BUILDING CAPACITY FOR PUBLIC UNDERSTANDING OF SCIENCE: A REPORT ON THE ROLE OF SCIENCE CENTERS [i]

Toplumun Bilim Anlayışının Geliştirilmesi:
Bilim Merkezlerinin Rolü Üzerine Bir Değerlendirme

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Abstract:

There is a growing need in the world for the proficiency in core competencies for public understanding of science. However, decision makers and public often lack access to information, knowledge and skills to engage in informed decision making regarding socio-scientific issues; besides, settings typically lack infrastructure to support such activities. This paper aims to explore and describe the critical factors and dynamics in science centers' strategic initiative to develop capacity for the improvement of public understanding of science and its core competencies regarding national and international standard practices.

Keywords: *Science centers, public understanding of science, socio-scientific issues*

Öz:

Bilim eğitiminin en önemli amaçlarından biri olan toplumun bilim algısının geliştirilmesi ya da toplumda bilimin daha iyi anlaşılabilmesi için gerekli bilgi ve becerinin artırılması dünyanın birçok ülkesinde tartışılan bir konu haline gelmiştir. Ancak alanda yapılan çalışmalar, karar mercilerinin ve toplumun bu konuda bilgi ve becerilere ulaşmada zorluklar yaşadığını ortaya koymaktadır. Özellikle toplumu ilgilendiren bilimsel konularda (sosyo-bilimsel konular), toplumu oluşturan bireylerin karar verme becerisinin ve bu beceriyi geliştirecek eğitim altyapısının eksikliği ön plana çıkmaktadır. Bu çalışmada, bilim merkezlerinin toplumda bilim anlayışını geliştirmede ki mevcut kapasiteleri, sahip oldukları stratejik önem ile ulusal / uluslararası arenada bilim merkezlerinin bu yöndeki tarihsel süreci ve gelişimi araştırılarak örnek bir sosyo-bilimsel konu üzerinden tartışılmıştır.

Anahtar Kelimeler: *Bilim merkezi, toplumda bilim, sosyo-bilimsel konular*

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[i] This project has been carried out since September 2012 and planned to be finished in December 2013 by the Ministry of Environment and Urban Planning, and The Scientific and Technological Research Council of Turkey. The main aim of the project is to create capacity for the risk management of climate change in urban, rural and coastal parts of Turkey and raise awareness on both the effects of and adaptation to climate change by the means of education.

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INTRODUCTION

The increasing impact of scientific and technological advances not only has positive effects on countries' economic growth but also has pervasive effects on everyday life at both individual and social levels. Along with the developments in science and technology, people have increased the quality of their life while they had increased concern about the possible adverse effects of these developments especially in terms of global socio-scientific issues, such as climate change, hunger, energy consumption, increase in population etc. The increasing concern of society on socio-scientific issues has brought the science and society dialogues forward for the sake of public understanding of science. Thus, it has been a requirement to enhance better understanding of socio-scientific issues by the public at large by means of not only schooling but also through informal learning opportunities.

There has been a rich literature offering great variety of ways to enhance public understanding of science since it has been reported several times that there is a broad interest of public in science. For example, some of the European programs now sponsor projects that give public the opportunity to discuss developments in science and technology directly with specialists (e.g. Researchers' Night Project). Wherever possible, industry and universities increase their partnership with the government in similar programs (e.g. Climate Change Awareness Project with the Ministry of Environment and Urban Planning in Turkey). However, many of the programs, such as scientific exhibitions and events that are aimed at making people better informed of science, are targeted at younger generations rather than adults. The few investigations gave insights about how people learn in informal settings like museums, science centers, zoos, aquariums, natural areas, and community organizations; and the contribution of these settings to public understanding of science.[1]

Therefore, in this report, we examined the particular contribution of science centers to public understanding of science and suggested a socio-scientific case as an example.

1. THEORETICAL FRAMEWORK

Public Understanding of Science

Public understanding of science (PUS), also known as 'public awareness of science' or recently 'public engagement with science and technology', is a term related to the attitudes, behaviors, opinions and activities that public has when interacting with scientific knowledge ('Public awareness of science', n.d.). As the

[1] Falk and Dierking, "Lifelong science learning for adults," 1063-1079.

goal of all science education efforts, PUS was generalized as a body of scientific understanding and capabilities, and it was historically described as a combination of knowledge as well as a set of scientific skills and habits of mind.[2] Nonetheless, the research on PUS reports a wide range of competing values for the appreciation of science in social contexts.[3]

The Bodmer Report manifested by the Royal Society in 1985, drew attention to the need to improve public understanding of science. In the report, PUS involves subject matter knowledge and knowledge about science. The report claims that science and society communication can only be increased by ensuring the science understanding of those who are not professionally involved in science.[4]

