International Journal of Environmental & Science Education
Vol. 6, No. 3, July 2011, 251-266

Educational reforms as paradigm shifts: Utilizing kuhnian lenses for a better understanding of the meaning of, and resistance to, educational change

Serhat Irez • Çiğdem Han

Received 29 July 2010; Accepted 19 April 2011

Research acknowledges that reform efforts in education often face resistance, particularly on the part of teachers. This study attempts to get to a better understanding of the reasons of resistance to change on the teachers' side through utilizing the structure of scientific revolutions as described by Thomas Kuhn as an analogy. To this end, a recent curriculum reform in science education in Turkey is taken as a case. The previous and new biology curricula are analyzed comparing their emphasis, approaches to the nature of scientific knowledge, theories of learning, and models for teaching and approaches to the assessment of learning. This analysis revealed that the curriculum reform experienced in Turkey has introduced a new conceptual and theoretical framework for teachers, which is fundamentally different from the previous one. To this end, the study discusses that understanding the new paradigm introduced by the new curriculum could be one of the major barriers that teachers face in the implementation of the curriculum reform.

Keywords: educational reform, paradigm shift, teacher resistance

Introduction

Transformations in Understanding of Science and Science Education

Our understanding of the nature of scientific inquiry has experienced a major transformation over the last century (Hurd, 1998). Positivist-objectivist understanding of scientific inquiry which defends the application of inductive methods and argues that science employs value-neutral experimental observation which yields the discovery of incontestable facts about nature has fallen out of favour. Contemporary understanding of science describes science as a special way of knowing and argues that scientific inquiry is shaped 'ineluctably' by human values, scientific knowledge is produced rather than discovered, scientific observation is theory laden (Kuhn, 1970), and that there is no single correct scientific method (Lakatos, 1970).

These changes in the perception of the nature of scientific inquiry have revealed a need to re-examine the traditional purposes and practices of science education (Hurd, 1998). In 1970, for example, the National Science Foundation Advisory Committee for Science Education in the United States recommended that the traditional approach to science education in the sciences be

ISSN 1306-3065

http://www.ijese.com/

rethought with more 'emphasis on the understanding of science and technology by those who are not and do not expect to be professional scientists and technologists' (Report, 1970, p. iii, cited in Hurd, 1998, s. 409). The implication of similar reports was that notions of scientific literacy should be embedded in contexts that promote a socially responsible and competent citizen (Hurd, 1998).

Another major transformation affecting the nature of science education has been the transformation in our understanding about how people learn. Traditional approaches to teaching and learning in science which perceive learning as acquiring or 'reproducing' knowledge from credible sources and teaching science as transferring knowledge from teacher to students (Tsai, 2002) have transformed to a still controversial 'constructivist' view of learning (Matthews, 1997; Osborne, 1996), which views learning as constructing personal knowledge and understanding and, teaching as helping students construct knowledge. There are, of course, various forms of constructivism (Bickhard, 1997). Providing a detailed analysis on the forms of constructivism is beyond the scope of the paper, nevertheless, the term constructivism is used in this study to imply a broad philosophical position concerning science, science teaching and learning.

Such developments and transformations in social, philosophical and educational spheres have led calls for reform in science education around the world. Such calls have also found echoes in Turkey. Turkey has one of the biggest and youngest populations in Europe; therefore, education has been and continues to be of critical importance to the nation's social, political and economic development. Like many governments around the world, the Turkish government is aware of the importance of preparing its citizens for the challenges of the new century, and has introduced many reforms at various levels of education in the last ten years.

The latest of these reform efforts took place in secondary education in 2007. With this movement, both the structure and content of the secondary education were targeted. The length of the secondary education, which was three years, has become four years. The content and philosophy of secondary education has also targeted. In secondary science, for example, new biology, chemistry and physics curricula and curriculum materials have been introduced. These new curricula have presented new aims, learning and teaching approach, and method of assessment for secondary science teaching.

