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Science and Technology Teachers' Views of Primary School Science and Technology Curriculum

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Abstract

This phenomenographic study attempts to explicit science and technology teachers' views of primary school science and technology curriculum. Participants of the study were selected through opportunistic sampling and consisted of 30 science and technology teachers teaching in primary schools in Afyonkarahisar, Turkey. Data were collected through an open-ended question form, and content analyzed. The reliability was computed as 97%. Findings revealed that there are four themes generated; "a glance at the goals of primary school science and technology curriculum", "a glance at the content of primary school science and technology curriculum", "a glance at the teaching-learning process of primary school science and technology curriculum" and "a glance at the evaluation process of primary school science and technology curriculum". Participants' views were discussed under these themes.

Key words: Constructivism, Primary school science and technology curriculum, Science and technology teachers.

Introduction

A need of developing 21st century's manpower skills requires students to gain experience through activities, experiments, and research. Therefore, science classrooms should provide students learning environments that contribute to their development of life skills. Science teachers should provide opportunities for their students to make them adapt to others' works and ideas, solve problems, cope with works assigned, think through technical terms, and share their results (Bybee, 2010). All these can be achieved through development of contemporary curricula. Therefore, many countries have begun to consider more contemporary teaching-learning approaches such as constructivism, multiple-intelligence theory, etc., and have changed their education systems.

It is thought that constructivism that has become common in educational settings puts more emphasis on learning than on teaching, makes sense of learning, and is effective in raising contemporary individuals. This approach has also begun to be used in Turkey. More specifically, science and technology curriculum based on the constructivist approach that aims at making learners science and technology literate (MoNE, 2006) has begun to be implemented in the 2006–07 academic year.

The elements of a curriculum are goals, content, teaching-learning process, and evaluation, and all these elements are interrelated (Varış, 1998; Demirel, 2007). In line with this assumption, a new science and technology curriculum was developed and has begun to be implemented following the principles of constructivism. New curriculum includes goals in terms of intended learning outcomes, content in relation to domains of learning, teaching-learning process which is student-centered, and evaluation process in which both traditional and alternative measurement techniques are used. However, this curriculum should be analyzed in order to identify potential problems (Demirel, 2007). For this reason, views of teachers provide invaluable data.

After each educational reform whether it is related to curricula or not, it is a common practice to analyze teachers' views in order to explicit their approaches to new practices (Ponte, et al., 1994; Jansen, 1998; Davis, 2003; Peers, et al., 2003; Roehrig & Kruse, 2005; Watt, 2005; Chan, 2010; Tan, 2012). Similarly, there have been numerous studies on new science and technology curriculum, but these studies mostly deal with teachers'

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views of different curriculum components rather than of the whole curriculum, and are based on quantitative research design (Candur, 2007; Değirmenci, 2007; Şeker, 2007; Çengelci, 2008; Kara, 2008; Şenel, 2008; Akyol-İnç, 2009; Bedir, 2009; Bekçi, 2009; Belli, 2009; Unayağyol, 2009; Aydın, 2010; Küçükmert-Ertekin, 2010; Bülbül, 2010; Boyacı, 2010; Bulut, 2010; Dellalbaşı-Kılıç, 2010; Özçelik, 2011).

Based on the assumption that qualitative research is needed to obtain more detailed information about teachers' views of the new science and technology curriculum, this study aims at identifying science and technology teachers' views of primary school science and technology curriculum, following a phenomenographic approach. In parallel to this, this study attempts to answer the following research questions:

1. What are science and technology teachers' views of congruence between goals of primary school science and technology course and the new curriculum?
2. What are science and technology teachers' views of changes in the teaching-learning process proposed by the new curriculum?
3. What are science and technology teachers' views of changes in the evaluation process proposed by the new curriculum?

Method

Model of the Study

This study is a phenomenography which is one of qualitative research designs. Phenomenography is an empirical technique used in educational research that aims at uncovering the individual ways of experiences, conceptualizations, perceptions and understandings about different events (Marton and Booth, 1997). This study is a phenomenography that explicits science and technology teachers' perspectives about primary school science and technology curriculum based on their experiences and perceptions.

