1st Cycle of Basic Education Teachers and their Engagement in Science and Technology

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ABSTRACT— ***In recent decades, research in science education, based on the Science-Technology-Society trinomial, has achieved a remarkable dimension, the result of the view that holds Science and Technology (S&T) as engines for the development of society. It is therefore important to understand the engagement of teachers in the 1st cycle of basic education, as they are one of the cornerstones of future development, in particular through the involvement they may inspire in their students. In this sense, this article seeks to understand the 1st cycle teachers (elementary school teachers (grades 1-4)) in the district of Guarda, Portugal, as social and cultural actors.***

The results reveal a group of teachers with moderate interest in S&T issues and a lot of interest in topics involving environmental issues. The prominence of this subject suggests that the teachers have been influenced by educational policies as well as the extent of information acquired through the media on this topic. Although the sample consists of highly experienced teachers, they revealed a degree of engagement far short of what would be desired, indicating interest, almost exclusively, in attending debates and meetings on the environment.

As the teachers' engagement in S&T is a result of their social and cultural interaction in society, the authors stress the importance of creating a social network to promote the creation of an "identity" which can deal with a world characterized by rapid scientific and technological change, solidifying the scientific knowledge of the teachers involved and optimizing the educational component of these social actors in the promotion and development of scientific literacy.

Keywords— Scientific Culture, Teachers, Basic Education, Public Engagement with Science.

1. INTRODUCTION

In the 21st century, citizens need to keep up with scientific and technological developments that are emerging at a rapid pace. Information comes to individuals in different ways and in different communication platforms and it must be processed and assimilated in order to subsequently be applied to the understanding of information. It is precisely in the development of scientific and technological tools that allow the citizen to be contextualized in society that the role of Science Education lies. The focus of the science curriculum, in terms of education, is reflected in the idea that "all students, regardless of individual and cultural differences, should develop a scientific and technological literacy (Bolte, 2008). This promotion of scientific literacy includes an understanding of basic science concepts, making connections between Science, Technology and Society, the development of positive values and attitudes towards science, and the understanding of the nature of science. Moreover, students should enhance their critical thinking, problem-solving and decision-making skills. In studies related to this topic, there is a growing lack of scientific topics in the more advanced levels of education (Graber, 1998; Osborne, 2003). What is more, in the first years of teaching, the number of studies is smaller so only a general framework can be proposed (Rannikmae & Holbrook, 2007). When we move to the role of teaching in promoting scientific literacy, the studies are even more residual, resulting in a lack of meaningful data (Mbajiroug & Ali, 2003; Chin, 2005; Nwagbo, 2006).

Taking the above into account, the present study is innovative insofar as it seeks to gauge the degree of scientific literacy of 1st cycle teachers (elementary school teachers (grades 1-4)) of the Guarda district, ranking the interest in information on Science & Technology (S&T) topics. Taking as its focus elementary school teachers, this paper attempts to understand the extent to which science education is influenced by the role that the teacher plays in society.

In this sense, the first part of this research contextualizes the concept of scientific literacy, in retrospect, as intrinsic to the individual who participates actively in society, in that cognitive tools can be created for individuals who contribute to the harmonious development of the relationship between Man and Nature relationship, which then legitimizes many of the political strategies of the S&T matrix (Caraça, 2001). In the second part of the article, the importance of the promotion of S&T will be discussed in the context of elementary school, where the teacher's role is that of mediator between society and the classroom. Finally, the results will be presented in order to bring possible lines of action to the discussion of the definition of the optimization of scientific literacy levels for elementary school teachers.

2. SCIENTIFIC LITERACY

Since World War II, S&T has alternated periods of strong influence in the social, economic and cultural dynamics of societies with other periods of high scepticism about the role of science. These alternations are reflected in the literature, where the influence of S&T in society is divided, into three periods: 1) from the end of World War II to the late 50s; 2) the early 60s; and 3) the early 80s.

An analysis of these three periods in the literature reveals that the first period is characterized by a strong appreciation of scientific work due to the increase in the living standards made possible through S&T. However, with the early 60s, there was a reversal of S&T's primacy, and a number of publications advocated for greater social participation in decision-making on S&T issues (Bosso, 1987). These publications argued the need to shorten the distance, in terms of scientific knowledge, between laymen and scientists, so that the former could participate more actively in society. Despite this desire for civic participation, neither governments nor scientific and technological organizations nor the scientific community recognized that the citizens possessed the scientific and technological skills to define lines of research. Only in the early 80s did the scientific and political community recognize that citizens could veto scientific programs or projects. In this sense, this third stage is characterized by the dissemination of greater scientific information to citizens due to the exponential increase in scientific communication, which has resulted in an increase in both the speed and amount of public debates on S&T issues (Miller & Pardo, 2003; Felt, 2005).