The Nature and Impact of Educational Change: Introducing Kuhnian Paradigms

The main aim of any reform in education is to improve educational programs and practices which will, in turn, assist to meet overall objectives of education in more effective ways (Fullan, 1991). Change is a difficult process, because, educational change of any significance involves changes in organizational structures, communications, resource allocation, practices, and beliefs and attitudes (Avenstrup, 2007). Research acknowledges that reform efforts often face resistance, particularly on the part of teaching staff. Current literature on educational change usually attributes to external factors such as entrance examinations at different levels of education, parental pressure and top-down nature of reforms (Könings, Brand-Gruel, & Van Merrienboer, 2007; Wendy, 1991) and internal factors such as lack of training (Könings, Brand-Gruwel, & Van Merrienboer, 2007), leadership (Roehrig, Kruse, & Kernl, 2007) and communication (Wendy, 1991) as sources of the resistance to change on the teachers' side. Although this categorization of the sources of resistance to educational change on teachers' side is important and helpful in understanding the dynamics of educational change, multiple perspectives are still needed to capture the nature and aspects of this complexity (Anderson, & Helms, 2001; Schmidt & White, 2004).

To this end, this study assumes that the nature of scientific revolutions, as described by Thomas Kuhn (1970) in *The Structure of Scientific Revolutions*, provides one of the possible

ways to analyze the nature of large-scale educational reforms and the complexity of the process. Further, we believe that by using such an analogy, we could get to a better understanding of the reasons of resistance to change on the teachers' side.

Briefly, Kuhn argued that science is not a steady acquisition of knowledge, but rather 'a series of peaceful interludes punctuated by intellectually violent revolutions' in which 'one conceptual world-view was replaced by another'. He called these world-views "paradigms". The meaning of paradigm has been a loose one and various definitions have been utilized by scholars since Kuhn (Crocker, 1983; Masterman, 1970). In this paper, the term paradigm is used in a broad sense that refers to 'philosophical and theoretical framework of any kind'. One important aspect of Kuhn's paradigms is that the paradigms are incommensurable—that is, it is not possible to understand one paradigm through the conceptual framework and terminology of another rival paradigm. In other words, rival paradigms describe different worlds. The related question here is that what happens to a scientist that has experienced a paradigm shift in the field? According to Kuhn, when the "normal scientist" is confronted with evidence that the reigning paradigm may be mistaken, he or she tends to ignore that evidence and sticks with it. There may be many reasons for this conservatism, being educated in the new paradigm, having established themselves in it, perceived difficulty of learning a new conceptual framework, etc.

This conservatism is exactly what we utilized in our study. In one sense, large-scale educational reforms resemble scientific revolutions. As in paradigm shifts, large scale educational reforms bring new conceptual frameworks, introduce new educational aims and view on how people learn, require to adopt new teaching and assessment approaches and materials, etc. It is expected from the implementers of the reform, that is, from teachers, to comprehend and reflect the new requirements of the reform in their practice. However, this is not an easy task. Many teachers were educated with the conceptual framework and norms of the previous educational approach, as the normal scientist working in the old paradigm did before the paradigm shift in Kuhn's scientific revolutions. We assume that it is difficult for or cannot be expected from an experienced teacher, just as the normal scientist experiencing a paradigm shift, to comprehend and adapt himself/herself to the new world that is introduced by the educational reform.

With this conceptual framework and in order to exemplify how a large scale educational reform introduces a new world for teachers, this study analyzed the curriculum reform recently taken place in secondary biology education in Turkey. The curriculum is a crucial component of education and all else in the system is derived from this: how learners should be assessed, how teachers should be trained and develop, what textbooks and other learning support materials should be like, how schools and the educational system should be organized and managed, and the allocation of resources necessary for the system (Avenstrup, 2007). To this end, this study aims to describe and contrast the educational aims, epistemological positions and teaching and learning orientations of the previous and new biology curricula in order to analyze the magnitude of change and discuss possible implications of change for biology teachers and teacher education in Turkey.

