ANSWERS AND INNOVATIONS IN PRE-SCHOOL EDUCATION IN PORTUGAL AND SLOVENIA

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Answers and Innovations in Pre-School Education in Portugal and Slovenia

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Contents

Science Education in the Early Years – Guidelines and Perspectives

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Abstract

In Portugal, the guidelines for early childhood education point out that the sciences, included in the world knowledge area, should be dealt with in the early childhood centres with children from 3 to 6 years. In addition, there is a growing need to implement a research driven education based on active and participatory methodologies in order to initiate the construction of scientific content to develop reasoning. This aims to contribute to the understanding of the world, to reflect on what will happen if one dares to experiment to find out and innovate, to be autonomous, to cooperate with others and to fully exercise citizenship. In this context, the approach to sciences, from a science-technology-society perspective, has been gaining importance and assuming an integral and integrating role in children's learning, by promoting the development of competence and contributing to the construction of scientific literacy of the citizens.

Keywords: *Early childhood education; science education; science-technology-society perspective*

Introduction

There is wide consensus regarding the idea that all children should have the opportunity to learn about science in the early years, in order to raise their level of scientific and technological literacy. In this perspective, education in general and science education in particular should allow children to understand the world through the construction of increasingly vast and complex knowledge that allows them to interpret and understand the environment surrounding them. A quality science education from a very young age avoids the construction and stabilization of knowledge that deviates from scientific conceptions and favours future learning, as well as the development of competences in children.

In Portugal, according to the guidelines provided by the Ministry of Education, the sciences must begin in the early years. In early childhood education, sciences are integrated into the world knowledge area. This area should be seen as science awareness, and provides for the approach of scientific aspects, thus contributing to the scientific literacy of children and encouraging their democratic participation in informed decision-making. That is, from an early age, children must learn to view the world in a scientific way and should be encouraged to ask questions about nature and to seek answers; to collect data; to count and measure; to observe; to organize the collected data; to talk and communicate with others and to reflect on everything they observe. Hence, educators must stimulate children's curiosity and investigative spirit by providing them with situations and resources that motivate them to more concrete and informed learning, which should be based on a more humanistic perspective of science teaching that interconnects and promotes the Science-Technology-Society dimension.

With regard to science education in the early years, many ideas and approaches could be addressed. However, for this paper in particular we will look at the guidelines and goals for science education in early childhood education in Portugal. Then we will point out one of the main perspectives of science education that relates to Science-Technology-Society (STS).

Curricular Guidelines and Goals for Science Education

Government policies of the Ministry of Education have shown a concern to respond to the demands of the educational process and, consequently, to science education. In this context, several normative documents have been published, such as the Curricular Guidelines for Early Childhood Education (CGPSE) published in 1997 and revised in 2016 (Silva, et al., 2016); the booklet *Despertar para a Ciência – atividades dos 3 aos 6* [Awakening to Science - activities from 3 to 6]

(Martins, et al., 2009) and the learning goals for early childhood education (Ministry of Education, 2010).

According to the CGPSE (Silva, et al., 2016), natural sciences are included in the world knowledge area, stating that

> "a sensibilização às diversas ciências é abordada de modo articulado, num processo de questionamento e de procura organizada do saber, que permite à criança uma melhor compreensão do mundo que a rodeia" (p. 6) [awareness of the various sciences is approached in an articulated way, in a process of questioning and organized search of knowledge, which allows the child a better understanding of the world around] So, the main objective is to awaken children's interest in science and not the mere teaching of scientific concepts. In this context, the main intention is to create the foundations of scientific thought, which will be further developed and extended. It is important that there is always a rigorous concern, both in the processes developed and in the concepts presented, whatever the aspects to approach and their level of depth. It is essential to build a research attitude, centred on the ability to observe, on the desire to experience, on the curiosity to discover in a critical and knowledge sharing perspective (Silva, et al., 2016, p. 86).