Participants

Participants of the study were identified through opportunistic sampling. Opportunistic sampling technique is used when the participants are available to report their views (Schreiber and Asner-Self, 2011). Participants consisted of 30 science and technology teachers (21 females and nine males) teaching in primary schools in Afyonkarahisar, Turkey. All participants took part in the seminar given by the researcher. Teaching experience of the participants varies from 10 to 17 years and all have a certificate of teaching.

Data collection tools

Data were collected through an open-ended question form developed by the researcher. Phenomenography allows for collecting participants' experiences about or views of concepts through group interviews, observations, open-ended questions, drawings and historical documents (Marton 1994).

Validity and reliability

In order to establish internal consistency of the question form, four field experts reviewed the form. Items in the form were rearranged based on their evaluation, and the number of items was limited to three. These items are as follows:

1. How do you make connections between the goals of primary school science and technology course and the new curriculum?
2. What are proposed changes in the teaching-learning process of the new curriculum?
3. What are proposed changes in the evaluation process of the new curriculum?

Regarding reliability, the question forms filled by the participants were numbered from one to thirty. Then, each form was reviewed and participants' responses were coded. In the coding process, another expert in qualitative research was also involved. Next, coding of the researcher and of independent coder were compared. Using the formula suggested by Miles and Huberman (1994), namely "Reliability=Agreement / (Agreement + Disagreement)", the reliability of the form was found as 97%. The form was administered to the participants in June, 2011.

Data analysis

Phenomenography involves interviews or coding of written data forms to establish defining categories about experiences. If written materials are used, these are transcribed. Then, transcriptions are carefully read for several times and coded, leading to the development of categories and themes (Bradbeer et al., 2004 cited in Demirkaya and Tokcan, 2007). Phenomenographic analysis assumes that there will be a limited number of categories for each concept. More specifically, these categories are developed by the researcher through comparing participants' statements (Didiş et al., 2008).

In this study, the question forms filled by the participants were numbered from one to thirty. Then, each form was reviewed and participants' responses were coded. In the coding process, another expert in qualitative research was also involved. Next, coding of the researcher and of independent coder were compared. At the final stage of the analysis, four themes were generated as follows: "a glance at the goals of primary school science and technology curriculum", "a glance at the content of primary school science and technology curriculum", "a glance at the teaching-learning process of primary school science and technology curriculum" and "a glance at the evaluation process of primary school science and technology curriculum". Findings were presented under these headings with direct quotes indicated by numbers assigned to the related participants (For instance, T1, T5, etc.)

Findings

The themes, sub-themes and related categories developed as a result of the analysis are given in Table 1.

Table 1. Participants' overall views of primary school science and tehnology curriculum

Themes	**Sub-themes**	**Categories**
Goals of the science and technology curriculum	Living beings and life Matter and change Physical events Earth and universe	Living beings and natural events Nature and universe
	Scientific process skills	Higher order thinking skills Scientific psychomotor skills
	Science-Technology-Society-Environment	Connections between daily life and science Science and technology literacy Environmental awareness Science-related occupations
	Attitudes and values	Creativity Curiosity Sensitivity Empathy Self-knowledge
Contents of the science and technology curriculum		Connections between daily life and science Activity-based topics Encouraging thinking and reasoning Presentations free from rote memorization
Teaching-learning process of the science and technology curriculum	Advantages	Student-centered Novice methods and techniques Positive attitudes towards the course Joyful and entertaining courses for both learners and teachers
		Hard to use when prior knowledge of

	Disadvantages	students is not enough Needs time to make it conventional Does not sensitive to cultural differences
Evaluation process of the science and technology curriculum	Advantages	Objective Process evaluation Variety of measurement tools
	Disadvantages	Time consuming Demanding Crowded classes Difficult to use when students' background knowledge is not enough Students and parents are not aware of the significance of alternative evaluation approaches Insufficient introduction of methods and techniques

Findings Related to the "Goals of the science and technology curriculum"

As seen in Table 1, participants' views regarding the first theme, namely *Goals of the science and technology curriculum*, was grouped under four sub-themes*: Living beings and life, Matter and change, Physical events, Earth and universe, Scientific process skills, Science-Technology-Society-Environment, and Attitudes and values.* These sub-themes include their statements regarding course outcomes.