Realization of social progress is directly linked to the adoption of scientific understanding at all levels of modern society. Public understanding of science is considered as an essential component of a democratic society, supporting a modern science and technology-based life and economy. It brings benefits to individual decision making and also to democracy in a more general sense. It uses the knowledge, skill and enthusiasm of the public to help make the decision and recognizes that the public have a significant role to play. In particular, the ability to keep updated about current events in political science and to actively participate in the decision making mechanisms in a scientifically and technologically advanced society, has been deemed an essential goal of society.[5] However, most studies attempting to measure public general knowledge and understanding of science and technology conclude that the public is largely scientifically disinterested and illiterate.[6] This result can be attributed to the limitation of assessment scales but another probability is the inefficiency of the informal educational programs aimed at increasing PUS.

Here, in this report, we are specifically interested in the role of science centers as informal learning settings in promoting public understanding of science.

2. THE ROLE OF SCIENCE CENTRES IN PROMOTING PUBLIC UNDERSTANDING OF SCIENCE

According to Hooper-Greenhill, the construction of science centers is directly related to public understanding of science. The declaration made in the Copenhagen

[2] Brown, Reveles and Kelly, "Scientific literacy and discursive identity," 779–802.

[3] Tytler, "Dimensions of evidence, the public understanding of science and science education," 815-832.

[4] Ryder, "Identifying science understanding for functional scientific literacy," 1-44.

[5] Schibeci, "Reading, 'riting and 'rithmetic," 324-325.

[6] Bauer, Allum and Miller, "What can we learn from 25 years of PUS survey research," 79–95.

Declaration defines science centre "as a non-profit making permanent institution, in the service of the society and its development and open to the public, which acquires, conserves, communicates and exhibits, researches for the purpose of study, education and enjoyment, material evidence of men and his environment". Science centers provide necessary conditions or environment in which the visitors experience learning and all the elements necessary for promoting learning are present.

The prior aim of science centers is to contribute to public understanding of science through science education[7] by means of several learning opportunities offered to public. In this sense, science centers have been established in order to inform individuals about scientific developments and popularize science. Among the diverse purposes of science centers, there is the goal of introducing widely accepted scientific principles and reinforcing understanding of the philosophy of science.[8] All of the experiences in a science centre provide the visitors to look at the world with the perspective of a scientist, disseminate the seeds of scientific thinking, and give the audience's sympathy towards science and technology. Therefore, these centers have been attractive venues for learning science because of their explicit attempt to represent science through interesting, interactive and educative activities for all people regardless of their age or educational background.[9] In particular, adults seem to use these settings to fill their leisure time, to build identity, as a way of improving oneself either personally or professionally and as places to pursue hobbies and continue learning in personally meaningful ways.[10] If science is a way of understanding the world we live in, the important role science centers play in communicating science with the public is worth considering.

The first known science centre was Hellenistic Institute of Alexandria first established in 283 B.C. After that, at the end of the 18th century, the Louvre in Paris was the first public centre established as part of the state education system. In this process, these are the two notable events in world history of science. Then after, science centers have evolved through history in terms of institutional structures, content of facilities and purpose. Approximately 2,400 science centers have been established in the world and approximately 290 million people visit these centers every year.[11] It is the responsibility of the science centers, apart from other functions, to impart education through exhibition to the masses regardless of their educational background.

[7] Medved and Oatley, "Memories and scientific literacy," 1117-1132.

[8] Rennie, "Learning science out of school."

[9] Falk and Dierking, "Lifelong science learning for adults: The role of free-choice experiences," 1063-1079.

[10] Persson, "The Totonto Decleration," Accessed May 20, 2012. http://www.5scws.org.

[11] [11] TÜBİTAK,*"Bilim Merkezleri,"* Accessed December 5, 2012 http://www.tubitak.gov.tr/sid/934/pid/461/cid/9420/index.htm.

McManus described three models of science centers beginning with first generation, which focused on collections and research, and second generation, which had a training role as well. The third generation has evolved in two ways; one is including thematic exhibitions of larger concepts and the other is equipped with "de-contextualized scattering of interactive exhibits". Today, science centers have been continuing to develop and improve in their vision as well as their institutional structures considering the demands of the society. This recent generation of science centers combines interactive exhibits and trainings with hands-on and minds-on structured activities and new pedagogical approaches in response to the learning needs of new generations. These places offer rich educational resources with training programs including individual learning areas, scientific shows, activities, games, etc. Moreover, science centers provide easily accessible places to explore the 'secrets of science'. Thus, they offer visitors opportunities to have 'understanding of science'.[12]

When we inspect countries with healthy educational, social and economic infrastructures such as EU countries and the USA, the fact that science centers exist, and continue to adapt and thrive over time in these countries. Reversely, the community values scientific research and education – and sees how science is important in daily life.

