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Science Teachers' Opinions on Application of Competency-Based Science Model Components to Science Programs

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ABSTRACT

The aim of this study is to reveal the opinions of teachers, who gave the science lessons that took effect in Turkey in 2004 and 2013, on the sub-components of the programs and to identify to what extent the objectives of the program have been achieved. In total 89 teachers, out of which 42 were females and 47 were males, in the study which was conducted by the semi-structured interview method. Data collected from the study, where five questions were asked to teachers, was settled by analyzing the science programs according to components of the Ohio Competency Based Science Model. While result from the study shows that the teachers were qualified to ensure the development of some behaviors that were expected to be seen on the students as a result of science programs; especially the students gave a lower level of positive opinion about the components related with how they will use this data. In addition; while the teachers supported that the scientific process skills, are one of the basic elements of science programs, were sufficient for the gain of basic skills, they stated that they are not sufficient for the gain of some causal and experimental skills.

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1. INTRODUCTION

The rapid increase in knowledge, thanks to technology supported researches, has lead to the increase and change in information towards education, learning and teaching. As a natural consequence of this situation; the curricula implemented at schools are changing or being revised. There are many reasons that effect the changes in curricula. Some of them are as follows: the changing and developing world [1], advances in technology [2],[3] differentiation of societal needs [4], social changes [5], the emergence of new information [6], globalization [7]. Each of these and other similar causes has an effect on different levels. Program development activities; which depend on the requirements towards these causes; are carried out at certain intervals. The latest four studies, which were made in our country for the improvement of science lessons curriculum, were prepared in the years 1992, 2000, 2004 and 2013.

One of the reasons for the curriculum changes made in Turkey is students' inability to reach the desired learning outcomes. When national and international test results are analyzed, it is seen that Turkish students have low success levels. In Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) exams taken by the students from several countries; the Turkish students display low performance and besides their average success level is also low in national and central exams such as Transition from Primary to Secondary Education Exam (TEOG) Transition to Higher Education Exam and Undergraduate Placement Exam (LYS) [8]-[10]. In the PISA exam held in 2003; Turkish students ranked 35th among 41 countries and in 2009, they were ranked 44 among 65 countries in

science [11]. According to the results of the TIMSS in 2011; while 4th class students ranked 36 among 50 countries, the 8th class students ranked 21st among 42 countries. Roth [12] also stated that primary school student' access levels to scientific contents and arguments remains at a very low rate. But; just looking at the exam results will not be sufficient to state that the students' achievement levels in science field or any other field are low. Considering that the educational process consists of the following steps: a) objectives and achievements, b) the content, c) teaching-learning situations, d)assessment; laying the failure on the students, who are just a part of system components, will not provide sufficient information and contribution to put forward practical and qualified solutions. Given that each dimension of the education process has an important role on success and failure; the process should be evaluated together and separately in order to ensure that the studies, which are conducted or will be conducted, give general results. The factor discussed in this study is the opinion of the teachers; who are one of the important components and practitioners of the learning-teaching process; about the failure in the science area.

Haney, Czerniak and Lumpe [13], stated that the views of the teachers are crucial for the success of curricula and important for the success of the views of teacher education programs. Because; curricula are tools prepared for the use of teachers before anyone or anything. Therefore, to what extent the program is feasible and effective is associated with the perception of the teachers on the program. Aysan, Tanrıoğen and Tanrıoğen [14] arguing that students' success is influenced by many factors; stated that teachers' behavior have a significant impact on the success or failure. Dursun and Dede [15] and Weissglass [16] also argued that the major factor affecting learning is the teacher. The extent to which the curricula are implemented by the teachers; who are an integral part of the education process in this respect; is related with the results obtained. Bumen, Cakar and Yıldız [17] stated in their study that the teachers do not exactly implement the curricula given to them and they go for changes depending on their choices and the situation in the classroom. Yamaguchi [18] stated that science teachers have to face the effects of both the changes in curricula and taught content and also the accusations related with the differences among students. Crawley and Salver [19] arguing that this is related with the nature of the profession; stated that the teachers need orientation process to adopt and use the changes in curricula.