In view of this historical perspective, scientific literacy has assumed a key role in educating societies. Aikenhead (2006) argued that "learning is a daily interaction with the world, including intellectual challenges, personal changes, construction of a new self-identity, and recognition of power." Currently, this debate focuses on the role of formal and non-formal education in promoting scientific literacy and therefore, the global democratization of science (Aikenhead, 2009). Historically, science has been regarded as a specialized subject, only accessible to some, whereas currently it is desirable that all citizens be familiar with and knowledgeable about science (Popli, 1999) since the participation of all citizens is required in response to the issues S&T is currently facing (Martins, 2002), particularly in the definition of ethical and moral boundaries and lines of research. In this regard, and given the importance of Scientific Literacy, there has been a wide-ranging debate around this concept, marked by interpretations and reinterpretations of the definition itself.

Initially, the characterization of scientific literacy was done empirically. It was seen as a personal object of every citizen, enabling him to understand, among other concepts, the interrelationship between science and society; the ethical dimension of the scientists in the development of his work; the nature of science; the basic concepts of science; the difference between S&T; and the interrelationship between Science and Humanity (Pella, 1996). Also according to Pella, this characterization evolved to be limited to six dimensions or objectives: 1) understand the nature of scientific knowledge; 2) apply the interacting concepts of laws, principles, and theories constituting the Universe, as well as a picture of the Universe; 3) help to take decisions and solve problems; 4) appreciate and understand the interaction that exists between S&T and the interrelationship of S&T with other aspects of society; 5) have a more positive and exciting view of the universe as a result of a scientific education and 6) develop a wide variety of skills associated with S&T. For other authors, empirically, the concept of scientific literacy could be resumed as an individual's ability to read and write about S&T (Miller, 1998).

Later, at the turn of the millennium, this concept of scientific literacy was recast to relate to what the public should know about Science, which usually involves the understanding of the nature, objectives, and limits of science, associated with the knowledge of scientific concepts, seeking to create bridges between common sense knowledge of different cultures and the new internationalized scientific knowledge (Laugsksch, 2000).

The need to dilute the border between common sense and scientific knowledge is one of the many factors which, according to the extensive literature (DeBoer, 2000; Fensham, 2004; Hodson, 2002; Kolsto, 2001; Laugsksch, 2000; Tippens, Nichols, & Bryan, 2000), influence the interpretation of the concept of scientific literacy. These factors can be organized into a conceptual framework (Laugsksch, 2000) (fig. 1) to better illustrate the connections between the different factors.

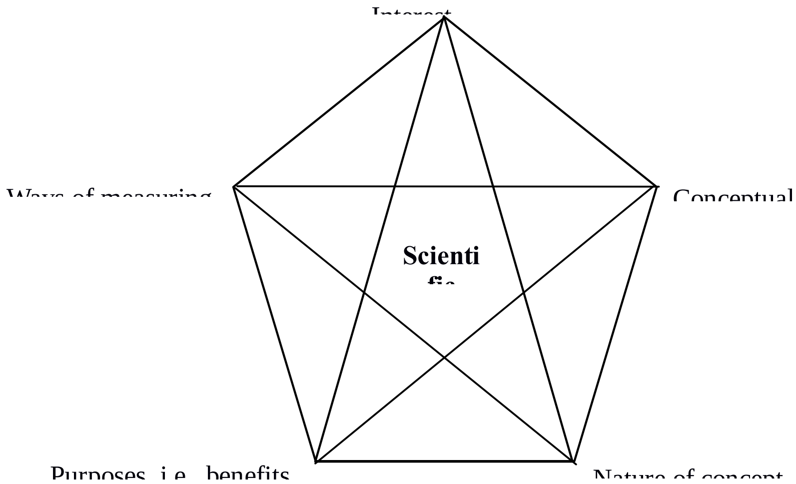

Figure 1: A conceptual view of scientific literacy (Laugsksch, 2000)

The analysis of the different definitions and interpretations of the concept of scientific literacy is critical to understanding its nature. The term *literacy* refers to the ability to read and write but the extension of the concept of literacy terms, e.g., computer literacy, cultural literacy, political literacy and obviously scientific literacy, suggests that the semantic aspect of this concept is important (Laugksch, 2000).

2.1 Nature of the Concept

The interpretations and uses of the term *literacy* are diverse, appearing in the literature as a synonym for learning, competence or minimum functional capacity to live in society. Therefore, understanding the semantic evolution of the word *literacy* helps to frame the nature of the concept.