Due to the crucial role of science centers in the society, supporting these places is perceived as a social responsibility all over the world as well as in Turkey. In order to investigate the history of science centers in Turkey, it is rational to begin from museums. Science centers are evolved from science museums in the process of Turkish educational system. However, the concept of "museum education" comes up more frequently in Turkey after the 1990s; the history of museum education extends until II. Constitutional. In 1868, a school museum was first established in Galatasaray High School which stressed the need for the use of the museum as a medium of learning and information. After that, school museums were opened in elementary and high school in Bursa in 1930, and again continued to be established between the years 1980 and 1990.[13] The Ministry of Education worked hard on behalf of expanding and strengthening education in museums. Some of these efforts are educational programs that stressed on the importance of museum education, such as Ataturk Education Museum, museum education seminars and workshops for teachers between 1996 and 1998.[14] Educational activities in museums came to the fore with the archaeological museums, private museums and science centers.

[12] Yu, "The National Science and Technology Museum of Taiwan," 107-113.

[13] Paykoç, "Türkiye'de Müze Eğitimi Uygulamaları: Tarihçe ve Örnekler."

[14] Paykoç, "Türkiye'de Müze Eğitimi Uygulamaları: Tarihçe ve Örnekler."

The concept of museum specializes as science centre in the leadership of Feza Gürsey Science Centre which is established on 23 June 1993 in Ankara. Then after, Rahmi Koç Museum in Istanbul, Child Universities in Ankara, Science Centers in Gaziantep, in Eskişehir, Istanbul Universities and Istanbul Technical University's science centers are established as good examples for the recent generation of science centers, where visitors are engaged in interactive learning sessions and experience science by hands-on and minds-on activities. The main aim of these science centers is to contribute to the formal education students have in their school. In time, these centers also adapted goals, as is the case in the world, to serve the larger public in order to promote life-long learning, to attract people from all ages to the world of science and develop positive attitudes towards science and technology. However, to what extent these aims are achieved by these science centers as well as to what extent the larger public is aware of the aims of these centers are still open to research.

Falk, Martin Storksdieck, and Dierking concluded that informal experiences such as reading out of schooling, going to museums, interacting with others, and the use of Internet are the mechanisms by which the public seek and acquire science understanding. Falk and Needham assert that, "Science learning is rarely, if ever, instantaneous. Individuals typically acquire an understanding of scientific concepts through an accumulation of experiences from different sources at different times. An individual's understanding of the physics of flight, for example, might represent the cumulative experiences of completing a classroom assignment on Bernoulli's principle, reading a book on the Wright brothers, visiting a Science Centre exhibit on lift and drag, and watching a television program on birds. All of these experiences are combined, often seamlessly, to construct a personal understanding of flight; no one source is sufficient to create neither understanding, nor one single institution solely responsible."

In their research, Falk and Needham point out to the relationship between public perceptions of science understanding and visits to the science centre. They claim that individuals who had visited science centre, which is California Science Centre (CSC), were more likely to feel informed about science, and they tend to visit the centre more than once. They back this result by the fact that a large number of adults who visited this specific science centre, including minority and lower income adults, believed that they had important learning opportunities both for themselves and their children.[15]

In this report, we propose that science centers, when enriched with variety of learning opportunities also targeting adults along with younger generations, can promote public understanding of science as in the example of CSC. As part of

[15] Falk and Needham, "Measuring the impact of a science centre on its community," 1-12.

learning opportunities, we suggest the use of socio-scientific issues as learning cases to draw attention of larger public. In the following, we reinforce our claim about socio-scientific cases and provide an example of such a case.

3. UTILIZING SOCIO-SCIENTIFIC ISSUES TO FOSTER PUBLIC UNDERSTANDING OF SCIENCE

Socio-scientific issues (SSI) have emerged recently as the social dilemmas arose as a result of the advancements in science and technology.[16] SSI are defined as the issues that are 'based on scientific concepts or problems, controversial in nature, discussed in public outlets and frequently subject to political and social influences.[17] According to many researchers, SSI may improve students' scientific literacy.[18] [19] In addition, SSI movement enhances cognitive, emotional and social development of individuals, and emphasizes students' intellectual development, while also trying to provide them with emotional and social development.[20]

SSI consists of scientific claims and arguments, political, ethical and epistemological perspectives. Besides, SSI are those individuals may easily confront in their daily lives both globally and locally such as genetic engineering, environmental issues, nuclear power usage, and effects of mobile phone use.

