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THE ROLE OF SCIENCE CURRICULA IN THE EXCLUSION OF CHILDREN FROM SCIENCE: PRESENTING THE GREEK CASE

[a]Anastasios SIATRAS, [b]Panagiotis KOUMARAS & [c]Fanny SEROGLOU

[a]Ed.D. Candidate, School of Education, Aristotle University of Thessaloniki, E-mail: asiatras@auth.gr

[b]Professor, School of Education, Aristotle University of Thessaloniki, E-mail: koumaras@eled.auth.gr

[c]Assistant Professor, School of Education, Aristotle University of Thessaloniki, E-mail: seroglou@eled.auth.gr

Abstract

In this paper we focus on the role of science curricula in the exclusion of pupils from science. Many researchers in the field of science education support that science curriculum development in many countries is based on educational practices which have nothing to do with children's interests, expectations and everyday life. Thus science courses appear to pupils not only boring but also detached from the real world. Science courses aim to educate pupils in a variety of "foreign" situations, using a terminology and a content (scientific theories, techniques, methods, terminology, symbols and formulae) that is neither familiar nor useful. Thus, pupils do not actively participate in science courses, and are indirectly "pushed" by the existing educational policy to scientific illiteracy leading to future citizens easier to manipulate. To obtain a scientific way of thinking, critical thinking and argumentation skills for dealing with scientific, political and environmental issues is important for pupils acquiring a socio-scientific understanding of the world around them. In this paper we use the SCAN (Science Curriculum Analysis) research model that we have developed in order to examine the Greek science curriculum. This analysis model focuses on four dimensions related to: a) knowledge, b) student practices, c) educational practices and d) social practices. We have already used this research model to analyze the Greek science curriculum. The PISA 2006 research results present Greece as a country with a high impact of students' background on their science performance. In other words, in Greece, pupils have more opportunities to succeed in science when they are coming from high socio-economic backgrounds. This fact has been the starting point of our analysis. The first findings of SCAN analysis of the Greek science curriculum support the idea that this science curriculum has a significant role in the exclusion of pupils from science. Goals within the science curriculum are mostly related to the hard core of scientific knowledge which referred to the academic world of science and appear isolated from everyday reality not welcoming pupils to science but rather excluding them from learning, understanding and enjoying science.

Keywords: science curriculum, social exclusion, educational policy

INTRODUCTION

A number of scientists have been referring to science as fact-based knowledge. Within this context a fundamental feature of science is that science deals solely with scientific facts and not with human values. Furthermore, science is seen as objective, certain and permanent knowledge

(Allchin, 1999). A different approach to science is based on the communication among different cultures, informed, creative and critical citizens who will be able to make decisions on contemporary social, cultural and environmental issues (Aikenhead, 1990; Bybee, 1997; Fensham, 1997; Seroglou, 2006). The socio-cultural approach to science takes into consideration the citizens' independent and critical thinking skills, their willingness and capability in teamwork and relies on continuous information exchange and individual creativity (AAAS, 1989; NCEE, 1983; NSTA, 1982; OECD, 2007). From this perspective, science is understood as the interaction of the scientific, social and cultural features of society.

The slogan 'Science for All' has been used in many countries for a long time (Brock, 1996). The accumulation of this idea has turned it into a powerful message and many countries around the world, one after another, changed their curricula to make the slogan a reality (Jenkins, 1999). The reason behind this change is that the world is entering a new era of renegotiating the financial relationships among countries and the free market under the umbrella of modern capitalism.

In the 19th century the conservative politicians in the United Kingdom argued that schooling for the working-class children (Cook-Gumpez, 2006) and the quality of content of science curricula (Hodson and Prophet, 1994) could turn out to be a risk for the upper class. In reality, they were concerned that the science curriculum of that time was more directly linked to the daily life of children having lower socio-economic backgrounds. Because of this, science curricula were tuned to the needs of the upper-class. Curricula became more compatible to the expectations of upper-class education which could afford – literally moneywise and metaphorically timewise – to acquire the knowledge of 'pure' science and exclude everyday life science. The term of 'pure' science describes situations which referred exclusevily to the academic world of science. The notion of schooling continued to change throughout the 19th century as well as the first half of the 20th century by being separated from children's daily life. As a result teaching and learning science within the school environment became an important cultural aspect only for a few who could actually afford their own education. In other words, schooling and scientific knowledge – which was communicated through education – were structured based more on the notion of upper/lower social classes (Cook-Gumpez, 2006). Thus, skills and competencies in science education aimed to the progress of the economic and social status of students individually (Soltow and Stevens, 1981) in the context of teaching concepts of 'pure' science. In other words, the goals of science education did not include the advancement of the community or the general welfare.

