the thought, as a action of spirit, seeks meanings. The concept of creative potential is used, suggested by the plastic artist Fayga Ostrower, as a motivational factor of thinking for production of meanings. It can be concluded that science teaching must aim at the development of the ability of not only knowing, but also thinking, promoting the expansion of the creative potential of students and teachers.

Keywords: Science and art, thinking and knowledge, creative potential, education and creativity.

Hanna Arendt e a distinção entre conhecer e pensar: reflexões para o ensino de ciências

RESUMO. Propõem-se contribuições teóricas para a formação de professores de ciências a partir da distinção entre conhecimento e pensamento apresentados por Hanna Arendt. Para a autora, a ação de conhecer, realizada pelas ciências, busca verdades, enquanto que o pensar, como ação do espírito, procura por significados. Utiliza-se o conceito de potencial criativo, proposto pela artista plástica Fayga Ostrower, como fator motivador do pensar para a produção de significados. Conclui-se, apontando que o ensino de ciências deve visar ao desenvolvimento da capacidade não só de conhecer, mas também de pensar, promovendo a ampliação do potencial criativo de alunos e professores.

Palavras-chave: ciência e arte, pensamento e conhecimento, potencial criativo, educação e criatividade.

Hanna Arendt y la distinción entre conocer y pensar: reflexiones para la enseñanza de ciencias

RESUMEN. En este estudio se proponen aportes teóricos para la formación de profesores de ciencias a partir de la distinción entre conocimiento y pensamiento presentados por Hanna Arendt. Para la autora, la acción de conocer realizada por las ciencias, busca verdades, mientras que el pensar, en cuanto acción de espíritu, busca por significados. Fue utilizado el concepto de potencial creativo, propuesto por la artista plástica Fayga Ostrower, como factor motivador del pensar para la producción de significados. Así se señala que la enseñanza de ciencias debe pretender el desarrollo de la capacidad no solo de conocer, sino también de pensar, promoviendo la ampliación del potencial creativo de alumnos y profesores.

Palabras clave: ciencia y arte, pensamiento y conocimiento, potencial creativo, educación y creatividad.

Introduction

This work is based on the fact that the crisis in the education of children and young people - where school dropout appears as one of the serious consequences - can also be the result of educational processes that fail to stimulate in students the divergent elaboration and critical questioning about the knowledge treated. This fact, disfavoring the development of the capacity for self-reflexive thought about the reality (Imbernón, 2011; Hernández, 1998). Such a context reduces the possibility that learning gains meaning in the student's mental world, eventually leading him/her to consider studies as tedious and even unnecessary. This model of education is incapable of promoting the 'authentic thinking' of subjects and does not motivate them to construct their own interpretations about life and its relations.

These are some aspects that appear in the analysis regarding the full formation of the subjects

when the education is discussed and its purposes for the society are considered. From this perspective,

> To educate with care means to learn to love without dependence, to develop human sensitivity in the relation of each one with himself, with the other and with everything that exists, with zeal, before a situation that requires caution in search of the full human formation (Brasil, 2013, p.18).

Thus, the purpose of the reflections presented here is to contribute to the debates about the formation of science teachers, considering the distinction between thought and knowledge, as proposed by Hanna Arendt (1906-1975), in the sense that this distinction invites the teacher to reflect on certain crucial aspects of his/her performance.

For this, an analysis of the concept of 'thinking', as defended by this author, is constituted in order to bring theoretical contribution to the proposed discussions, considering education as a process of construction of the subject in its entirety. Also will be used the concept of 'creative potential', presented by the plastic artist and teacher Fayga Ostrower (1920-2001), as a motivating factor of thinking for the production of meanings in the life of each subject.

The reflections that Arendt (2002) presents, relating philosophy and science, help in the understanding and the distinction between 'knowledge' and 'thought'. 'Knowledge' - the result of the process of being in the world, seeking to solve the questions of everyday life supported by science - is understood as the action of the intellect directed to the understanding of phenomena, that is, the search for *truth*. The elaborations of 'thought', in turn, seek to construct meanings by relating the cognitive acquisitions provided by knowledge. The author does not establish priority or supremacy between one and the other, even proposing the overcoming of the dualist vision of the world, characteristic of the sciences and main philosophical currents that influenced western humanity (Arendt, 2002).