In the last two science programs (2004 and 2013), where the teachers were given a guiding role; when the basic attitudes targeted to be acquired by the students are reviewed, it is seen that the vision is to make them gain "science literacy" [20],[21]. Depending on this vision; it is targeted that the students become science literate individuals who inquire, give effective decisions, solve problems, who are self-confident, open to communication, who can communicate effectively, who learn lifelong with sustainable development awareness; and they are expected to have an insight about the relationship between science and technology-society environment and to have psychomotor skills. The individuals with this skill are expected to use scientific process skills effectively. Also the main aim of the 2016 Project, which forms the basics of the American education system for approximately 30 years, is the science literacy of the students [22]. These aims of the last two programs in Turkey compromise with The Ohio Competency Based Science Model that is developed on the basis of The National Science Education Standards in Ohio in United States of America in 1994. This model has been established on four main components: a) Scientific research, b) scientific knowledge, and c) the conditions of learning science and c) applications for science learning. The adaptations of these components to the science and technology programs, which are still in force in Turkey, are presented in Figure 1.

This model can be considered as essential components of Science and Technology Program which was enacted in 2005 and Science Program, which was enacted in 2013 [20],[21]. Under the Scientific Research; which is the first component of this model, there are "process skills" and "mental habits". When the scope of the content emphasized in the education process and science programs are reviewed; it is clearly seen that the scientific process skills are intensely emphasized and the main approach of the study is to provide the students these skills [23]. The second dimension of the model is the "scientific information. In this model; disciplines that form the basis of the science and the dimensions of the information in these disciplines are discussed. The third dimension is all about "the conditions of science learning". Different approaches, method, technique etc. information that can be used in science learning and teaching have been covered in this dimension. The final component of the model is "applications for science learning;" and this component covers the information about for which purposes the students will use the information they learn within the scope of this course [13].

According to this model, there should be a certain content to provide specific skills to the students. As seen in the model; a scientific content should be presented in order to gain scientific process skills and other mental skills. Science programs that are still in force in Turkey in this regard are consistent with Ohio Skill-Based Science Model.

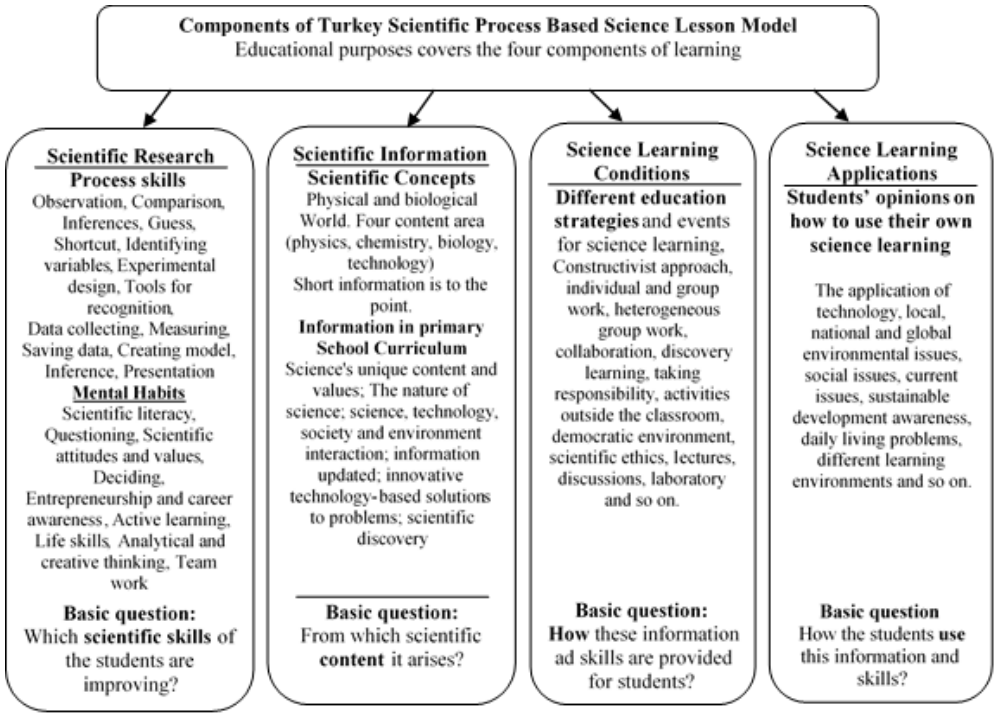

Figure 1. Components of scientific process based science lesson model

The third dimension of the model is science learning conditions and it seeks the answer to the question of how the students will be made to acquire these skills and content. The approaches and studies taken as basis for students' learning these skills match with the contemporary practices in theory. The last element of the model is related with how and where the students use the skills they gained. This element of science programs is compatible with the current literature and curricula of the developed countries.