In the same way, the learning goals aim at the holistic development of the child and the articulated construction of knowledge, in an integrated and globalizing approach of the different areas. This document aims to clarify and guide the educators in the planning of processes and. The sciences encompass three areas: location in space and time; knowledge of the natural and social environment; dynamics of natural and social interrelations. The goals to be achieved in each of these areas are specified in order to privilege an increasingly elaborated scientific thinking, allowing the child to understand, interpret, orient and integrate herself in the world that surrounds her. For example, at the end of early childhood education the child is able to identify the origin of a given customary use material; to classify materials by large groups relating their properties with the function of objects made from them; to compare the germination process of distinct seeds and the growth of plants, among others.

In the booklet *Awakening to Science – activities from 3 to 6* a wide range of activities on diverse topics to work on with children are also included, in order to contribute to the development of their scientific literacy: Initially the child is structuring their curiosity and the desire to know more about the world around them. This will create the conditions to take the first steps in small investigations, which are intended progressively more complex. This is how children begin to build scientific literacy, especially through the exploration of the world with the

guidance of the pre-school teachers. This type of documents will also enable educators to implement science education in their work contexts more regularly and more effectively (Rodrigues & Vieira, 2014).

According to Gomes (2008), the development of the sciences with young children must be implemented with some caution. Firstly, activities must be scientifically structured and grounded, and presented in a language adapted to the children's ages. Secondly, they should allow the increase of children's curiosity of knowing the world around them through practices that foster their experiences in different ways. The most appropriate methodologies seem to be observation, practical/experimental and investigative work, fieldwork and project work.

According to Fialho (2006), scientific activities offer children the possibility to get to know the world in a more rigorous and detailed way, "through the use of various procedures and capacities (observe, record, measure, compare, describe, interpret) that are not exclusive of science. Thus, there is a strong connection between the sciences and other curricular areas, namely mathematics and communication and expressions" (p. 3).

Harlen (2007) states that the most recent research has focused on how children develop their ideas about the scientific aspects of the world around them and has also drawn attention to the consequences of the type of activities that promote learning. The author emphasizes that understanding and conceptual development requires close interaction between children's ideas, content and processes.

As such, initial ideas can be modified, eliminated or strengthened in the light of evidence. The result depends on how the ideas relate to the evidence, as well as on the evidence in question, so the development of selection techniques, application and proof of ideas is fundamental for their evolution (Harlen, 2007, p. 12).

In this same perspective, Rosa (2005) states that science should help children "make sense of what goes on around them and realize how things work. Helping children to understand the way things take and to develop the conceptual understanding of connections helps them to find relationships between phenomena" (p. 31). This seems to be the path to pursue in early childhood education.

According to Harlen (2007), in science education several areas of knowledge can be worked on with children. The choice of these areas should take into account the following criteria: (i) to help children understand everyday events and the world around them; (ii) to be available to all children, taking into account their mental maturity; (iii) to be accessible and verifiable through the use of techniques and procedures carried out by children and (iv) to provide a solid foundation for further scientific education. In the process of reconstruction and development of better ideas, science education should: (i) help children become aware of their own ideas and have access to the ideas of others, in order to be able to compare

them; (ii) help children to apply ideas (their own or others') to a problem or situation and to prove their usefulness in particular situations; (iii) help children to think critically about how ideas should be used and proven, and looking for more effective ways of doing things.

In addition to the development of scientific capacities, science education, when contextualized within a social and affective feature, also contributes to the development of values, social behaviours and scientific attitudes. In this context a more cognitive dimension (openness of mind, curiosity, creativity, objectivity, intellectual honesty, respect for evidence, critical thinking, persistence, flexibility of thinking) is highlighted, as well as an affective dimension (respect, tolerance, cooperation, love of truth, self-confidence).

Many of these attitudes are necessary to the competences in scientific literacy, such as the questioning of the reality observed for decision-making and the resolution of problems; the use of intuition in the investigative process; creativity, curiosity and critical spirit in the search for alternative solutions and ways (Fialho, 2009).

In short and sharing the opinion of Hidalgo, Risueño, Montijano & Perales, (2009) science education, in the early years, develops skills such as predicting, observing and explaining, which may include a competition of knowledge and interaction with the physical world. In turn, these are linked to other competences related to capacity, communication, language, learning to learn, autonomy and personal initiative.