The work that underlies this analysis is *The Life of the Spirit* (Arendt, 2002). In this book, the author presents her motivations to discuss how 'thinking' is related to the human capacity to judge on the basis of good and evil ideas, and to act on that judgment. As she explains, her motivation for this theme came after watching the trial of a Nazi soldier for crimes against humanity. Arendt (2002: p. 5-6) states:

> What stunned me was that the conspicuous superficiality of the agent made it impossible to retrace the incontrovertible evil of his deeds, in their roots or motives, at any deeper levels. [...] There was no sign of firm ideological convictions or specifically bad motivations [...] - it was not stupidity, but thoughtlessness.

The author was surprised at the inability of the defendant to make any reflection on the meaning of the facts and his participation in them. Her perplexities led her to the following question: "[...] is it possible that the problem of good and evil, the problem of our ability to distinguish what is right from wrong, is connected with our ability to think?" (Arendt, 2002, p. 6). Motivated by this primary inquiry, Hanna Arendt went on to develop her research. Her work has gone through the search for answers that philosophy has carried out, from its beginnings, to the question: what is 'thinking'?

These aspects are decisive for the considerations that this work proposes, as they will aid in the analysis of the training of science teachers.

The being and the appearing

According to Arendt (2002), the formation takes place in the subject with permanent actions on the world and on himself/herself, in ever deeper movements of self-knowledge. This author sustains that the capacity to think is given in the dialogue with the world and in the internal dialogue, which are not located on opposite sides, but both correspond to the feeling of belonging to this world in which one lives. Being in the world and being of the world, thus, are two understandings that complement each other. The first is related to the capacity of the human being to perceive a reality that was already there when it arrived and will continue when it leaves. The second is oriented to the possibility of the human being to be integrated into a universe of which he/she is participant, in which he/she perceives and is perceived. In this sense, being and appearing coincide (Arendt, 2002). To feel alive is to feel perceived.

> Nothing and no one exists in this world whose very being does not presuppose a spectator. In other words, nothing that is, as it appears, exists in the singular; everything that is, is proper to be perceived by someone. Not Man, but men inhabit this planet. Plurality is the law of the Earth (Arendt, 2002, p. 17).

This reality indicates that living beings are, at the same time, subjects and objects. As they perceive others, they also perceived by them. According to Arendt (2002), there is no subject that is not also an object, and does not appear as such to someone who guarantees its objective reality. The Cartesian self, the consciousness of oneself, is not enough to assure

reality. This is because we are social beings, perceiving and being perceived; we are not only in the world, but we are also of the world. Being alive, says Arendt (2002, p. 18) "[...] means being possessed by an impulse of self-exposure that responds to the very quality of appearing of each one [...]" or "Every living thing depends on a world that solidly appears as the location of its appearance, the appearance of other creatures with which it act alongside and of spectators who recognize and certify its existence" (Arendt, 2002, p. 19).

This phenomenal nature of the world - the primacy of appearance from which no one can escape - pertains to our everyday life, to common sense. Against this unshakable conviction of common sense, Arendt (2002, p. 21) tells us, there is an ancient supremacy of Being and truth over mere appearance: "[...] the supremacy of the foundation which does not appear beneath the surface which appears". The author opposes to this conviction, since such belief is based on the dualistic theory that puts the world of appearances in a condition of inferiority in relation to that of ideas.

Arendt (2002) brings up a debate about how philosophy intended to establish that the true world is one that does not submit to sensory perceptions, since our senses in various circumstances deceive us. Thus, the 'old metaphysical dichotomy' was established between Being, which is true, and mere appearances. Arendt (2002) points out Descartes (1596-1650) as one of the most important representatives of this philosophical vision. In this belief, the philosopher must leave the world of what is apparent and direct himself/herself to the perceptions of the spirit, because only the latter can unveil what lies behind the appearances of reality (Arendt, 2002). He departs from the world that appears, moving away, in order to undertake a path of inquiry and seeking the first foundation, which would be the cause of the apparent universe. For this philosophical view, the quality that the world has to appear was what suggested the existence of something that is not mere appearance.

Arendt (2002, p. 20) quotes the philosopher Immanuel Kant: "[...] if we look at the world as appearance, it demonstrates the existence of something that is not appearance [...]" and this something "[. ...] must rest on a transcendent object [...]" which defines appearances as mere representations. Arendt opposes this attitude of Kant, which is based on the prejudice that perceptions about the world are mere representations, and says that Kant was lost in affirming that "[...] there is undoubtedly something distinct from the world that contains the basis of the order of the world" (Arendt, 2002, p. 20).