In such educational reforms; teachers play an important role to achieve the desired goals and opinions of these teachers about reforms are the most important sources of information about the programs [24]. The aim of this study is to determine the views of teachers about science and technology they applied and science curricula and to analyze their views as per Ohio Proficiency-Based Science Model components.

2. RESEARCH METHOD

In this study; for the purpose of obtaining in-depth description from teachers through a semi-structured interview, a qualitative research method has been used. Since the focus is on the applications aimed at science programs of the teachers in the data acquisition process, study is included in scope of case study. Also since single unit of analysis has been discussed in an integrated way for their opinions teachers introduced about program applications, integrative single case pattern has been used [25].

2.1. Sample

Sample of the study is formed by 89 teachers who work at state and private primary and secondary schools and conduct science classes. 42 of the teachers are females and 47 of them are males. It has been stated that among female and male teachers, the ratio of the ones work at primary schools is 50%, whereas the ratio of female teachers work at secondary schools is 40%, male teachers is 60%. Number of form teachers who participated in the study at primary school stage is 34, at secondary stage it is 55. It has been indicated that seniority of the teachers is on average 14 years and the range value of their seniorities is 37. Seniority of the teachers work at primary schools is approximately 15 years, whereas this number for teachers work at secondary schools is 12,3.

The stages of education in Turkey are: pre-school, primary school, secondary school, high school and higher education. Among these; primary school, secondary school and high school (before 1997 it was 5; between 1997-2012 8, 2012 and after it is 12 years) are compulsory education. In order to generalize pre-school education and make it compulsory, what is aimed is to increase the number of the teachers and improve the physical possibilities [26]. Transition to secondary and higher education is carried out through

centralized exams. Most of the teachers forming the sample of this study are graduates of four-year faculties, whereas some of the teachers with higher seniority are graduates of teacher's training schools with three-year education or graduates of colleges with two-year education.

1-4th grades of compulsory education apply to primary schools, 5-8th grades apply to secondary schools, 9-12 grades apply to high schools. The educations in primary schools are performed by form teachers, secondary and high school educations are performed by field teachers. In Turkey, form and field teachers study considerably in the Faculty of Education. There are, for primary and secondary school teachers 4 years, for high school teachers 4 and 5 years of education processes. For secondary teachers since 2010, there is pedagogical formation education. Applicants with this certificate and all other teacher applicants' assignments are through Public Personnel Selection Examination.

2.2. Data Collection Tool

Opinions of the teachers about science and technology and physical sciences have been collected through semi-structured interview forms. This form is consists of two parts. The first part is the factual questions addressed to identify the demographic features of the teachers; second part is the open ended questions addressed to identify the science class applications. Questions included in the first part are composed of independent variables such as sex, seniority, schools they are graduated from which might have influences on their Professional opinions. The second part has been prepared by taking Haney, Czerniak and Lumpe's [13] studies which analyze the Ohio Competency Based Science Model established by Ohio Education Department and rearrange this model according to four basic aspects as a reference. Contents of the sciences programs prepared by Turkish Education Board of Ministry of Education in 2004 and 2013 have been analyzed through content analysis according to this model's components and codes and themes under each aspect have been revealed.

In this model; four aspects of science including scientific research, scientific knowledge, conditions of a science teacher and applications to learn science are covered. Questions have been prepared to address the elements in the four aspects of this model. These questions address the purpose of sciences, scientific process skills, necessary skills and conditions to learn sciences, positive and negative aspects faced during science applications. In order to decide whether the questions prepared as 5 questions have content validity, views of three domain experts have been taken and necessary corrections have been made based on the suggestions and interview form has been finalized accordingly. In accordance with the suggestions of the experts, 30 minutes given to the teachers to answer in written the six questions prepared on four aspects and interviews have been recorded in written format with the consent of the teachers.