The word *literacy* derives from the Latin term *litteratus*, a term that has evolved from its initial link to those who acquire knowledge to the current definition as the set of minimum knowledge and skills required to play a specific role in society (Laugksch, 2000; Miller, 1998). This phase of the application of scientific knowledge by the individual in order to be an actor in different social theatres suggests a social context where the definition of scientific literacy places more emphasis on competence since it seeks to accomplish a task. This task could vary, ranging from reading a newspaper or magazine about science, and the ability to think critically and independently about a problem, to quantitative analysis or logical reasoning. This puts scientific literacy on another level as far as situations of task resolution are concerned, characterized by the degree of engagement in and with society (Irwin & Michael, 2003). This engagement level between science and society comes from the fact that the scientifically literate citizens are invited to not only participate actively in making scientific and technological decisions, but also monitor the scientific policy of their governments. According to this normative perspective, citizens should have access to a sufficient level of information in order to define their scientific knowledge, with the objective of making informed decisions (Ávila, Costa, & Mateus, 2002). It turns out that, when they lack this information/scientific content, citizens build alternative ideas without a scientific basis (Miller, 1998; Laugksch, 2000). By the early 90s the idea had spread that disbelief and scepticism towards S&T emerges from the alternative conceptions of scientific concepts, leading to the lay public *vs.* science specialist dichotomy. It derives from the citizen's lack of belief in S&T in opposition to the "excess" of belief on the part of the specialist (Gross, 1994).

This "Deficit Model" emerged from this lack of connection between S&T and the citizens, characterized by a robust, but not especially strong, correlation between the theoretical scientific knowledge and a positive attitude towards science. This view of the lack of scientific knowledge on the part of citizens is not complete if we do not include the social context for each individual, to the extent that the fears, which weaken the citizen-science relationship, result in the view that each individual constructs of the world. The factual knowledge of science is, therefore, not enough to offset the effect of the dominant thought in society about the risk of engaging in S&T (Slovic & Peters .1998).

To "fight" against this gap in the knowledge of its citizens, a conceptual framework that promotes interaction between citizens and society is required through a participatory model or exchange of ideas in which the lay public and Science experts interact, with benefits for both parties. Burns (2003) and Kerr (2007) propose a relationship that is based on the premise that there is a sharing of experiences, of different perspectives, and the production of scientific knowledge that contributes to increasing the understanding of S&T in society (Kerr, 2007). It is precisely at this point that a new form of teaching emerges which breaks with the vision of non-contextualized Science, disconnected from the constraints and social interests.

In its trail there is an educational model that should enhance "science as culture" (Weinstein, 2004), foreseeing the contextualized scientific knowledge in society, acquired and assimilated as value and in the manner of their own organizations (Kerr, 2007).

2.2 From science education to the subculture of teachers

In recent decades, research in *Science Education*, based on the science-technology-society (STS) line of research, has achieved a remarkable dimension, due to the inclusion of this investigative line that defends science as the engine for societal development. The construction and development of the scientific literacy concept, as demonstrated earlier, and consequent ramifications as the public understanding of science, or scientific culture, "la culture scientifique" (the latter term also adopted by UNESCO), have led to a proliferation of conceptual frameworks of the STS Perspective that influenced educational policies on Science Education.

Historically, the construction of the concept Science-Technology-Society emerged in the late 70s and early 80s as a consequence of the need to boost innovation in science education. This idea had already been suggested in *Science Education* by Jim Gallagher, who wrote that, "for the citizens of the future, in democratic societies, to understand the interrelationship between science, technology and society can be as important as understanding the concepts and processes of science" (Gallagher, 1971, p. 337).

This epistemological framework introduced new and diverse proposals, which suggested an assessment of the role of science as an actor in society, a strong need to improve science education for action, and an approach to interdisciplinary education. After nearly three decades, the STS perspective can be seen as a temporal spiral that maintains its support base as a teaching methodology, subject to insights and refinements of its conceptual framework, which result from the need to monitor the evolution of the concept of scientific literacy in all its manifestations.