Philosophy sought, in metaphysics, the first cause of the universe, the origin of creation. For this conception, there is belief in a spiritual world, which is the origin of everything, and this material world in which we live and move is the manifestation of another foundation that is not apparent (Arendt, 2002). And in order to access this spiritual foundation, the philosopher must leave the world of appearances, withdrawing into an absolute solitude, distancing himself/herself from the influences of the body's senses that deceive and cover up the truth. Arendt does not agree with this characteristic of the philosopher who places in the life of thought the highest expression of the divine and is directed to few thinking and solitary beings.

Thus, according to Arendt, Descartes' interest was to find something about whose reality no suspicion could be raised; something that was far from the illusory intervention of sensory perceptions. Arendt firmly attacks this perception of a solitary self, stating that:

> The Cartesian *res cogitans*, this fictitious, bodyless, senseless and abandoned creature, would not even know that there is a reality and a possible distinction between the real and the unreal, between the ordinary world of conscious life and the private world of our dreams (Arendt, 2002, p. 38).

We also find in Merleau-Ponty (1999, p. 9) questions about this Cartesian way of thinking in which the 'cogito' devalues the perception of another, teaching that "[...] the Self is accessible only to itself". The true 'cogito' does not define the existence of the subject by the thought of the existence that he/she has, but by eliminating any idealism, reveals to the subject his/her condition of being in the world (Merleau-Ponty, 1999). Husserl, in his *Phenomenology*, comes to integrate consciousness into the world of life, in clear opposition to the Cartesian understanding, in affirming that 'consciousness is consciousness of', that is, no subjective act can do without an object (Arendt, 2002). We can only be sure of the presence of the object by the use of our senses and the confirmation of those who also perceive it. What we perceive has independent existence from the act of perceiving, and this is guaranteed by the fact that the object also appears to others and is recognized by them. Merleau-Ponty (1999, p. 1) manifests himself in relation to our presence in the world: "But phenomenology is also a philosophy that replaces the essences in existence, and does not think that

one can understand man and the world of another way if not from its facticity".

The intention of Hanna Arendt in bringing these questions about the being and being of the world, about Being and appearance, is to show that existence and thinking are in the same world, even if spiritual activity does not have the characteristic of showing itself. The ability to think is the activity that allows the spirit to withdraw from the world without ever leaving or transcending it (Arendt, 2002).

It is in this sense, of questioning the notion of duality of the world that Hanna Arendt intends to demonstrate the distinction between 'knowledge' and 'thought', seeking to show that one does not oppose the other but rather they are complementary. However, she seeks to state that they are of different natures and, consequently, carry out different operations. These aspects will be analyzed below.

Thought and knowledge

There are in human beings spiritual activities, and these activities correspond to the capacity of "[...] a withdrawal from the world as it appears to us, in a backward movement, toward the self" (Arendt, 2002, p. 19). Arendt brings a conception of 'thought' which distinguishes itself from the usual way of considering this concept which often sees this mental activity as logical reasoning, or as a means to acquire or produce knowledge, to solve problems, and to deliberate on our actions (Almeida, 2010). For Arendt, 'thinking' goes beyond knowing and acting, as we can perceive in her statement:

> We are what men have always been - thinking beings. By this I mean only that men have an inclination, perhaps a need to think beyond the limits of knowledge, to make this ability more than an instrument for knowing and acting (Arendt, 2002, p. 11).

However, says Arendt, as we are engaged in spiritual activities, our characteristic of being in the world does not disappear, because there are no two worlds. There is not even a supremacy of the things of the spirit, which does not appear, on which appear, contrary to what the old philosophy wanted to demonstrate, supported in a dualistic perspective.

The natural sciences extend the comprehensive capacities of the subject, projecting them to the discovery of the world, to perceptions of his/her interaction with the environment, to the possibilities of transforming nature, while discovering that he/she must preserve it for the own survival. Sensations, the five biological senses, are apparatuses that establish the forms of action on the world, and are the vehicles through which this world is apprehended by the subject (Arendt, 2002). Using these meanings, intelligence establishes relationships between objects, constructing concepts with which it will cope in order to expand its understanding of life and its interrelations. This knowledge about the world is necessary for our understanding of how to live in it.