2.3. Analysis of the Data

Data collected through semi-structured interviews from 83 teachers who work at primary and secondary schools have been analyzed with content analysis method [27]. Then, views of the teachers have been coded in accordance with the information related to the dimensions included in the model and these codes have been classified according to ''research, knowledge, conditions and applications'' themes, which are the four main components. The reason to use such kind of classification is reducing the units when performing content analysis will contribute to the relevance of the results [28].

Content analysis has been used while forming a master key for the data of the research. For the content analysis; stages such as forming a frame; processing the data according to thematic frame, identifying and interpreting the findings have been carried out. After research data have been coded independently by two researchers, code and theme list have been finalized. After this stage, data have been analyzed by two researchers independently from each other according to code and theme list. Cases where researchers use the same code for the explanations of the teachers are accepted as agreement; cases where they use different code are accepted as dissent. Coding has been performed through the view of the other researcher in situations where one researcher is in a contraction. Reliability of the data analysis by this way; have been calculated by using the [Agreement / (Agreement + Dissent) x 100] formula [29]. Consistency level among the coders has been observed as 87%.

3. RESULTS

In this section, content analysis results of the answers received from teachers according to science program components in Turkey are included. Four components of the program (scientific research, scientific knowledge, conditions of learning science, and applications for learning science) and two sub-dimensions of scientific research from these components (scientific process skills and mind habit) have been studied as subtitles.

3.1. Scientific research component

For the data collected for this component, separate content analysis has been carried out for two different aspects. The main question in this module is: "which scientific skills of the students will improve?" Related to this question, emphasis is put on two main features: a) Scientific process skills, b) Mind habits.

a) Scientific process skills: With the application of science technology and sciences will improve which scientific process skills in students?

Table 1 presents the result descriptive analysis result. It has been observed that, as a result of the analysis carried out, teachers think that out of the scientific process skills of students during science class, the skill improved most has been "designing an experiment". With the studies and activities carried out in science classes, the view that "recognizing of materials" and "observation" skills of the students have been developed, supported by the majority of the teachers. "Reason", "measuring" and "creating model" are scientific process skills that have been developed according to the teachers though less than the first two skills. "Comparison", "making an inference", "predicting" and "presenting" skills have been observed as the skills that have been developed by a minority of the teachers. "Estimation", "identifying of variables", "data collecting" and "data collecting" have been identified as the skills that have not been developed in science classes.

Table 1. Descriptive statistics results

Scientific process skills	f
Designing an experiment	65
Recognizing the tools-materials	48
Observation	27
Deduction	21
Setting a model	18
Measurement	14
Prediction	11
Making an inference	7
Presenting	6
Comparison	4
Identifying variables	0
Estimation	0
Data collection	0
Recording data	0

b) Mind habits: With the application of science technology and sciences will improve which mind habits in students?

Based on the scientific process skills shown in Table 2, teachers claimed that activities carried out during science classes improve '' active learning'' skills of students the most. This is followed by ''problem solving'', "scientific skill", "team work", "attitudes and values aimed at science", "questioning" "scientific literacy'' and "life skills'' have low values. Teachers also stated that science classed are not effective on improving '' analytic and creative thinking'', ''entrepreneurship and carrier consciousness'' and ''decision making'' skills.

Table 2. Analysis aimed at mind habits to be developed in students

Mind habits	f
Active learning	72
Problem solving	53
Scientific skill	28
Team work	11
Attitude and values aimed at science	9
Questioning	8
Scientific literacy	8
Life skills	4
Analytic and creative thinking	0
Entrepreneurship and career consciousness	0
Decision making	0

3.2. Scientific Knowledge Module

Which kind of scientific content science and technology and sciences programs are made of? As seen in Table 3, teachers stated that by including the students into the process, science programs encourage

students to learn (application, research, broad themes, scientific discovery), suitable for the standards of the students (student relativity, broad themes, less information is succinct, daily life, up-to-dateness, improvableness). A minority of the teachers made positive statements about the program's concreteness, attractiveness, clarity and support of technology, also finding creative solution and supporting with an entertaining content aspect has been found insufficient by many of the teachers. Furthermore, teachers claim that science and technology and sciences are not effective in connecting with the other classes.