Methodological and Analytical Framework

As the main aim of this study was to assess the nature and the scale of the change between the previous and new biology curricula, a qualitative oriented approach was employed and Ethnographic Content Analysis (ECA) (Altheide, 1996) was chosen as an appropriate methodological framework for this particular research. One of the strengths of the ECA is that it aims to provide a systematic and analytical, but not rigid, approach to content analysis. Categories and variables initially provide guidance, but others are allowed and expected to emerge during the analysis,

including an orientation to constant discovery and constant comparison of relevant situations, settings, styles, images, meanings, and nuances (Aitheide, 1996, p. 16).

In this framework, the method of reviewing started with the *determination of dimensions* which would initially guide the researchers for a through analysis of the previous and new biology curricula. In this stage the conceptual framework offered by Fullan (1991) informed our analysis. According to Fullan, change is multidimensional and, in order to clarify the meaning and scope of any educational change, at least three components or dimensions of a new program should be considered: (1) the possible use of new or revised materials (such as the content of the curriculum), (2) the possible use of new teaching approaches (such as teaching strategies and activities), and (3) the possible alteration of beliefs (e.g., pedagogical assumptions). In the light of this framework and considering the organizational structure of the two curricula, four dimensions which could guide the initial analysis were detected: *The curriculum's emphasis*, that is, the educational objectives set by each curriculum; *the theory of learning,* that is, the pedagogical assumption of each curriculum on learning; *the model for teaching,* that is, teaching strategies and activities each curriculum suggests; and, each curriculum's approach to *the assessment of learning.*

Having agreed on these dimensions, the initial analysis (*independent coding stage*) started by thorough examination of the previous and new biology curricula and evidence was sought to reveal overall emphasis of each curriculum regarding these dimensions. At this stage, each researcher conducted an independent analysis and coding. Here, all statements, phrases or explanations related to each curriculum's approach regarding one of the dimensions were coded and grouped together. For example, explanations or statements informing the pedagogical assumption of the curriculum on learning were grouped under the dimension "the theory of learning". In majority of cases, there was direct evidence revealing the curriculum's approach regarding the dimensions. For example, there was a separate section in the new curriculum with regard to learning where teachers were informed about the learning approach adopted by the curriculum. In some cases, however, researchers had to search for indirect evidence to reveal the curriculum's approaches to some of the dimensions. For instance, there was no separate section explaining the theory of learning employed by the previous curriculum, therefore, the researchers looked for other sections, such as the student learning outcomes stated at the end of each unit, in order to find illuminating evidence.

Second stage in the analysis was *collective comparison*. In this stage, researchers compared and contrasted their findings. In many cases, the researchers reached similar codes and conclusions. In cases of disagreement, the researchers worked together case by case until an agreement was established on the same codes and interpretations. Some of the statements were placed within more than one dimension as they provide information about more than one dimension. For example, some of the statements about the theory of learning also provided information about the teaching orientation of each curriculum. This collective comparison process also helped the researchers to check the consistency, or lack thereof, between the curriculum's statements regarding a dimension or between the dimensions. Any inconsistency identified as a result of this analysis was noted and was followed up by the examination of related sections for clarification. During the collective comparison stage, the researchers agreed on including *the nature of scientific knowledge* as a new dimension to the analytical framework in the light of intense direct and indirect evidence emerged during the analysis with regard to the epistemological standpoints of the two curricula.