Perspectives on Science Education

As a result of a growing research and innovation effort in the field of science education, a learning-centred perspective in solving problems relevant for children and guided by the investigative practice is envisaged. This teaching perspective is in line with the teaching of science-technology-society (STS). It aims to provide a holistic vision of science and technology with a view to promoting citizens' literacy by enabling them to participate democratically in informed decision-making (Rodrigues & Vieira, 2014).

According to Yager & Blunck (1995), the concept of STS was defined by the National Science Teachers Association (NSTA) as the teaching and learning of science and technology in the context of human experience. The authors stress that learning concepts and processes without a real-world context may be impossible. The major potential of STS is its broader view of science and its identification in a real context as fundamental for learning to actually occur.

The research carried out by Kaya, Yager e Dogan (2009) concludes that the main goal of STS-guided science education is to provide all students with science

and technology literacy, regardless of their individual variability and characteristics. STS education contributes to working and developing awareness of important topics/issues. For instance, most social problems, such as peace in the world, preservation of the environment, etc., imply science and technology. In addition, it is not possible to separate the moral dimension of science from the disciplinary content when it comes to addressing science education for all, and there is indeed an absolute need to protect the planet and its inhabitants (Blanco, Brero, Jiménez & Prieto, 2006).

According to researchers such as Aikenhead (2002); Gordillo (2005); Acevedo-Díaz (2008); and Akcay & Yager (2010), to include the relations between science, technology and society in student-centred curricula will not only provide basic scientific training, with more appropriated views of science and the work of scientists themselves, but will also decisively contribute to the training of citizens who can freely express their opinions on various ussies and topics of their daily life, with underlying fundaments and knowledge of the cause.

For Aikenhead (2009), STS curricula present common objectives, namely: (i) to focus the curriculum on children and their interests; (ii) to promote the use of the internet and other media; (iii) to increase the scientific literacy of citizens; (iv) to arise an interest in science and technology in all children; (v) to stimulate interest in the interactions between science, technology and society; and (vi) to develop in children critical thinking skills, logical reasoning, creative problem--solving, and especially decision-making.

For Galvão e Reis (2008), in an STS science curriculum, scientific contents are integrated into the world of children according to their interests and needs, in order to help them to understand the objects and events they face in their daily routine. "In this way, the aim is to increase children's interest in science and scientific activity and their level of scientific literacy and involvement in processes of discussion and evaluation of social and scientific issues" (p. 131).

Regarding the themes to be addressed, STS subjects are those who seek to relate science, technology and society, comprising a social, historical and epistemological context, taking into account that "conceptual knowledge depends on the context in which you learn and use" (Jiménez, 2003, p. 16).

According to Pedrosa e Henriques (2003), the use of transversal themes, such as rocks, light, living beings, among others, are relevant to curricular content approaches integrating STS interrelations and can contribute to the emergence and consolidation of critical attitudes on development. These critical attitudes are essential to inform and develop civically responsible and coherent behaviour.

The development of STS subjects presupposes the educational articulation of public controversies related to the progress of science and technology and with

social and/or environmental implications. Following these considerations, it should be pointed out that the content for STS teaching should include: (i) explanatory aspects of the relationship between science, technology and society in a perspective of education for democratic action; (ii) the assumption of a multicultural dimension; (iii) study of the global environmental impact and quality of life; (iv) economic and industrial aspects of technology; (v) the need to understand the limited nature of scientific knowledge; and (vi) the discussion of personal values in an active perspective (Pereira, 2002).