Tablo 2**.** Sub-themes and categories under the theme, "Goals of the science and technology curriculum"

Sub-themes	**Categories**	**f**
Living beings and life	Living beings and natural events	1
Matter and change	Nature and universe	1
Physical events		
Earth and universe		
Scientific Process Skills	Higher order thinking skills	13
	Scientific psychomotor skills	5
Science-Technology-Society Environment	Connections between daily life and science	12
	Science and technology literacy	8
	Environmental awareness	5
	Science-related occupations	4
Attitudes and Values	Creativity	7
	Curiosity	2
	Sensitivity	1
	Empathy	1
	Self-knowledge	1

It was found that intended learning outcomes related to the sub-themes, Living beings and life, Matter and change, Physical events, and Earth and universe were less addressed by the participants. Some views of the participants in regard to these sub-themes are given as follows:

T.25. *"It is important that students should learn their own body structure, that of other living beings as well as nature and natural events.",*

T. 21. *"Science is the most appropriate way to reach knowledge since it analyses the nature and universe."*

The participants argued that science and technology course should improve students' scientific process skills, indicating the significance of higher-order thinking and scientific psycho-motor skills. The followings are some of the views of the participants:

T. 4. *"(These skills are) required for students to perceive their environment, to interpret the events surrounding them and to find solutions to the problems they come across,"*

T. 5. *"Science education is needed for students to understand and comprehend the daily events. Because it contributes to the development of their skills of analysing, thinking differently and problem-solving."*

In addition, the participants stated that intended learning outcomes regarding Science-Technology-Society-Environment are also important for students. With regard to this sub-theme, participants' views were commonly about connections between daily life and science, science and technology literacy, environmental awareness and science-related occupations. The views of the participants emphasizing the importance of such intended learning outcomes are given as follows:

T. 15. *"Science provides the students with the opportunity to learn and be informed about all devices and equipment that they come across in their daily life and also, about how these devices work.",*

T. 9. *"We use science in each aspect of life. Therefore, comprehending live better or becoming science literate person is important."*

In regard to the last sub-theme under the heading of goals, the participants dealt with creativity, curiosity, being sensitive to environment and self-knowledge. Related statements of the participants are given below:

T. 21. *"…In basic education level, children's developmental stage should be taken into consideration. Therefore, science is significant for them to develop self-knowledge, improve their learning styles and to answer their questions arisen from their natural curiosity.",*

T. 14. *"…For me, science is a life-style. It refers to being aware of the events surrounding you and of the fact that the world is more than just you. Science allows for being aware of the cause-effect relations. It improves environmental awareness, sensitivity and empathy."*

Findings Related to the "Content of the science and technology curriculum"

The second theme, namely *content of the science and technology curriculum*, was also grouped under four categories: Connections between daily life and science, activity-based topics, encouraging thinking and reasoning, and presentations free from rote memorization. The views of the participants with regard to these categories are about connections between daily life activities and science, activity-based topics, encouraging thinking and reasoning, and presentations free from rote memorization.

Table 3. Categories under the theme, content of the science and technology curriculum

Categories	**f**
Connections between daily life and science	7
Activity-based topics	5
Encouraging thinking and reasoning	5
Presentations free from rote memorization	3

The participants reported that science and technology curriculum involves connections between science and daily life activities. The related views of the participants are given below:

T. 3. *"In the new curriculum, science topics are mostly linked with daily life activities rather than being theoretical and abstract …",*

T. 18. *"…topics covered in the new curriculum help students in comprehending the events surrounding them. Therefore, the students become aware of these events*."