The final stage was *meaning making stage*. In this stage, firstly, the evidence obtained from each curriculum was analyzed independently in order to reveal the overall approaches of the two curricula regarding the dimensions. Again, the researchers conducted their analysis individually

in this phase. During the analysis, the researchers carefully analyzed sentences, statements and phrases obtained from the curriculum in order to describe the overall orientation in each dimension. As the reader will see in detailed discussions in the results section, related literature and discussions in each dimension guided meaning making stage. For example, in considering the curriculum emphasizes, the framework developed by Roberts (1982) guided the analysis. In the last phase of the meaning making stage, the researchers compared and contrasted their analysis. Again, in cases where there were disagreements, a reconciliation process conducted until an agreement was formed. Following section presents the results of this analysis and, describes and compares the two curricula's approaches with regard to five dimensions.

Results

Curriculum Emphasis

One of the important steps in curriculum development process is the identification of coherent set of messages to the student about science (Roberts, 1982). Because, Roberts argues, such messages *'constitute objectives which go beyond learning the facts, principles, laws, and theories of the subject matter itself – objectives which provide answers to the student question: "Why am I learning this?"'* (p. 245). The answer to this question reflects the emphasis on what is valued and desired in the curriculum. Roberts calls this *curriculum emphasis* and, discusses and describes seven different emphases utilized by curriculum developers in the last century. He argues that each emphasis, naturally, shapes the content and the structure of the curriculum.

The framework and classification defined by Roberts was used in analysing the differences regarding the emphases of both curricula. To this end, the overall objective of the previous biology curriculum emerged as;

> *... to help individuals who will constitute the science-society to acquire scientific problem solving skills for the problems they may encounter in their everyday life ...* (Ministry of National Education [MNE], 1998, p.131).

This overall objective was followed by a list of attainment targets. *"Learning the general structure of living things"* was, somewhat inconsistent with the overall objective, on the top of the list. This was followed by "*learning about and caring environment"* and *"developing habits needed for a healthy life".* Parallel to these attainment targets, the previous curriculum put emphasis on the learning of biology content and developing skills to solve everyday problems utilizing a scientific approach**.**

In light of this analysis, the previous curriculum's approach falls into the *Correct Explanations* and the *Everyday Coping* emphasis in Roberts's (1982) framework. Roberts argues that the *Correct Explanations* emphasis stresses science products that are accepted by scientific community. This emphasis gives the messages *"master now, question later"*. The *Everyday Coping* emphasis, on the other hand, declares that science is an important means for understanding and controlling one's environment (Roberts,1982).

The overall objective, or the 'vision' as it is called, of the new curriculum is stated as;

> *... to educate scientifically literate individuals that understand the nature of science… appreciate the necessity of learning biology… possess adequate cognitive conceptual frameworks regarding biological concepts… comprehend the*

> *relationship between science-society-technology… approach problems with the principles of scientific inquiry.* (MNE, 2007, p.3).

The structure and content of the new curriculum were shaped in order to achieve the overall objective. To this end, the new curriculum targets developing skills and attitudes related to the aforementioned overall objective (that is educating scientifically literate citizens) as well as developing knowledge of biology. The attainment targets are divided into three groups in the new curriculum. These are; a) *Science-Technology-Society-Environment*, b) *Communication Skills, Attitudes and Values*, c) *Scientific Inquiry and Science Process Skills*.

Considering such an overall objective and related attainment targets, the new curriculum's emphasis bears the aspects of three emphases in Roberts's (1982) classification. These are the *Structure of Science* emphasis, the *Science, Technology, and Decisions* emphasis and, the *Scientific Skill Development* emphasis.

The new curriculum's emphasis includes the *Structure of Science* emphasis as it stresses and gives messages about how science functions intellectually in its growth and development (Roberts, 1982). The new curriculum targets student understanding on the nature and status of scientific knowledge, the interplay between evidence and theory, the role of models for explaining natural phenomena, the subjective nature of science, etc. Unlike the previous curriculum's emphasis on *Everyday Coping*, the new curriculum puts an emphasis on the limits of science in coping with practical affairs. The new curriculum also stresses the development of scientific process skills as opposed to learning the products or content of science, which were emphasized in the previous curriculum.