According to Arendt (2002), science has as its object the study of nature, observable phenomena, the regularities of the world. Science seeks the laws that command the universe. Science moves in the plane of appearances, of evidences, of what the senses can grasp and amplifies the perceptive capacity, creating equipment and technologies for this purpose. In this way, science helps to broaden our 'knowledge' about the environment in which we live, our biological (mental and organic) body, and understand our place, our space of life. For this reason, science is permanently in search of truth, contributing to the expansion of cognitive capacities.

Scientific research is thus situated in the world of appearances (Arendt, 2002), and, according to its discoveries and overcoming errors and interpretations, builds on the world ever more extensive knowledge. It also carries out overcoming conceptions about the processes that govern the universe, characterizing revolutions in the way of interpreting the world. Evidence is being replaced by new, as science is expanding its understandings.

Over the centuries, and especially in the seventeenth and eighteenth centuries, due to the significant advance in scientific discoveries, among many, with Galileo and Newton, science came to enjoy a status that had not yet reached (Souza Santos, 2008). Its credibility, methodologies, achievements provided the belief in unlimited progress "[...] which accompanied the awakening of modern science and remained as its dominant inspiring principle" (Arendt, 2002, p. 43). For Arendt, technologies introduce scientific discoveries into everyday life, bringing them closer to common-sense experience. All these knowledge are targets of the action of the intellect that wishes to apprehend all that is given to the senses. "Cognition, whose highest criterion is truth, derives this criterion from the world of appearances in which we orient ourselves through sensory perceptions, whose testimony is self-evident, that is, unshakable by arguments and substitutable only by other evidence" (Arendt, 2002, p. 45).

The activity of knowing is related to our sense of reality, so Hanna Arendt states that scientific knowledge is close to common sense, distancing itself from it only by the degree of refinement of the

knowledge in question. As an example, we can bring intellectual changes that occurred after the heliocentric theories suggested by Nicolaus Copernicus (1473-1543) about the Earth's motion relative to the Sun. The understanding up to that time was that the Earth was at the center of the Universe, and that Sun orbited around it. Today the understanding that it is the Earth that moves around the Sun is already given as common sense.

Bronowski (1977) points out that there are three central ideas of science: order, cause, and chance. However, the author emphasizes, none of these ideas originates in science - all are older than their applications. "All are broader and deeper than the techniques in which science expresses them" (Bronowski, 1977, p. 19). This author reinforces the perception that science moves in this plane of understanding, stating that "They are ideas of common sense. I mean that they are generalizations that we all do on a daily basis and that we use continuously to help us govern life" (Bronowski, 1977, p. 19).

Unfortunately, common sense has no documented history, argues Bronowski (1977). Science organizes and records events and situations, searches for the regularities of phenomena, and always searches for new, broader interpretations - that distinguishes it from common sense. Science has a history, elaborates records that demonstrate the evolution of ideas. Thus, according to Bronowski (1977), from the scientific investigations, the ideas of common sense are renewed throughout history, as we can verify when analyzing the concept of gravitational force, proposed by Newton in the seventeenth century, and that today it is part of everyday understanding of people.

In agreement with Bronowski, professor and scientist James Conant (1958) writes that common sense corresponds to a series of procedures and concepts that have proved to be of significant utility for the practical uses of mankind. "Some of these concepts and conceptual systems were transferred to science with only a small thinning and for a long time proved to be fruitful" (Conant, 1958, p. 33).

Quoting Kant, Hanna Arendt indicates that truth is situated in the evidence of the senses - knowledge and truth are related to that which can be confirmed by the testimony of others - and is turned to what is perceptible, to what is apparent to the senses and is understandable by cognition. Arendt does not deny that *thought* has always been present and has played an important role in all scientific endeavor, but its end is 'knowledge' or 'cognition', which belongs to the world of appearances. Thus, as science seeks the truth, its conclusions cannot be questioned, since they are based on facts, measurements and findings, irrefutable proofs confirmed by experience. Arendt understands that the thinking of science corresponds to a withdrawal from the world, but always due to specific results, which cannot be defied, generating unquestionable evidence that can only be modified from new evidence. In this sense, science presents coercive propositions (Arendt, 2002). Thus, Arendt (2002, p. 43, 46) concludes, in the two quotations below:

> In this sense, science is only a refined extension of the reasoning of common sense, in which the illusions of the senses are constantly dissipated, as the errors in science are corrected.
>
> [...]
>
> Even the inexorability of the progress of modern science - which constantly corrects itself by discarding answers and reformulating questions - does not contradict the basic goal of science - seeing and knowing the world as it is given to the senses; and its concept of truth is derived from the experience that common sense makes of irrefutable evidence that dissipates error and illusion.