Aikenhead (2005) refers to Peter Fensham as one of the examples of this evolution; in 1985, building bridges between scientific and technological education, Fensham (1985) contextualized S&T in relevant topics for students. At this stage, Fensham's STS perspective was characterized by a one-way influence of science and technology on society. Later, in the 90s, Fensham reconceptualized the Science/Technology/Society influence according to the bi-directional interaction mode. This idea was taken up by Bingle and Gaskell (1994), when they referred the need to acquire scientific and technological knowledge to create a support base for making decisions and solving problems, inherent to the Science/Technology/Society trinomial. The evolution of the STS perspective has gained a new dimension – Interculturality. Aikenhead (2007), the driving force behind this line of thought, alerted not only to the need for STS teaching to include a cultural perspective so that the world's cultural boundaries can be negotiated but also to the importance of framing science education in the economic, social and environmental development of societies. Ultimately, science education seeks to humanize the teaching of Science. This cultural nature of science was taken to yet another level by Kolsto (2000), who focused his study on the analysis of controversial science issues based on scientific knowledge and argued that contact with the characteristics of scientific knowledge, its values, limits and nature is crucial for decision making on controversial science-based issues. Cachapuz (2008) states that "this author [Kolsto] considers the argument that improving citizen/student performance needs to emphasize science and production processes of scientific knowledge as an institution".

In the evolution of the STS Perspective concept, a number of meanings have emerged which have caused some disturbances. To minimize the interference of the concept, Aikenhead (2007) created a spectrum of meanings for the STS Perspective, based on the degrees of interaction of science and technology with social topics, which expresses the relative importance granted to the STS contents, taking into account two factors: content structure (STS content and traditional science content ratio) and student assessment (emphasis on the STS content versus traditional science content). From the result of these factors, eight categories emerged (fig. 2) with varying degrees of teacher engagement in STS content .

1 Motivation according to STS content.
2 Casual incorporation of STS content.
3 Intentional incorporation of STS content.
4 Specific subject via STS content.
5 Science via STS content.
6 Science along with STS content.
7 Incorporating science into STS content.
8 STS content

Figure 2: STS Categories in school science

Category 1 represents the lowest level of STS engagement and category 8 represents the highest level of engagement. A dramatic change in the content structure occurs between categories 3 and 4. In category 3, content is framed in the specific subject while in category 4 content comes already framed in a technological or social context. In Category 5, interdisciplinarity of science content becomes evident. This reversal reflects the emergence, in Science Teaching Research, of five areas of intervention: 1) the integration of environmental issues in the science curriculum; 2) the appearance and progressive development of Science, Technology, Society, and Environment approaches; 3) the integration of issues related to the History, Philosophy and Sociology of Sciences; 4) the recognition of technology as a key training area; and 5) student development of "scientist" skills with the goal of minimizing student indifference towards science and science-based professions (DeBoer, 1991). To increase the training of scientifically-evolved individuals so that they fully exert their citizenship, the literature argues that Science Education should start in the early years of formal education for a number of reasons: a) the student has a positive image of science and scientists; b) the student is an observer by nature and tries to interpret the phenomena that surround him; c) the student is able to understand some of the most basic scientific concepts; d) the attempt to interpret the surrounding phenomena develops his/her ability to think; and e) premature contact with the explanation and understanding of phenomena is a positive discriminating factor when the students, during basic education, come into contact with these concepts once again.

Despite all these reasons, it is noted that in grades 1-4, when sciences are taught, they are not motivating to the child; there is a gap between what they are capable of doing and understanding and the activities in which they are allowed to participate. The main argument for denying a number of activities is the high degree of complexity of some concepts. However, this argument is refuted insofar as complex and abstract concepts can be explored at the elementary level, allowing students to develop these concepts and acquire new vocabulary (Van Hook & Huziak-Clark, 2008). The literature (Cachapuz, Praia, Jorge, 2002; Martins, 2002; Martins *et al*, 2007) points to a predisposition of elementary school children toward learning science; clearly, the elementary school teacher should promote scientific literacy in order to develop socially active citizens.

When Maddock classified "science and science education as cultural enterprises which form a part of the larger cultural matrix of society and that educational considerations concerning science must be viewed in light of this perspective" (Maddock, 1981, pp.10), he was developing the thesis that science education should be framed in a multicultural perspective. Accordingly, teaching should take into account the multidimensional cultural world of the student in order to apply this principle to a particular situation and express it in terms of curricular materials and classroom methods.

This line of thought accompanies the socio-constructivist learning perspective presented by Solomon (1987), resulting from the evolution of personal constructivism, based on research on the rational aspects of conceptual change that Solomon expanded, looking to accommodate non-rational aspects of change and the nature of conceptual development. More recently, the debate around the concept of scientific literacy as regards elementary school teaching staff (grades 1-4), has gained new ground with the framework provided by Norris & Phillips. These authors argue that, in addition to attention to the nature of scientific literacy, teachers are also aware of the level of their own scientific knowledge and of their impact on students' learning (Norris and Phillips, 2003).