To conclude, as discussed above, the two biology curricula have radically different emphases regarding the objective of biology education at secondary level. This difference in the emphases shows that these two curricula have different worldviews. Consistent with their difference in worldviews, analysis revealed that the curricula also have different understandings about the nature of science and scientific knowledge.

Nature of Scientific Knowledge

The analysis revealed that the previous and new biology curricula have radically different perspectives with regard to their perceptions of the nature of scientific knowledge. While the previous biology curriculum presented the nature of knowledge from a positivist-realist perspective, the new curriculum adopts a constructivist perspective. Science, for example, was defined as *"cumulative knowledge gathered through observations and experiments"* (MNE, 1998, p.139) in the previous biology curriculum. What is immediately evident from this description is an introduction of science as *body of knowledge*. The view that science represents a body of knowledge was implicitly supported throughout the units by portraying biology as a collection of facts. For example in the unit titled *Views about the Origins of Life* in which the theory of evolution was introduced, the curriculum stated that

> *"... the factual knowledge in biology was presented in the earlier units, this unit, however, presents interpretations of these."* (MNE, 1998, p.211).

Such a description of science and scientific knowledge also underpinned another view that there is an existing truth or reality out there and science represents the way of reaching that reality or truth. This view portrayed science as a process of discovering (or collecting, exploring) what is out there. The previous curriculum presented this process as *the* scientific method. The

scientific method, according to the previous curriculum, was a step-wise and universal procedure in science. The previous curriculum's expectations from the students were;

- *Write and/or recall the steps of the scientific method.*
- *Decide whether the steps of the scientific method were used in a given example of a scientific investigation.*
- *Write and/or recall that it is required to follow the steps of the scientific method in the solution of problems in biology*. (MNE, 1998, p.139-140)

The previous curriculum saw following the steps of scientific method as necessary in order to produce and guarantee objective knowledge. Another requirement in obtaining objective knowledge in science, according to the previous curriculum, was the characteristics that scientists should have.

(Students should)

- *Explain the characteristics that a scientist should have.* (MNE, 1998, p.139)

Further, the previous curriculum suggested teachers to ask questions such as "*List the characteristics of a scientist*" in the assessment of learning. Although the curriculum did not provide a list of these characteristics, the textbooks that used the previous curriculum as the framework did. The research study by Irez (2009) revealed that the secondary biology textbooks reflecting the previous curriculum's approach provided list of characteristics that a scientist should have. These included characteristics such as being objective, honest, hard-working, determined, logical, and sceptical amongst many others.

On the other hand, science is described from a constructivist perspective in the new biology curriculum. For example, the new curriculum introduces science as a dynamic process of generating *testable and falsifiable* explanations about natural phenomena.

(students should)

- *Develop an understanding that science* [scientific knowledge] *has testable, experimental and falsifiable nature.*
- *Realize that scientific knowledge is tested, corrected or renewed in the light of new evidence.* (MNE, 2007, p.17)

These statements also imply the tentative nature of scientific knowledge. Indeed, in various places, the new curriculum emphasize that all scientific knowledge is subject to change. It views the tentativeness of scientific knowledge from a Kuhnian perspective in that change in science is explained as a paradigm shift.

(Students should)

- *Explain the role of evidence, theories and/or paradigms in change of scientific knowledge.*
- *Realize that change in science is continuous and sometimes in the form of paradigmatic shift.* (MNE, 2007, p.17)

In contrast to the previous curriculum, the new curriculum does not present science as an objective enterprise. Instead, it suggests that science and society influence each other and perceives science as a product of society and human-culture.

(Students should)

- *Understand that socio-economic and cultural contexts influence the development of biology.*
- *Understand and gives examples about the contributions of societies that have different historical and cultural pasts to the development of biology.* (MNE, 2007, p.17)

Further, the new curriculum does not claim that scientists should have certain characteristics to ensure objectivity in science; instead, it discusses that subjectivity is natural and expected in science.