In this sense, climate change is one of the SSI which is complex and controversial, that is, individuals may hold different viewpoints about the global climate change. Scientific evidence has shown that climate change involves major impacts on humans and is caused primarily by human activities.[21] Increase in temperature will continue for a long time even if gas emissions were to be drastically cut down due to a time lag between causes and impacts of atmospheric change.[22] Undoubtedly, increase in the greenhouse gas emissions causing changes in the climate system is one of the most prominent challenges that the humankind faces.[23]

[16] Sadler, "Informal reasoning regarding SSI: A critical review of research," 513-536.

[17] Sadler and Zeidler, "Patterns of informal reasoning in the context of socio-scientific decision making," 113.

[18] Kolstø, "Scientific literacy for citizenship: Tools for dealing with the science dimension of controversial socio-scientific issues," 291-310.

[19] Sadler, "Informal reasoning regarding SSI: A critical review of research," 513-536.

[20] Topcu, "Development of attitudes towards socio-scientific issues scale for undergraduate students," 51-67.

[21] Environment Agency, "Floods in the South West: The story of Winter 2000."

[22] Wigley, "The climate change commitment." 1766-1769.

[23] Schreiner, Henriksen and Hansen. "Climate education: Empowering today's youth to meet tomorrow's challenges," 3-49.

According to Matkins and Bell, although the idea that global climate change has occurred due to human actions is treated as empirically proven by many researchers, the literature on global climate change reveals that this idea is tentative (e.g. Lindzen, 1999). Besides, climate change is one of the most up-to-date issues that is largely debated on the media and international agencies. Politicians try to find out ways to decrease the greenhouse gas emissions both locally and internationally.[24] For instance, there is still a discussion about the acceptance of Kyoto Protocol showing that climate change is one of the most controversial issues in the international arena.[25] Therefore, about such an important issue, individuals should generate their own views to find solutions and hold their own perspectives to participate in political debate as a part of the society they live in.

Through science education, new generations would be more knowledgeable and aware of the controversial science-related social issues as climate change. This arise the need for adaptation to, as well as mitigation of, climate change. To this end; government and public should take action together toward climate change for both adaptation and mitigation. However, the public is not aware of the need for wider collective and individual responsibility and involvement in responding to climate change. Responsibility toward environment is the first step for approaching environment in a friendly manner. If an individual recognizes the crucial role of his/her responsibility on environmental issues, he/she is expected to gain environmental friendly behavior spontaneously. Referred spontaneous action can be acquired step by step within the context of a science centre, in a natural scientific setting. For example; a climate change gallery in a science centre, can change the way people think, talk and act about the climate change. A glimpse into the science centre's technical documents or exhibits can quickly convince people in scientists' and engineers' ability to develop the array of technical solutions that can make a sustainable future possible.

4. CONCLUSION AND RECOMMENDATIONS FOR FURTHER ACTIONS

As in the case of Kyoto Protocol, to be able to act in harmony with all other countries, it is essential that everybody, especially the decision makers, should have a minimum level of scientific literacy understanding which enables Turkey to designate its internal and external policies accordingly.

Turkey ought to be in this framework. New science centers have an extensive social task. They can play a key role in improving the public perception of science, contributing to a positive evaluation of science and its technological de-

[24] Matkins and Bell, "Awakening the scientist inside: Global climate change and the nature of science in an elementary science methods course," 137-163.

[25] Schreiner, Henriksen and Hansen, "Climate education: Empowering today's youth to meet tomorrow's challenges," 3-49.

velopments. In addition, they can stimulate the population's education about the characteristic activities and abilities of science. They can also help people to understand scientific concepts linked to the present day and propose steps for integrating them into culture.

In Turkey, science centers also play a significant role in supporting and complementing formal education. They can be visited by numerous school children every year and present aspects of science that differ in content and form from those in educational centers. Such aspects are more closely related to current affairs and interdisciplinary areas and are linked to situations involving play, happiness, and freedom of initiative.

After 1990s; The Scientific and Technological Research Council of Turkey (TUBITAK) opens a call as "Science Centre Foundation Support" and directly supports the establishment of science centers. Besides TUBITAK, universities and municipalities also supported foundation of Social and Science Centers. These endeavors also encouraged by media, non-governmental organizations and most importantly ministries. Number and diversity of science centers will increase in the next ten years due to the new policies of Science, Industry and Technology Ministry. Based on new policies, in developing countries like Turkey, the trend of creating public science centers should be supported, until there is at least one per city in Turkey. It is a fact that education is the potent instrument for human development, on which the level of all national development depends. A science centre policy has to be established so that an awareness and sensitivity are created and more and more people are attracted to science centre. This decision is expected to change the understanding of science in Turkey in the coming years.

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