Table 3. Analysis of the teachers aimed at the content of science programs

Characteristic of scientific knowledge	f
Application oriented	38
Student relativity	29
Broad themes	28
Research oriented	25
Less information is succinct information	22
Daily life	20
Scientific discovery	16
Up-to-dateness	14
Improvableness	14
Concreteness	8
Attractiveness	8
Clarity	7
Support of technology	6
Creative solution	3
Being entertaining	2
Connection with the other classes	0

3.3. Learning Conditions Module

How science and technology and sciences programs provide this knowledge and skills for the students? According to Table 4, science teachers agree that content of science programs they carry out in their classes are aimed at enabling students to participate in activities, discovery, improving their active participation skills. Teachers also stated that books and subsidiary books contribute to the students' learning of science. Also, the improving student's responsibility aspect of the program has been supported by 13 teachers. While it is indicated that program encourages students even slightly for teamwork and individual work; it has been stated that it has a slight contribution on especially cooperation, laboratory and technology issues.

Table 4. Analysis of the teachers aimed at the content of science programs

Learning conditions	f
In-class activities	33
Discovery	23
Active participation	21
Constructivist	17
Course material/source book	16
Responsibility	13
Team work	7
Individual work	6
Visualization	5
Subsidiary sources	5
Cooperation	5
Support of technology	4
Non-class activities	4
Laboratory/experiment	3
In-class discussion	1
Heterogeneous group	0
Democratic environment	0
Scientific ethics	0

The subjects teachers emphasize are carrying out activities more than experiments and discussions are not sufficient. All of the teachers are of the opinion that science program applications are not sufficient enough to build heterogeneous groups, providing a democratic environment and scientific ethics.

3.4. Applications Module for Science Learning

How the students use the information and skills they acquire from science and technology and science programs? When Table 5 is reviewed; it is seen that the teachers' views on how students will use the information and skills they acquired from science programs are mainly related with daily life problems. It has been stated that teachers' views that students will use this information and skills in further educational phases, solving environment programs and technological applications are supported, albeit at very low levels. One teacher from each thinks that this information may be used for solving world problems, for complying with social life and for career choices. None of the teachers stated a view that the science programs are intended to raise the ability for creating a different learning environment and raise development awareness.

Table 5. Analysis of teachers' views about how the students will use the information and skills

Use of the Acquirements	f
Daily life problems	18
Next steps	4
Environmental problems	3
Technology applications	3
World problems	1
Social life	1
Career choice	1
Different learning environments	0
Development of awareness	0

4. DISCUSSION

When the views of the teachers, who conduct the science curricula in Turkey, on the implementation of the lessons are analyzed according to Ohio Competency Based Science Model components; while it is seen that the programs are sufficient to provide some dimensions of scientific process skills, it is seen that they stated that they are inadequate to provide many of them. While the scientific process skills is a concept that arose in the 1960s; it came to the forefront in Turkey with 2000s. Especially with the science and technology program that was prepared in 2004, the improvement of these skills was specifically emphasized [24]. The teachers, who applied these programs to their classes, stated that the science studies are sufficient to acquire "experiment design, tool identification" dimensions that are in the scientific process skills dimension of science programs. Besides, the teachers stated that they are not sufficient for acquiring "identifying variables, estimation, data collection, development awareness and saving data" skills. The content of the nature of the science was examined Ozden and Cavlazoğlu [30] through the analysis in 2004 and 2013 and these two programs were stated to be insufficient for acquiring scientific process skills which is an important component of scientific literacy. Temiz and Tan [31], Bulus-Kırıkkaya [32], Oztuna-Kaplan, Cavus, Toraman and Yılmaz [33] stated in their studies that this skill cannot be acquired in science education in Turkey. Despite that, scientific process skills are intensively emphasized in science programs; there are many reasons why teachers state that most of these skills can be acquired slightly or even cannot be acquired. As a result of the negotiations, Turkmen and Kandemir [34] point out that the teachers do not have sufficient information about scientific process skills. Unsal [35], Christodoulou, Griffiths, Stevens, Gray and Denley [36] stated in their studies that the teachers didn't have self-confident in program implementation and, they didn't have sufficient qualification for teaching science. Tekbıyık and Akdeniz [37]; thought that the schools experience some problems in acquiring these skills especially due to the physical impossibilities and the intensity of the program.