Vieira (2003) lists some STS contents, namely population growth, hunger, use of additives in food, water management, distribution and quality, energy and soil use, acid rain, the decrease of tropical forests, pollution and contamination of the environment, waste management and human health. This author considers that combining all the presented criteria with studies and perspectives on STS education it is possible to isolate about ten principles for the identification and selection of the contents to be worked on. Thus, these contents must (i) be relevant to the child's daily situations (social significance), that is, they really pose a question or problem in which everyone can, somehow, disagree with as to their statute or resolution; (ii) have long-term relevance (especially for the next decade), being an important topic that will probably remain as such for a significant proportion of them in adult life; (iii) be likely to help citizens to participate in a scientifically intelligent manner towards social and political decisions on issues involving science and technology; (iv) are associated with thinking capacities; (v) demonstrate adequacy at the level of cognitive development and social evolution of students; (vi) are applicable in contexts other than school; (vii) relate to subjects for which children show interest and enthusiasm; (viii) will contribute to people's ability to ponder questions concerning the meaning of humanity, such as life and death, of perception and reality, of individual good versus collective well-being, certainty and doubt (philosophical value); (ix) will enrich the childhood (a period of life that is important in its own right and not only because of its future outcome); and (x) can be studied adequately and safely with the resources available.

Other relevant aspects to address are the resources and strategies used, which should allow the child to give meaning to topics and problems and to resource to them in their daily lives and in the interpretation of the world around them. In this sense and according to Membleia (2002), the STS approach implies the diversification of strategies, resorting to research activities and cooperative learning with active involvement of the children in the resolution and decision-making on close and relevant problems. When worked on in context, the STS approach can consistently promote child-centred strategies and applications of science as a way to develop understanding of scientific ideas (Santos & Braund, 2009).

STS science education requires some methodological approaches that, according to Blanco, Brero, Jiménez e Prieto (2006), should take into account issues such as: integrated treatment in which the scientific knowledge, values and processes associated with society, science and technology are combined in a creative way through democratic principles and processes; to value concrete, real, relevant, specific, and social-based problem contexts; situations in which specific knowledge, skills and attitudes are achieved; the development of social skills: knowledge on hearing and listening; to understand others; to be supportive and tolerant, to reach agreements, to debate; to provide opportunities for children to investigate, to evaluate and decide on real problems of science and society in which they are involved; to emphasize actions consistent with the decisions made; to approach contents in a multidisciplinary, transdisciplinary and interdisciplinary perspective; to promote values of respect, solidarity and cooperation; to use active and diversified methodologies adapted to the contexts and topics to be dealt with.

On one hand, Membleia (2002) explains that STS pedagogical resources should: (i) enhance accountability and promote students' understanding of their role in the community and in nature; (ii) contemplate the mutual influences among science, technology and society; (iii) ensure balanced opinions; (iv) train children in decision-making and solving concrete problems of the present; (v) promote responsible action; seek the integration of ethical issues and values; and (vii) encourage trust in science.

On the other hand, Caamaño (2009) considers that the resources and activities on materials that come from STS projects can be very useful for science education in the contemporary world, since the field of experimentation of new methods and activities is expected to revert to new forms of understanding and acting within curricula, as well as in the updating of many contents.

In the line of the previously mentioned considerations, the STS approach, as a whole and taking into account the topics to be addressed, as well as the strategies and resources to be used, favours science education and should start from an early stage in the most diverse contexts, including early childhood education.

Final Considerations

Science Education has been gaining ground in the early childhood education centre and a need has been felt to implement an education full of research activities based on active and participatory methodologies. The objective is to initiate the construction of scientific content to develop reasoning, to contribute to the understanding of the world, to reflect on what will happen if one dares to experiment to know and innovate, to be autonomous, to cooperate with others and to fully exercise citizenship.

The current guidelines point towards the need for scientific literacy for everyone, aiming at the exercise of global citizenship, where social issues can be debated and children can build their capacity to become active and participatory citizens. In this context, the STS approach allows better preparation of children for life. To this end, it is necessary to provide educators with adequate and innovative continuous training, leading to changes in their didactic-pedagogical practices in a collaborative environment among all stakeholders. In short, we consider that the (re)conceptualization of research and cooperative activity in problem-solving, following the STS interface, suggests changes in the organization of educational environments and the roles of educational actors themselves. This teaching approach raises children's interest in science learning and provides the adoption of more positive attitudes towards learning science. It should start at an early age and involve children's ideas, imagination and activity, with the educator's involvement and effort in recognizing this teaching approach. Reflections should focus on how to develop the ability to think in children, to experiment and to re-formulate ideas and competencies, trying to respond positively to the needs of today's society and to themselves as a person.

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