At this point, the notion of "teaching identity" appears as the factor that enables the framing of the teacher's ability to adapt to the constantly changing nature of scientific literacy (van Veen, Sleegers & van de Ven, 2006). Wenger's work (1998) is meaningful in this context, since he sees the teachers' social and cultural environment as vital to the creation of their own teaching identity. From this perspective, the formation of an educational identity stems from the assumption of a social position molded from a combination of personal and social biographies (McDougall, 2010). It is precisely this view of science teaching that the present research shares, in that it seeks to assess the engagement of elementary school teachers as social and cultural actors. The assessment of the degree of teacher engagement and the scientific worldview can lead to the creation of strategies and methodologies to further develop the teaching skills essential to optimize the promotion, teaching, and learning of science and technology in the context of the classroom.

3. OBJECTIVES

For the promotion of individual scientific knowledge it is important to create mechanisms that allow citizens to come into contact with Science. As we live in an imminently technological society, the use of the media is seen as the vehicle for the promotion and dissemination of scientific knowledge (Caraça, 2001).Nevertheless, a number of authors (Hofstein, Eilks & Bybee, 2010, Holbrook, 2005; De Vos, Bulte & Pilot, 2002) argue that contemporary scientific knowledge should not be not focused on the condition of science as knowledge as isolated and restricted to a group of individuals. As a corollary, the authors suggest that the status of science in society should be valued from the moment when scientific knowledge is first disseminated. However, it is not enough to promote scientific knowledge transmission mechanisms; it is essential to assess whether the message reaches the citizens and, as such, it is important to assess whether there is any correlation between the interest in a given topic of S&T and the information garnered on the subject through the media.

Given the existing literature and some exploratory study (Irwin & Michael, 2003; Norris & Phillips, 2003), the present research has sought to answer the following questions:

- **Research Question 1**: Is the degree of interest of elementary school teachers in issues of S&T related to the degree of information acquired through the media on these same topics?
- **Research Question 2**: Is the degree of engagement of elementary school teachers in S&T related to the degree of interest on these same topics?
- **Research Question 3**: Is the degree of engagement of elementary school teachers in S&T related to the degree of information acquired through the media on these same topics?

Note that research question 3 appears based on the importance of the promotion/dissemination of scientific knowledge through the media.

From the previous research issues, the following assumptions took place:

- **Hypothesis 1:** The degree of interest of elementary school teachers in issues of S&T is related to the degree of information acquired through the media on these same topics.
- **Hypothesis 2:** The degree of engagement of elementary school teachers in S&T is related to the degree of interest on these same topics.
- **Hypothesis 3:** The degree of engagement of elementary school teachers in S&T is related to the degree of information acquired through the media on these same topics.

4. METHODOLOGY

4.1 Sample

This research was carried out in the district of Guarda in the elementary schools, which cover grades 1-4, referred to as the the first cycle of basic education (*1st CEB*, in Portuguese). The sample is drawn on the teachers at these schools, selected by the probabilistic sampling method, with the technique of cluster sampling.

The study sample consists of 85 participants, of which 77 (90.6%) were female (Mo = 1) and 8 (9.4%) male. The average age of the sample was 48.36 years (SD = 6.44), ranging between the ages of 30 and 61. In this sample, 80 (94.1%) have a degree or the equivalent, 2 (2.4%) have a Masters and 3 (3.5%) did not answer (Mdn = 1, IQQ = 0). Among these teachers, the average service time is 24.28 years (SD = 7.13), with a minimum of 4 (four) and maximum of 31 years experience.

4.2 Instrument

On the grounds of the need to assess the scientific knowledge level of citizens, the first studies to measure scientific literacy emerged in the late 50s, and later in the 70s of the last century. These early studies were carried out in the U.S.A. by the National Science Foundation. A decade later, the European Commission published its first findings on the scientific literacy of its European citizens. From that first publication to this day, the results of various editions of this study have been presented, including the most recent edition, the "level of knowledge – Special Eurobarometer/Wave 340 73.1. – TNS Opinion and Social questionnaire" (Eurobarometer, 2010). The Eurobarometer is a methodological instrument designed to determine the degree of scientific knowledge and its correlation with the Science attitudes/interests (Durant, 2003) that is used to then analyse the perceptions of European citizens about S&T (Irwin and Michael, 2003). Using a similar Likert scale, for this study, six topics, translated into Portuguese, were used from the latest edition of the "level of knowledge – Special Eurobarometer/Wave 340 73.1. – TNS Opinion and Social questionnaire" (Eurobarometer, 2010).