The participants stated that primary school science and technology curriculum provides students opportunities to take part in many activities. They argued that such activities are important and useful in delivering the content. The related statements of the participants are as follows:

T. 11. *" …I can say that students began to take part in activities as if they are playing a game.",*

T. 13. *"The new curriculum requires allocation of much time for activities. These activities make the learning long-lasting. Course becomes much more attractive through the activities in workbook and other activities."*

While talking about the content of the new curriculum, the participants stated that it encourages students' thinking and reasoning. For instance,

T. 14. states as follows: *"The new curriculum allows for the support for the connections of cause-effects rather than rote memorization. For me, students were not requested to think frequently within the framework of the old curriculum. Now we encourage students to think."*

Findings Related to the "Teaching-learning process of the science and technology curriculum"

Unlike the first two themes, the participants' views regarding the third and fourth themes emerged in the form of positive and negative aspects of the themes. Therefore, the third and fourth themes were categorized into two: positive and negative aspects.

As seen in Table 4, the theme of the teaching-learning process of the science and technology curriculum involves participants' views of advantages and disadvantages of the new curriculum with regard to the teaching-learning process of the curriculum.

Table 4. Sub-themes and categories under the theme, teaching-learning process of the science and technology curriculum

Sub-themes	Categories	f
Positive aspects	Student-centered	11
	Joyful and entertaining courses for learners	9
	Positive attitudes towards the course	5
	Joyful and entertaining courses for both teachers	5
	Novice methods and techniques	3
Negative aspects	Hard to use when prior knowledge of students is not enough	4
	Needing time to make it conventional	2
	Does not sensitive to cultural differences	2

The participants pointed out that there are many positive aspects of the teaching-learning process of the new curriculum. They stated that this process is student-centered. The related remarks of the participants are as follows:

T. 7. *"I think students are active participants of the course. They deduct the results themselves."*

T. 25. *"I am trying to make my students much more active in the process of teaching-learning."*

They also stated that novice learning methods and techniques should be used in order to implement the curriculum better. For instance,

T. 23. states the following: "*The new curriculum has positively contributed to my teaching. I have learned new teaching methods and techniques. Also, I have found opportunities to employ them."*

The participants also mentioned that courses have become joyful and attractive for both teachers and their students after the implementation of the curriculum, and that students have developed more positive attitudes towards the course. Related remarks of the participants are given below:

T. 29. *"I, as a teacher, began to be pleased with my teaching. Now my course is one of the students' favorite courses."*

T. 30. *"Learning has become long-lasting and courses more attractive."*

T. 16. *"Science has become one of the most liked courses. I fondly teach the course. I am happy that my students understand the topics I teach. I began to love my job."*

On the other hand, the participants stated several negative aspects of the new curriculum regarding the teaching-learning process. Such statements are given as follows:

T. 8. *"Since background information of students is not sufficient, the implementation of the new curriculum is very hard. I should use lectures while teaching the topics.."*

T. 1. *"...I think that the new curriculum does not address all children from different backgrounds. It is not easy to teach the same topics using the same methods to students from Ankara and to those from Hakkari."*

T. 12. *"With the new curriculum, a new system has begun to be used that is student-centered. However, it is not fully implemented because students are used to take information rather than construct it themselves. Or their prior knowledge is not sufficient to realize it. Also, sources are limited. Although we attempt to use a student-centered approach to learning, it is not completely in practice."*

Findings Related to the "Evaluation process of the science and technology curriculum"

With regard to the fourth theme, namely, *evaluation process of the science and technology curriculum*, participants' remarks are grouped under positive and negative aspects. These are given in Table 5.