About the "mental habits" dimension of the research component of the model; most of the science teachers think that the applied science programs improve mostly the active learning and problem solving skills of the students. The view that the programs are for acquiring scientific skills of the students has been supported approximately by 1/3 of the teachers. It is a remarkable situation that the programs improve "analytical and creative thinking, entrepreneurship and career awareness and decision-making skills" view is supported by none of the teachers. Very few number of teachers stated that these studies ensure "teamwork, attitude and values towards science, questioning and scientific literacy skills" acquisition of the students. Duit and Treagust [38] stated that science literacy is a significantly considered skill in 21st century but both TIMSS and PISA results indicate that these skills are not sufficiently provided to the students. In their study; Tekbıyık and Akdeniz [36] stated that the teachers think that the science lessons have positive features such as directing the students to active learning and exploring, keep them away from memorization, direct them to questioning and interpretation, and able to be used in daily life. Celep and Bacanak [39] also put forward that scientific process skills, which are one of the main emphasis of science, is effective in active learning and problem solving skills of the students. An important result of the research is that the teachers support the

idea that these upper level skills, which are brought into the forefront in science programs, cannot be acquired to the students.

In the science programs, which is the second component of the model, it has been defined that the teachers answered the question related with the extent to which the "scientific information" can be acquired mostly by stating that "directed to implementation, relativity with the student, broad plots, directed to research, brief information is to the point and the daily life skills" are acquired up to a certain level. One of the teachers supported that the science program directs the students to inter-disciplinary studies by establishing relation with the other lessons. Another point, which is remarkable here, is that teacher's support to the attention dimension of the science program is low. According to the data collected by Lewis and Leach [40] from the students at the age range 14-16; they stated that the students have limited ability to understand scientific information. For students' understanding the scientific information; it is stated that first of all they need to have a sound basis for the nature of the science [41]. In his study; Turgut [42] stated that despite students understanding the controlled experiment logic; the experiments have some illusions for the creation and testing of scientific information. This case shows that trying to provide the students upper level skills before providing some basic skills generally do not give efficient results. The results of this study support this status.

It has been stated that teachers mostly support classroom activities for the "conditions" dimension of the program that is on the third component of the model. This may be caused from the fact that there are several activities in textbooks prepared for both 2004 and 2013 science programs. 1/3 of the teachers think that science programs ensure conditions for exploring. The constructivist feature of the program is supported approximately by 1/5 of the teachers and only 5 of the teachers support that the cooperation term emphasized in the program is ensured and they stated that the heterogeneous, democratic classroom environment and scientific ethical conditions cannot be ensured. Bulus-Kırkkaya [32] also put forward that the science program is not sufficient to improve the cooperative work of students. Kubat [43], stated that the fact that the content about the achievements in the program is limited and as one achievement is related with several topics is seen as a problem by teachers; and they positively evaluate that the achievements are directly connected with the content and it is compatible with the availability level of the students.

Teachers stated a relatively low level of opinions about "applications" component, which covers the information of how students will use the information and skills they learn within the scope of the program, when compared with the other components. The most supported usage area in this component is about daily life skills. It has been identified that very few teachers given positive opinion about the environment, technology and social cases where the acquired information can be used. In the study made by Cebesoy and Donmez-Sahin [44], it has been emphasized that the number of environmental issues in the science and technology program is insufficient. It has been understood from the answers given by the teachers that science applications are quite insufficient to direct the students to different learning environments and to career selection. In the negotiations held with 14 teachers by Yıldırım and Gungor-Akgun [45]; it has been put forward that the science programs are insufficient in terms of environment-human interaction, effective participation of the students, access to information diversity, general knowledge, increasing availability, persistency; and it is at a medium level in terms of information and relating this information with daily life. While above the mentioned results indicate that their own applications are sufficient for gaining some of the goals in the science programs, teachers express negative opinions in gaining some of the goals that are mentioned often and importantly in the program.

5. CONCLUSION

Teachers have the opinion that science programs are not sufficient in including some aspects of causative and experimental stages of scientific process skills. Hence, it will be beneficial to include new contents and activities aimed at these skills that are accepted to be gained less by the teachers. Besides that, according to teachers' opinions, whereas science programs improve abstract individual skills more, team work is not accepted as improving more concrete skills such as development consciousness, entrepreneurship. It will suitable for include applications and theoretical information that can improve these skills. According to the opinions of the teachers, it will be helpful if science classes are entertaining and to strengthen the relation with other classes. Furthermore, it is believed that building the democratic environments where students can gain a notion of ethics will contribute to the social acquisition aspect of the classes.

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