Hanna Arendt considers these aspects as part of common sense, not in the sense of reducing them and considering them less important, but as something that can be confirmed by the evidence and which can be shared with others. And the author presents her interpretation that thought goes beyond the senses, because the spirit wants to understand the meanings.

For this reason, 'thought' is not direct connected at responding to the same nature of questions that science seeks. But 'thought'aims at meanings, proposing questions which "[…] are, all of them, unanswerable by common sense and by its sophisticated extension, which we call science" (Arendt, 2002, p. 46). 'Knowledge' deals with the search for the truth of what is in the plane of appearances, and is the object of study of science. Science seeks ever more universal truths, and 'thinking' wants to go beyond these truths. Therefore, for Hanna Arendt, the distinction between 'truth' and 'meaning' is decisive for any inquiry into the nature of 'thought'. The following quotation assists the understanding of the philosopher's understanding:

> When I distinguish truth and meaning, knowledge and thought, and when I insist on the importance of this distinction, I do not want to deny the connection between the search for meaning of thought and the search for the truth of knowledge. In formulating the unanswerable questions of

> meaning, men assert themselves as questioning beings (Arendt, 2002, p. 48).

Hanna Arendt, in her philosophical investigations, seeks to distinguish 'knowing' and 'thinking, truth' and 'meaning', and states that "Waiting for truth to derive from thought means confusing the need to think with the urge to know" (Arendt, 2002, p. 48). She seeks in Immanuel Kant the support for her arguments; however, the author argues, this philosopher made the distinction between intellect and reason, but "[...] cannot break with his convictions that the ultimate purpose of thought as well as of knowledge is truth and cognition" (Arendt, 2002, p. 49). Arendt's effort moves in the direction of dispel this conceptual confusion, trying to prove that the actions of the spirit are in categories different from those of cognition.

People are conditioned in their existence by their presence in the world, by their 'being of the world'. Limited by a life span between birth and death, they must work to live and seek a place in society where they feel good. Cognition and knowledge enable them to explore the world and its reality; investigate nature and its phenomena in search of truths that enable them to live better; need to keep their biological body intact in exchanges with the environment, selecting foods, protecting themselves from climatic variations and possible threats, all in order to maintain their internal regularities. For this, it is necessary to know this external reality, and it is in this sense that the intellect acts as an interpreter, as a cognitive element.

But as long as they are situated in the world to understand it, people can transcend it through thought. With this spiritual capacity, in Arendt's view, they can judge the reality presented to them. "They may want the impossible, as for example, eternal life; and can think, that is, speculate significantly on the unknown and the unknowable" (Arendt, 2002, p. 56). The acts of the spirit are not content with something that is immediate, and seek to surpass what is given to cognition in permanent interrogations. This action of thinking has no visibility; it is not given to appearances, although the objects with which it deals with are originated by the world and by our life in this world.

It should be reaffirmed that for Arendt there is no supremacy of this spiritual life over apparent life. The author performs a significant rescue in opposition to the old philosophy, of what appears, of what is perceived by the senses and the intellect, eliminating hierarchies in these processes of existence. She states:

> We may conclude that our common standards of judgment, so firmly rooted in metaphysical presuppositions and prejudices – according to which the essential lies beneath the surface and the surface is the 'superficial' -, are wrong; and our current conviction that what is within us, our inner life, is more relevant to what we are than what appears outside is not more than an illusion (Arendt, 2002, p. 25, emphasis added).

Hence the importance of emphasizing that this activity of the spirit of withdrawing from the world to be alone with itself has no approximation with the Cartesian view that despises the factual reality. The distinction we find in Arendt is that she holds that thinking is not concerned with the pursuit of truth - that is the intention of cognition. The action of the spirit is by the need to find meanings, so it is directed to aspects that are not visible or shareable with others, except through communication and language. The spirit proposes questions that are neither verifiable by science nor by common sense, so one cannot interpret meaning in the model of truth (Arendt, 2002).

The search for meanings by the action of the thought does not occur through the concern with solid results or with propositions of truth. "Thus, thinking derives from the concrete experience, but it has to distance itself from it in order to subject it to reflection, or, in Arendt's words, we must stop to think" (Almeida, 2010, p. 857). This distancing from the world allows the temporary suspension of the presence of people and things, and enables an internal dialogue, analyzing the very questions of being (Arendt, 2002).