4.3 Procedure

This work was based on a non-experimental, exploratory study which began with a review of the literature, which served to define the research objectives, research questions, the sample and the testing instrument. The instrument validity was assured by the selection of a questionnaire that had been previously applied (Eurobarometro, 2010; Ferreira, 2004).

Having determined these aspects,, the teachers at the sampling of 18 schools from the 14 counties of the district of Guarda were contacted by snail mail and, later, by telephone. After this initial contact, a researcher went to each of the institutions to deliver and, later, pick up the completed questionnaires. Participants responded independently to the questionnaires without the presence of the researcher.

The data collected was coded and processed statistically, using IBM SPSS Statistics Standard ®, which gave rise to the results presented in the next section.

5. ANALYSIS AND DISCUSSION OF RESULTS

In this section, the results are revealed and discussed, paying close attention to the research questions and the hypotheses of section 3.

5.1 Degree of Interest in S&T topics

From table 1, 78.8% of the sample are "Very Interested" and only 21.2% are "Moderately Interested" in Environmental Problems (with the median and the mode at 1 – "Very Interested"). Also noteworthy is the topic New Medical Discoveries, where (43.5%) reported being "Very Interested" in this subject, contrasting with the majority (56.5%), who reported being "Moderately Interested" (corresponding to the median and the mode at 2 – "Moderately Interested").

Table 1 – Degree of Interest

	1 Very Interested	*2 Moderately Interested*	*3 Not Interested*	*4 Don't Know*
Environmental Problems	78.8%	21.2%	-	-
New Medical Discoveries	43.5%	56.5%	-	-
New S&T Discoveries	37.8%	58.8%	2.4%	1.0%
Sports News	4.7%	54.1%	35.8%	5.4%
Art and Culture	25.9%	69.4%	3.5%	1.2%
Politics	8.2%	64.7%	22.4%	4.7%

In the other side, for the topic Sports News, although most responses were "Moderately Interested" (with the median and mode at 2 – "Moderately Interested" as well), another 35.8% responded that they were "Not Interested". This result may be due to the fact that a high number of teachers were female and therefore, in Portugal, culturally less predisposed to follow the Sports News.

5.2 Degree of Information acquired through the Media

From table 2, the degree of information acquired through the media on the topic Environmental Issues (28.2%) is the highest, followed by the topics Sports News (19%) and Politics (18.8%). Nevertheless, almost all the responses for the topic Environmental Issues as "Very Informed" or "Moderately Informed" (both the median and the mode are at 2 – "Moderately Informed"). And once gain, the topic Sports News presents a dissonant result, with 26.4% responding that they "Don't Know"..

Table 2 – Degree of Information

	1 Very Informed	*2 Moderately Informed*	*3 Not Informed*	*4 Don't Know*
Environmental Problems	28.2%	70.6%	1.2%	-
New Medical Discoveries	2.4%	92.9%	3.5%	1.2%
New S&T Discoveries	4.8%	90.5%	4.7%	-
Sports News	19%	53.6%	-	26.4%
Art and Culture	8.2%	82.4%	9.4%	-
Politics	18,8%	69,4%	8,2%	3,6%

The fact that the responses are similar for different subjects can be explained by the fact that these teachers, perhaps in a subconscious attempt to hide their own knowledge gaps, have responded in a "socially acceptable way (Felt, 2005), whereby teachers tend to respond "comfortably", in accordance with the normal standards of society.

5.3 Degree of Engagement in S&T discussions and meetings

For the Degree of Engagement, based on the results from Table 3, the degree of teacher engagement with S&T is stronger when they deal with donations, with 4.7% responding that they regularly donate to research. Nevertheless, the statistical results are poor, with the median and the mode at 4 – "Never", which corresponds to "Never Donates". The result for making donations was quite surprising due to the poor economic situation which makes it difficult to donate at all lack of cultural environment to donate to scientific subjects; these results may be explained by the way the question was framed in the field of medicine, which in turn is related to health. As for the other questions, the median (2 – "Occasionally") reflects a higher degree of engagement for signing petitions or attending meetings, although the respective mode is 3 – "Rarely".

Table 3 – Degree of Engagement

	1 Regularly	*2 Occasionally*	*3 Rarely*	*4 Never*
Do you make donations to research in the field of medicine?	4.7%	23.5%	21.2%	50.6%
Do you sign petitions or participate in demonstrations on nuclear power, biotechnology or the environment?	2.4%	20.0%	32.9%	44.7%
Do you attend meetings or debates on Science and Technology?	1.2%	24.7%	49.4%	24.7%
Are you part of any non-governmental organization which deals with issues of Science and Technology?	-	1.2%	15.3%	83.5%

These results suggest a reduced degree of S&T teacher engagement, just showing an occasional engagement when making donations or attending discussions/meetings on S&T. This fact is of particular importance for the social actor who has a mission to promote/foster this same engagement in S&T students. With this marginal participation in S&T, the production of S&T transmission mechanisms among students will be heavily conditioned.