THE INTERRELATION BETWEEN SCIENCE EDUCATION AND SOCIAL EXCLUSION

Research in the field of science curricula has shown that curriculum development leads to a "guided" education and tends to develop easily manipulated citizens (Hodson and Prophet, 1994) regardless whether curricula are based on educational practices which have nothing to do with the daily experience of children (Millar, 1981) or on teaching science without any theoretical background (Jenkins, 1999). Moreover, in our time the restructuring of capitalism creates new conditions which encourage the exclusion of children from education generally and from science education in particular. Rifkin (1995, 2005) argues that modern capitalism is completely different from what we have known it to be so far. The principles of traditional employment, the purchasing of goods and property ownership have been replaced by newly formed, more important ideals such as access to education. Therefore, teaching students 'pure' science and lab-oriented knowledge can be seen as an action of denying them access to the scientific knowledge which is important for their future life, because it generates the abhorrence of students towards science and results to excluding them from the understanding of the world around them.

A critical discourse within the field of scientific literacy has been developed in order to confront students' exclusion from learning and understanding science (Hodson 1994; 1999; Hodson and Prophet 1994; Millar, 1981; Roth and Calabrese-Barton, 2004; Seroglou, Koulountzos and Siatras, 2011). Hodson (1994) supports that the politicization of science education could be a solution. He proposes a four-level model for the deconstruction of science understanding as a rigid and matter-of-fact knowledge. Within this framework science is seen culturally and technologically interrelated with society and tries to reveal the links of science education with the increasingly complex and powerful features of society. Through the politicization of science education students as future citizens will be able to develop their own views concerning science and be prepared to take action in a scientifically/technologically rich environment.

Figure 1: Vicious circle of the reproduction of the social power by the dominant group

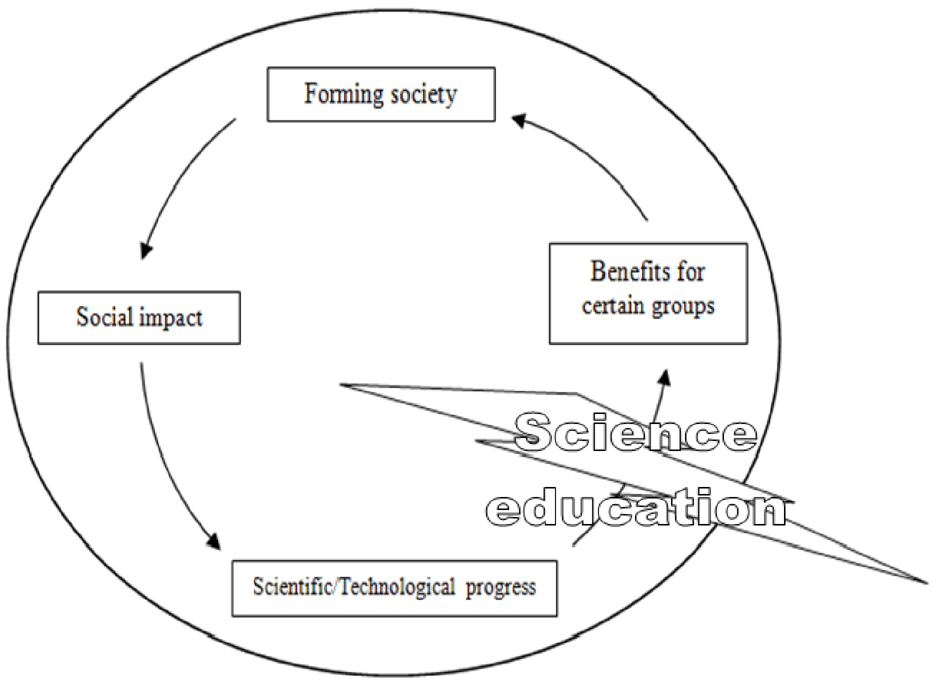

Figure 1 shows how the reproduction of social power works against socially excluded groups. The scientific and technological progress in our society benefits certain groups only; namely the ones that are comfortably settled in a wealth of opportunities. These benefits are highly empowering and as a result these groups can determine the way society is organized through their great impact on it. However, the benefit of scientific literacy is that it enables socially excluded groups to equally participate in the forming of society just like the privileged groups do. Specifically, through scientific literacy students are not only able to develop their critical thinking by learning science but really act in the frame of decision making as informed citizens and communicate their understanding on important environmental or political issues. In other words, students will be able to realize the values reflected on the scientific and technological progress in order to break up the vicious circle of the reproduction of social power by the dominant group.

PRESENTING THE RESEARCH MODEL

In order to research the broader aims and specific goals of science curricula we have developed a Science Curriculum Analysis model, also known as SCAN model, which focuses on four dimensions related to knowledge, student practices, educational practices and social practices.