There is a need to think beyond knowledge. And this dialogue deepens when the being questions itself about what makes it judge the facts in one way or another; what makes him/her want this or that way; wonder what led him/her to have interest in one object, not another. This is done by appropriating the objects of its memory, bringing them to the reflections of the spirit, trying to understand their forms of relationship. Thought has no commitment to truths, and this frees the being to the imagination, expanding the relations that the intellect is capable of doing. The search for meaning reveals the creative nature of the spirit. The processes of creation and the encounter with novelties can only occur in this sphere of reflection, in the action of thinking, in the free disposition of the spirit (Arendt, 2002).

Thus, for Arendt, science offers elements about nature that promote understanding and relationships. Betting on a thought involved with life, related to the world where their actions are to

live. This activity of thinking is an action that seeks the meaning of life. Science can aid in the movements of the spirit for the construction of meanings, expanding the creative potentialities, fundamental elements for education. In this sense, it is possible to continue with this reflection, seeking relationships between science, creativity and education.

Science, creativity and education

When teaching focuses only on the study of concepts and understandings about nature, the objectives will be directed towards the intellectual capacities of the student and the teacher. In this context, the lessons learned will be laws, rules and principles existing as being independent of our interpretations.

Thus, the teacher will have his/her teaching action based on technical rationality, since he/she should provide conditions for students to develop skills to apply their learning in problem situations (Shäffer & Ostermann, 2013). Learning then remains on the plane of knowledge, and the meanings one can make about scientific knowledge do not become relevant. Cognitive schemes are automated and these are imposed by the established social model as the only form of appropriation of the laws of nature.

In a research carried out with 20 physics teachers, Shäffer and Ostermann (2013) identified teaching practices directed to the accomplishment of tasks aiming to reach results in evaluations. According to the authors, in this group of professionals "There are no coherent elements with a social and transformative practice that indicates teachers as reflective professionals or as critical intellectuals" (Shäffer & Ostermann, 2013, p. 309). The understanding of these teachers regarding the teaching function is limited to the domain of techniques through which they can achieve the expected objectives. In analyzing these results in the light of Hanna Arendt's reflections, we can assume that in the training of these teachers little was invested to motivate them to develop a critical attitude towards how scientific concepts are constituted. It can be noticed that the focus in their undergraduate courses was restricted to the physics knowledge, leaving little percentage of hours dedicated to teaching matters, confirming the research developed by Gatti (2010).

Several authors have highlighted that the model of science teaching in schools does not promote the development of a free and autonomous subject (Briccia & Carvalho, 2011; Wolffenbuttel, Harres & Delord, 2013). Such a context does not encourage the subject to turn to what he/she is - an agent who interprets nature from himself/herself - because he/she regards the world as a distinct object (Arendt, 2002). These constraints promote the establishment of ideologies in the subject, hindering their true possibilities as a being of the world, determined by historical and social perspectives (Arendt, 2002).

In these circumstances, authentic thinking does not occur, and the individual does not perceive himself/herself as creator of realities, assuming pretensions of validity over his/her propositions without the due reflexive process promoted by thought. This model of education prevents students from developing their creative potential, since they encourage only the establishment of established laws without questioning. According to Thuillier (1994), this model of education causes students' developing a conformist behavior in relation to the sciences and states: "Therefore, it is also, by definition, an education that makes conformists who receive it; and which deprives them of the possibility of calling into question the generally implicit presuppositions on which the knowledge transmitted rests" (Thuillier, 1994, p. 244).

A form of teaching that proposes learning solely as the appropriation of truths and laws governing natural phenomena reject students' prior views and convinces them that they have wrong ways of interpreting the world. This education simply proposes information, that is, it leads the student to accept the certainties that science can offer. To the extent that scientific knowledge is already established, there is no longer room for conjecture and speculation. Thus, learning means to assimilate truths.

Nevertheless, this model of education does not lead to thought as the action of the spirit, as was pointed out in the perspective presented by Hanna Arendt; nor does it encourage the creative potential indicated by Fayga Ostrower (1987).

The teaching of science should therefore be directed, not only to issues of knowledge, but go beyond them, providing apprenticeships for thought, surpassing scientific truths looking for meanings, i.e. building relationships. From this point of view, the simple presentation of concepts defined as correct by the scientific community discourages the student from participating in discovery actions, hindering the relationship with the knowledge. There is no experience of knowledge (Lave & Wenger, 2002).