5.4 Degree of Interest in S&T topics versus Degree of Information acquired through the Media

Given the importance of the promotion/dissemination of scientific knowledge through the media, it is essential to assess the existence of a correlation between the interest in a particular topic of S & T and the information gained on this issue through the media. This idea stems from the following research question and hypotheses underlying the research, which are presented in table 4:

Table 4 - Research Question, Research Hypothesis, Null Hypothesis (H_0) and Alternative Hypothesis (H_1)

Research Question 1	Research Hypothesis	Null Hypothesis (H_0)	Alternative Hypothesis (H_1)
Is the degree of interest of elementary school teachers in issues of S&T related to the degree of information acquired through the media on these same topics?	The degree of interest of elementary school teachers in issues of S&T is related to the degree of information acquired through the media on these same topics.	***There is no association*** between the degree of interest of elementary school teachers in issues of S&T and the degree of information acquired through the media on these same topics.	***There is an association*** between the degree of interest of elementary school teachers in issues of S&T and the degree of information acquired through the media on these same topics.

For each of the S&T topics (Environmental Problems, New Medical Discoveries and New S&T Discoveries), Spearman's Correlation Coefficient was calculated. The selection of this test was based on two factors: i) the research question points to an association test; and ii) the following variables are ordinal – the degree of interest and the degree of information (Martins, 2011). The results of the application of Spearman's Correlation Coefficient, for each of the topics, were as follows:

Table 5 – Spearman's Correlation Coefficient for S&T topics

Theme	Correlation Coefficient	Sig. N (2 extremities)	N
Environmental Problems	0.228	0.036	85
New Medical Discoveries	0.163	0.135	85
New S&T Discoveries	0.198	0.071	85

The combination of the results of Spearman's correlation coefficient (table 5) with the Statistical Decision (table 6) has shown that there is a significant positive correlation between the degree of interest and the degree of information acquired, through the media, on the part of elementary school teachers for **Environmental Problems**, where r_{pb} =0.228 and p = 0.036. In contrast, there is no correlation between the degree of interest and the degree of information acquired, through the media, on the part of elementary school teachers for **New Medical Discoveries**, where r_{pb} = 0.163 and p = 0.135. However, **New S & T Discoveries** showed a marginally significant positive correlation between the degree of interest and the degree of information acquired, through the media, on the part of elementary school teachers.

Table 6 – Statistical decision (Martins, 2011)

	If $p < 0.05$	**If $p > 0.05$**	
Null Hypothesis (H_0)	Reject	Accept	
Alternative Hypothesis (H_1)	Accept	But $p < 0.10$	But $p > 0.10$
Conclusion	*Statistically significant results*	*Marginally significant results*	*No significant results*

5.5 Degree of Engagement in S&T discussions and meetings vs. Degree of Interest in S&T topics

As follows from the above results, the degree of engagement of elementary school teachers in S&T is virtually non-existent except for participation in meetings or discussions about S&T. Given these results, Research Question 2 and the underlying research hypotheses on participation in S&T discussions and meetings is the focus of table 7.

Table 7 – Research Question, Research Hypothesis, Null Hypothesis (H_0) and Alternative Hypothesis (H_1).

Research Question 2	Research Hypothesis	Null Hypothesis (H_0)	Alternative Hypothesis (H_1)
Is the degree of engagement of elementary school teachers in S&T discussions and meetings related to the degree of interest in S&T topics?	The degree of engagement of elementary school teachers in S&T discussions and meetings is related to the degree of interest in S&T topics.	***There is no association*** between the degree of engagement of elementary school teachers in S&T discussions and meetings and the degree of interest in S&T topics.	***There is an association*** between the degree of engagement of elementary school teachers in S&T discussions and meetings and the degree of interest in S&T topics.

The results of the application of Spearman's Correlation Coefficient, for each of the topics, were as follows:

Table 8 – Spearman's Correlation Coefficient for S&T topics.