Table 1: The SCAN research model

Knowledge	1. Cognitive dimension 2. Meta-cognitive dimension 3. Emotional dimension
Student practices	1. Collection, elaboration, and exchange of information 2. Problem solving 3. Attitudes
Educational practices	1. Learning theories 2. Teaching methods 3. Methods of assessment
Social practices	1. Social values 2. Social impact 3. Collaboration / Teamwork

a) Knowledge

Within knowledge there is the cognitive dimension of science. We examine scientific symbols, models and terminology as well as the science concepts included in science curricula. In the meta-cognitive dimension we concentrate on curriculum goals which encourage pupils to reflect on and control their own learning activities. In the emotional dimension goals are examined which are related to the development of pupils' interests and motives that affect both their attitude towards learning science as well as their attitudes on socio-scientific issues that derive from the content of science curricula (Seroglou and Koumaras, 2001).

b) Student practices

In the student-practices dimension we examine science curriculum goals which are interrelated with the teaching of the method of collecting, evaluating, sharing and recycling information in order to build the character of students as future citizens and reinforce their problem-solving skills.

c) Educational practices

With the term 'educational practices' we refer to the deeper level of the curriculum design. Our analysis within this context is concentrated on the educational tools that have been used to design a science curriculum such as the factors of learning methods e.g. whether a teacher-centered model is proposed for the science classroom or whether teachers should award students quantitatively or by assessing their overall performance.

d) Social practices

In the last dimension of the SCAN research model we aim to analyze the social impact of science curricula. In this dimension we categorize curriculum goals which aim to produce responsible and thinking citizens, by highlighting the affinity of critical thinking to all scientific, social and cultural domains. In other words, we examine whether science curricula include goals for the advancement of the modern society.

PRELIMINARY FINDINGS

Examples of science curricula which include topics related to teaching of 'pure' science and lab-oriented knowledge can be found in many contemporary educational reforms. After analyzing the Greek science curricula with the SCAN model we found that the curricula for the fifth and sixth grades of the primary school fall in this category. These science curricula were developed in 2002 and have been implemented to the Greek educational system for the past eight years (Ministry of National Education and Religious Affairs, 2003).

Eleven- and twelve-year-old students in Greece are expected to memorize specific matter-of-fact knowledge focusing on hands-on or laboratory situations. Furthermore, many goals are related to specific information, theories, methods and techniques paying attention solely to cognitive skills.

Specifically, within the fifth and sixth grade (11-12 year-olds) science curriculum goals concern an advanced understanding of chemical solutions, chemical phenomena, atom theories, chemical compounds, symbols of the elements and chemical compounds, acids, bases and salts (unit about the structure of matter). Within the unit 'Movement and Force' goals are related to movement, power and pressure. The unit 'Energy' is made up of information on heat, electromagnetism, light, sound, power, energy conversion. The last unit "Human Body" describes in detail the operation of the circulatory system, the functions and parts of the digestive, hearing and vision systems, and the function of vaccinations.

Table 2: Characteristics of Greek science curricula which lead students to academic world of science

1	Definitions of natural phenomena
2	Teaching about microcosm (structure of matter) – no real world
3	Specific and lab-oriented knowledge
4	Science curriculum goals do not take under consideration the pre-existing knowledge of students

DISCUSSION

From the analysis of the goals, the specific objectives, the units and the proposed activities within Greek science curricula for the fifth and sixth grades of the primary school we come to the conclusion that Greek science curricula are based on teaching "pure" science and lab-oriented knowledge. Furthermore, science teaching is encouraged to be solely concentrated on the microcosm (structure of matter) through teaching pupils specific definitions regarding natural phenomena.

In our view this kind of scientific knowledge -which is promoted in the Greek science curricula- is extremely specific and promotes solely the education of a small group of pupils who may become future scientists, excluding the majority of student population. For example, students are expected to learn in detail all parts of the human heart, eye, ear or tooth. Furthermore, pupils are expected to go through the so-called "laboratory world" of science, doing experiments and using specific materials. It is noteworthy that broader social issues are presented in science curricula through a completely specialized approach without taking into account pupils' life and interests. In the unit "Infectious Diseases" the sixth-grade science curriculum instead of placing emphasis on the protection against infectious diseases, describes concepts such as microorganisms, the content of vaccines or components of drugs, presenting in this way a wider social issue in terms of absolute and specific "academic knowledge"; a "non-real" world for pupils.

CONCLUSION

The purpose of this paper has been to pose questions concerning the interrelation of science curricula and social exclusion. In order to achieve our aim we developed the SCAN (Science Curriculum Analysis) research model and then used it to examine the Greek science curricula. The first findings from the analysis of the Greek science curricula support the idea that the science curriculum plays a significant role in the exclusion of pupils from science. Our opinion is that these findings – even still in their preliminary form – explain the high impact of student's background in science performance. Goals within science curricula related to the hard core of science appear isolated from reality beyond school not welcoming pupils but excluding them from learning, understanding and enjoying science. The transmission from theory to practice involves several stages that the SCAN model attempts to touch upon and we hope that the future implementations of our model on a variety of national curricula will offer the chance both to improve the model as well as clearly define its dynamics in interpreting educational policies implied through science curricula.

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