Table 5. Sub-themes and categories under the theme, evaluation process of the science and technology curriculum

Sub-themes	Categories	f
Positive aspects	Objective	9
	Process evaluation	5
	Variety of measurement tools	4
Negative aspects	Time consuming	7
	Demanding	7
	Students and parents are not aware of the significance of alternative evaluation approach	7
	Insufficient introduction of methods and techniques	5
	Hard to use in crowded classes	2

Participants stated that there are many positive aspects of the evaluation process of the new curriculum. More specifically, they argued that students, by means of rubrics, are informed about how their learning will be evaluated that makes the evaluation process more objective. The following remarks indicate such positive views of the participants:

T. 6., *"The measurement-evaluation process of the new curriculum is much clearer."*

T. 18. *"…The measurement- evaluation process of the new curriculum is more objective and has positive effects on the evaluation of student learning."*

T. 3. *"The measurement- evaluation process of the new curriculum is a bit demanding, but I think it is much more objective."*

In addition, participants pointed out that the evaluation process of the new curriculum deals with the learning process rather than learning outcomes. Supporting statements of the participants are given below:

T. 8. *"Since the learning process was included to the evaluation process, evaluation becomes much more objective. Therefore, we can evaluate student learning more globally."*

T. 17. *"Now we are assessing how interested students are in courses, what students do in courses through detailed scales while we had not assessed students' relations to courses except oral and written exams before.".*

Participants also regarded the use of various measurement tools in the evaluation process of the new curriculum as a positive change. The following remarks of the participants indicate these positive views:

T. 16. *"I could not employ all measurement tools, but try to employ the one that is the best for my class. On the other hand, different measurement tools teach us that student learning can be differently evaluated."*,

T. 13 *"I think that using different tools for measurement is significant."*

On the other hand, participants stated several negative aspects of the new curriculum regarding the evaluation process. Participants frequently argued that the use of the evaluation process is demanding and time consuming since classrooms are crowded. The related remarks of the participants are given as follows:

T. 9. *"Unfortunately, I could not employ new measurement-evaluation methods and techniques in each activity. Because my class is crowded, making the process much more time consuming."*

T. 11. *"I should admit that I cannot make use of measurement tools fully due to time constraints."*

T. 29. "*(The evaluation process is) much more transparent and realistic, but its use is demanding and time consuming."*

The other point criticized by the participants was about students' and their parents' approaches to the new evaluation process. They specifically stated that the process is not understood by students and parents. The following remarks of the participants show such concerns:

T. 10. *"Getting high marks without studying hard has been increased."*

T. 25. *"Majority of the students and parents regard the performance-based assignments and projects as a way to get 100 and to raise the average."*

Some of the participants stated that they cannot employ alternative measurement and evaluation techniques, since these are not fully explained to them. Such statements are as follows:

T. 21. *"In theory, traditional evaluation methods are replaced by contemporary ones. However, in practice, I think that traditional evaluation methods are still dominant in the process."*

T. 15 *"…The problems may arise from the fact that teachers were not fully informed about the evaluation process and approach of the new curriculum"*

Results and Conclusion

The study deals with the views of science and technology teachers of the new primary school science and technology curriculum. Their views are categorized under four themes: "a glance at the goals of primary school science and technology curriculum", "a glance at the content of primary school science and technology curriculum", "a glance at the teaching-learning process of primary school science and technology curriculum" and "a glance at the evaluation process of primary school science and technology curriculum".

With regard to the goals of the curriculum, the participants commonly argued that intended learning outcomes stated in the curriculum, particularly those related to skills and attitudes, are appropriate for students' developmental stage. They further stated that the curriculum supports scientific process skills of the students, their understanding about the relationships between scientific topics and daily-life activities, science and technology literacy, and environmental awareness, and that they appreciate with these aspects of the new curriculum. These findings are similar to those of Şeker (2007), Çengelci (2008), Unayağyol (2009), Bülbül (2010) and Dellalbaşı-Kılıç (2010). In these studies, it was also found that "teachers have generally positive views in relation to the goals of the new curriculum."

Regarding the content of the new curriculum, it was found that science and technology teachers regard the curriculum as one in which topics are related with daily-life activities, learning activities are provided in many cases, and students are encouraged to think and reflect. These findings are in parallel with the findings of the studies carried out by several researchers, including Candur (2007), Koç (2010), Boyacı (2010) and Kamaraj (2009).