Therefore, teaching science has to be permeated by activities that encourage students to propose questions about nature and its phenomena, in actions that motivate the development of creative

capacities. The discovery of potential increases the capacity of self-perception and perception of the world in processes of self-knowledge. The motivation for learning establishes itself from this perception of itself, and manifests itself in the capacity to problematize the own potentials of perception and creation.

Paradoxically, however, that science that could augment the ability to understand the universe and the relationship that has with it has distanced the human from its object. Motivated by the ability to dominate, beings are confused in their ability to think. In the words of Arendt (2002, p. 12),

> As we turn to what is perceived, which is revealed by sensations, we leave aside what is not seen, and we almost inevitably live by an increasing difficulty in moving on any level in the realm of the invisible.

Ostrower (1987) agrees with Arendt when refers to the alienation to which men have been subjected. Abstaining from his capacity to think, man failed to realize his ability to "[...] establish relationships between the multiple events that occur around and within him" (Ostrower, 1987, p. 9). Therefore, says the author, culture is the foundation on which the individual refers to everything he/she does, in his/her attitudes and behaviors and, consequently, his/her creative possibilities. These observations lead us to question the learning processes proposed for science when they lead students to believe that scientific concepts were constructed without relation to the social and cultural context of their times.

For Ostrower (1987), creating is basically forming. The creative act integrates the capacity to understand and, consequently, to relate, order, configure, signify. "In the questions that man asks or in the solutions he finds, in acting, in imagining, in dreaming, man always relates and forms" (Ostrower, 1987, p. 9). "Man creates [...] because he needs" (Ostrower, 1987, p .10). These attitudes pointed out by Ostrower in relation to the artistic processes to be developed by the individuals approximate those necessary for the construction of scientific conceptions and elaboration of theories on the nature. In this sense, it can be said that to do science is to make art.

Teaching sciences with this focus is understood as proposition of questions that lead teachers and students through processes of knowledge and thought that make them able to also elaborate theories about facts, objects and their relations. These constructions about being and being in the world promote in individuals the expansion of self-knowledge and responsibility towards the Universe where they live and that they share with others. In this way, the teacher should challenge his/her students to also establish relationships between scientific knowledge and social issues in each community, overcoming "[..] limitations, prejudices and complexities, establishing a useful scientific education, very different from the one that has been performed today" (Rocha Filho, Basso & Borges, 2007, p. 35).

When Hanna Arendt stresses the importance of thinking, she demonstrates that it does not mean withdrawing from the world; on the contrary, it is from the experience and the questions about its environment that the subject finds elements for the construction of meanings. The sciences thus become valuable tools for that teacher who sets out to challenge his/her students to knowledge of themselves and their abilities.

The perception of oneself as a social being goes through the inner elaboration of sensations, through the possibility of establishing dialogue with oneself - it is a companion (Arendt, 2002). In this sense, the possibility of inner dialogue is the condition for dialogue with others; in the educational context, it can be said that it is a condition to be a teacher. Putting your own convictions into question means being willing to understand each other's beliefs. The inner dialogue projects the being to the social dialogue, to the political one. Arendt (2002, p. 141) builds her understanding of what is to be thought in this sense of inner dialogue, from the Socratic teachings, stating that with the discovery of Socrates, "[...] we may have interaction with ourselves, as with others, and the two types of interaction are somehow related". Ostrower (1987, p. 13) helps us in these reflections about being and perceiving:

> Perception delimits what we are capable of feeling and understanding, because it corresponds to a selective ordering of stimuli and creates a barrier between what we perceive and what we do not perceive. It articulates the world that reaches us, the world we come to know and within which we know each other. It articulates our being within non-being.

Thus understood, thinking means movement within oneself, establishing internal dialogue. These processes occur when the individual expands his/her look beyond the verifiable, bringing new conceptions and perceptions, other possibilities of interaction between knowledges. The teacher who develops these perceptions in himself/herself may, more naturally, be in front of his/her students not as someone who only holds knowledge, but is able to encourage his/her students to doubt and ask. Thus,

other coherences can be established (Luft, 2005). The spirit creates, invents, innovates, because it is not committed to aspects already given, ideologized; it is not content with ready-made definitions or crystallized truths (Ostrower, 1987; Arendt, 2002). "The perception of oneself within acting is a relevant aspect that distinguishes human creativity. Moved by ever new concrete needs the creative potential of man appears in history as a factor of achievement and constant transformation" (Ostrower, 1987, p. 10).