Theme	Correlation Coefficient	Sig. N (2 extremities)	N
Environmental Problems	-0.003	0.982	85
New Medical Discoveries	0.245	0.024	85
New S&T Discoveries	0.175	0.109	85

The combination of the results of Spearman's correlation coefficient (table 7) with the Statistical Decision (table 6) has shown that there is a significant positive correlation between the degree of engagement of the elementary school teachers in S&T discussions and meetings and the degree of interest in **New Medical Discoveries** r_{pb} = 0.245 and p = 0.024. In contrast, there is no correlation between the degree of engagement of the elementary school teachers in S&T discussions and meetings and the degree of interest in **New S&T Discoveries**, r_{pb} = 0.175 e p = 0.109 and **Environmental Problems,** r_{pb} = -0.003 e p = 0.982. This last result stands out because the topic **Environmental Problems** did very well in the Degree of Interest, implying that, when teachers are so well informed, this can be a cause for less engagement in discussions and meetings.

5.6 Degree of Engagement in S&T discussions and meetings vs. Degree of Information acquired through the Media

Following the same line of thought of the previous point, Research Question 3 is presented with the underlying research hypotheses on participation in discussions and meetings in S&T (table 9).

Table 9 – Research Question, Research Hypothesis, Null Hypothesis (H_0) and Alternative Hypothesis (H_1)

Research Question 3	**Research Hypothesis**	**Null Hypothesis (H_0)**	**Alternative Hypothesis (H_1)**
Is the degree of engagement of elementary school teachers in S&T discussions and meetings related to the degree of information on S&T topics acquired through the media?	The degree of engagement of elementary school teachers in S&T discussions and meetings is related to the degree of information on S&T topics acquired through the media.	***There is no association*** between the degree of engagement of elementary school teachers in S&T discussions and meetings and the degree of information acquired on S&T topics through the media.	***There is an association*** between the degree of engagement of elementary school teachers in S&T discussions and meetings and the degree of information acquired on S&T topics through the media.

The results of the application of Spearman's Correlation Coefficient, for each of the topics, were as follows:

Table 10 – Spearman's Correlation Coefficient for S&T topics

Theme	**Correlation Coefficient**	**Sig. N (2 extremities)**	**N**
Environmental Problems	-0.155	0.157	85
New Medical Discoveries	-0.002	0.987	85
New S&T Discoveries	-0.036	0.793	85

The combination of the results of Spearman's correlation coefficient (table 10) with the Statistical Decision (table 6) has shown that there is no correlation between the degree of engagement of the elementary school teachers in S&T discussions and meetings and the degree of information acquired through the media about **Environmental Problems** (r_{pb} = -0.155 and p = 0.157) **New Medical Discoveries** (r_{pb} = -0.002 and p = 0.987) and **New S&T Discoveries** (r_{pb} = -0.036 and p = 0.793). These results show clearly that there is no association between the information acquired through the media and the teachers' engagement in discussions and meetings. We can also infer that, as they are very different activities in that engagement needs more action from the teacher than the mere acquisition of information. Similarly, they can point in opposite directions, giving negative correlations; the more the teacher is informed, the less they will participate in S&T discussions and meetings.

5. CONCLUSIONS

The focus of this research has been the elementary school teacher as a social and cultural actor. The results indicate that it is a group of teachers who reveal a moderate interest in S&T topics and a considerable amount of interest in topics involving environmental issues. The prominence of this interest is not surprising, since over the past few years the educational policies have focused considerably on environmental sub-topics, such as global warming and greenhouse gases, recycling, and ecosystem conservation. The existence of a significant positive correlation between the degree of interest in environmental problems and the degree of information acquired through the media on the same topic leads to the conclusion that the repeated incidence of this topic in the media serves to increase the teachers' interest.

The results for the New Discoveries in S&T topic were lower than the results obtained for Environmental Problems, which reveals that, if the educational agents develop further educational policies focused on S&T topics (such as lifelong learning, specific plans for the teaching of science, and S&T issues that range across different areas of knowledge) combined with media promotion/dissemination strategies, the values may, in the future, be more in line with those obtained for the subject Environmental Problems. Although the sample is constituted by a group of teachers with extensive experience in teaching, these teachers revealed a degree of engagement far short of what would be desired. It seems that the more informed they are, the less are they motivated to engage in S&T discussions and meetings.

6. FUTURE WORK

Given that teacher involvement in S&T is a result of their social and cultural interaction in society, it is vital that a social network be created that generates a multiplicity of homogeneous materials in the form of a multiple-entry network, open to new participants who may be connected in unique and unexpected ways, leading to new lines of action-reaction (Melo, 2011). This network should attract teaching peers, training institutions, and social agents which, together, create an "identity" which would give teachers a stronger handle on a world characterized by increasing diversity in developing countries, globalization, rapid changes in science and technology and the erosion of the traditional notion of the Nation-State. Finally, the creation and development of this network will solidify scientific knowledge for teachers and, thus, optimize the educational component of this social actor who can promote and develop scientific literacy in today's changing world.

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