The views of the participants regarding the teaching-learning process of the curriculum can be summarized as follows: the teaching-learning process is mostly student-centered, the use of novice instructional methods and techniques is encouraged, and courses have become more attractive for both teachers and students after implementation of the curriculum. These positive findings regarding the teaching-learning process of the curriculum are similar to those of the studies by Charalambous & Philippou (2010) and Adal (2011). However, science and technology teachers also expressed some negative views regarding the teaching-learning process of the curriculum. More specifically, they argued that the curriculum cannot be easily developed if the prior knowledge of students is not sufficient, and hence, the curriculum does not address all students with different cultural backgrounds. These findings regarding negative views of the participants are consistent with the findings of other studies carried out by Peers et al. (2003), Kara (2008), Unayağyol (2009) and Boyacı (2010). Furthermore, Lee and Yin (2011) also found that teachers may have both positive and negative views with regard to the implementation of new curricula.

Regarding the evaluation process of the new curriculum, it was found that participants have both positive and negative views. The characteristics of the evaluation process of the curriculum that were regarded as positive by the participants are as follows: more objective measurement, evaluation of the learning process, and use of various measurement tools. The finding of variety of measurement tools seen as a positive aspect of the evaluation process is consistent with that of the study by Hargreaves and Earl (2002).

Negative views of the participants regarding the evaluation process are mostly related to the following points: use of alternative measurement tools is time consuming; demanding and hard if the classroom is overcrowded. Furthermore, participants were found to have complaints about not being fully informed about the use of alternative measurement methods and techniques. The findings about negative views of the participants regarding the evaluation process of the curriculum are consistent with those of Şenel (2008), Akyol-İnç (2009), Bedir (2009), Belli (2009), Chan (2010), Özçelik (2011) and Özön (2012).

Science and technology teachers taking part in the study were generally pleased with the goals and content of the curriculum while interestingly, they had some concerns about the teaching-learning process and evaluation process of the curriculum. It is seen that negative views were about teaching practice and that participants were in a need of professional help. This finding is consistent with that of previous studies, including Ponte et al. (1994), Manouchehri (1998) and Labate (2007). Although the curriculum is effective for some years, there are still problems experienced by teachers. The reason for such problems may be that mostly theoretical courses are given to the teachers rather than practice-oriented ones during their in-service training, and that teachers have some prejudices against the curriculum. Roehrig and Kruse (2005) also had similar arguments in their study.

In conclusion, regarding the goals of the curriculum, participants commonly argued that intended learning outcomes stated in the curriculum, particularly those related to skills and attitudes, are appropriate for students' developmental stage. They further stated that the curriculum supports scientific process skills of the students, their understanding about the relationships between scientific topics and daily-life activities, and science and technology literacy. However, they also argued that the curriculum cannot be easily developed if the prior knowledge of students is not sufficient, and hence the curriculum does not address all students with different cultural backgrounds. The characteristics of the evaluation process of the curriculum, namely more objective measurement, evaluation of the learning process, and use of various measurement tools are regarded as positive by the participants. On the other hand, the following points are regarded by the participants as negative: use of alternative measurement tools is time consuming, demanding and hard if the classroom is overcrowded. Furthermore, participants were found to have complaints about not being fully informed about use of alternative measurement methods and techniques.

Recommendations

Based on the results of the study, it is possible to suggest the following points to be taken into consideration:

- In order to stay views of the participants regarding the fact that implementation of the curriculum is difficult for students from different cultural backgrounds abide, textbooks may include many examples addressing these differences and involving different levels of complexity.
- In-service training activities may involve more practice-based activities rather than theoretical presentations to avoid negative perspectives of the curriculum such as being "demanding", "time consuming" and "not being effectively introduced".
- Necessary arrangements can be made to reduce class size in order to provide an available setting for the implementation of the curriculum.
- In addition to teachers, students and parents might also be informed about the significance and aims of alternative measurement and evaluation methods and techniques.

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