The permanent transformation to which the individual is challenged relates to the capacity of being sensitive. The perceptual capacity extends the sensibility that "[...] represents a constant opening to the world and connects us immediately to what happens around us" (Ostrower, 1987, p. 12).

The discovery of his/her potentialities generates in the individual the need to exert such potentials, conceiving them as creative processes (Ostrower, 1987). According to Ostrower (1987, p. 30), "[...] the existing potentialities will constitute their own motivation; will be a permanent proposal of the individual, a proposal of itself for itself".

Thus, the understanding described here is that those who in their professional work are dedicated to education need to reflect, always focusing on the aspects of thinking and creative potential of themselves and their students. Imbued with these convictions, the teacher will be able to devote himself/her to discovering how much the knowledge he/she will propose in his classes will be able to encourage students in their discoveries about the world and about themselves. It is in this sense that the teacher can influence children and young people, leading them to become authors of their lives, expanding their understandings and discoveries about the world and about who they are (Hernández, 1998). The sciences cease to be a mere curricular component, but they become tools of construction of meanings. The learning proposals of these teachers will be directed to the incentive to research, motivating the students in discoveries that will strengthen their self-esteem. The distinction between knowing and thinking can encourage the science teacher in his/her reflections and evaluations about his/her own teaching work and can help in his planning of activities, according to the objectives proposed.

Final considerations

The conclusions of Hanna Arendt and Fayga Ostrower about thought, knowledge, and the creative act suggest deep reflections to those who devote themselves to teaching. It is necessary to encourage the teacher to this inner dialogue and to ask questions such as: what led me to become a science teacher? How is being a teacher related to my quest to understand myself and to know myself? How do the learning propositions motivate me in discovering who I am? How does my attitude, as a teacher, encourage my students to build themselves and their own history? What do the learning about science give me in understanding my presence in the world and my self-knowledge?

Regarding scientific knowledge, it is almost common sense that social and political development did not accompany technological development. But we must question what this technological advance means. What is advancement, what is development? These issues, and certainly others, will be permanently present as motivators of human doing, characterizing the condition of a being who asks himself and recognizes his/her limitations while realizing that it is possible to overcome them. Therefore, the teacher who questions his/her certainties, analyzing the assumptions that have led him/her to a certain way of being in the world, will develop a critical attitude towards the knowledge of his/her area of teaching. In this way, their understanding of the sciences and the way concepts are constructed throughout history will be broadened. Thus, he/she will be in front of students as someone who listens to them, who perceives them and challenges them to perform their own discoveries.

In his/her pedagogical actions, the teacher who cultivates thinking as the action of the spirit develops the clarity that his/her students need to unveil the world that manifests itself to the senses. While performing the movement within himself/herself, seeking interpretations and coherences, this student discovers how to be creative, potentially able to elaborate his/her theories about the world, life and its complexities.

Debates and reflections presented point to the incessant problematization of education, to the search for other meanings, to new ways of proposing learning about the sciences. Certainly the changes do not exclude studies and deepening on scientific development and nature, since the research on its area of knowledge must compose the teacher's competences. Therefore, education for thought requires rigor and dedication, but it also requires finding other possibilities of interpreting the world, calling into question forms of understanding that are sometimes assumed without reflection. If the teacher wants to encourage children and young people to discover their creative potentialities, in

processes of self-knowledge, it is essential that they have this goal for themselves.

It is believed that learning proposals that integrate science and art can contribute to the development of the creative being of each individual. The creative act is, therefore, a process of self-knowledge, since it provides the subject with the construction of previously non-existent relations. The realization that doing science is linked to creative processes may motivate the overcoming of purely technical teaching of laws and equations. The teacher can advance to new strategies, instigating the creativity of his/her students in the scientific doing. By reflecting on these relationships, pupil and teacher acquire new capacities and can recognize themselves as generators of novelties, perceiving the transformations in themselves, characterizing true learning.

This spirit which integrates the sciences into a universal scope, as one of the aspects of knowledge for which there are no demarcations, must permeate education, motivating each one to be, as Nietzsche proposes, an artist of his/her own life.

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Received on December 29, 2015.
Accepted on April 13, 2016.