(Students should)

- *Realize and discuss the effects of different attitudes and values in science.* (MNE, 2007, p.17)

In sum, the analysis conducted with regard to approaches of the previous and new biology curriculum pointed out a significant difference between their depictions of science and scientific enterprise.

Theories of Learning

One of the main themes utilized in the comparison of the previous and the new curriculum was their approaches to learning. Results pointed out that, again, there was a significant difference between the approaches of the two curricula.

Although there was not a separate section in the previous curriculum explaining its orientation to learning, close inspection of the unit plans and the sections where suggestions for teaching were presented gave clues about its approach. *Writing and recalling* of the given information was the constant emphasis in the student attainment targets presented throughout the curriculum.

(Students should)

- *Write and/or recall the important discoveries of the scientists who contributed to biology.* (MNE, 1998, p.139)
- *Write and/or recall the living and non-living factors affecting environment.* (MNE, 1998, p.158)

Such statements, according to Tsai (2002), are typical indicators of traditional learning approach. Further, the statements in *Learning-Teaching* and *Suggestions for Teaching* sections were also parallel and supported to such learning approach.

> *Students should be provided with examples regarding how they can utilize the scientific method in their daily life.* (MNE, 1998, p.140)
>
> *Important functions (contributions) of biology should be explained.* (MNE, 1998, p.140)

As seen, the structure of these statements itself indicates that teaching was perceived as the transfer of knowledge in which the student is the passive receiver without any cognitive involvement in the learning process.

The new curriculum, in contrast, explicitly states that the knowledge can not be constructed without active cognitive involvement of the learner; that comprehension occurs as a result of adaptation in the conceptual change process; that learning of a new concept depends on previous

experiences and knowledge; that learning is socially constructed and; that language and social context play an important role in the construction of knowledge (MNE, 2007). In short learning is explained as a conceptual change process. The student's realization of what s/he knows is an important aspect of the process. Therefore, special attention is paid to and explanations are given about alternative conceptions that students may possess in each topic.

This orientation to learning is apparent and verbalized in all attainment targets throughout the curriculum.

> (Students should)
> - *Realize the limits of the technological development process, its resources and the possible effects of technological applications.*
> - *Develop an understanding about the relationship between Science-Society-Environment.* (MNE, 2007, p.17)

The structure of these statements clearly shows the difference in the approaches of the previous and new biology curricula regarding learning. While learning was depicted as a passive process in the previous curriculum, it is perceived as an active process in which the learner's involvement in the construction of knowledge is required.

Models for Teaching

It is natural to think that a curriculum's teaching approach is linked to the way it perceives learning. It is because the learning environment should be designed in accordance with how and what students should learn. The analysis of the two curriculum documents revealed that, as expected, they presented teaching approaches that are compatible with their learning orientations.
The role of the teacher in the previous biology curriculum was described as providing knowledge for students in line with its objectives which were presented earlier. Following is an example that gives clues about the previous curriculum's teaching approach.

The non-living factors effecting living things are explained as light, temperature, climate, minerals, water, and pH. (MNE, 1998, Unit 'The Environment and Living Things', p. 159)
As it is exemplified in this statement, what was expected from the teacher was to present (or transfer) certain, absolute and true knowledge to students. According to Tsai (2002) presenting the nature of scientific knowledge in such an absolutist manner is an important indication of traditional teaching orientation. Such statements were abundant in the previous curriculum, as the following is one another example.

> *The discovery of the cell is taught by narration and experiments.* (MNE, 1998, Unit 'The Cell', p. 151)

Parallel to its learning orientation, the new curriculum differs from the previous one in terms of its approach to teaching biology. To this end, the required teacher competencies to meet the objectives of learning are described as follows in the new curriculum:

> *... constructivists teachers who realize the importance and emphasize the role of student-centred activities, realize individual differences but not disregard social skills, possess an assessment approach that focuses on the assessment of learning process as well as products...* (MNE, 2007, p.17)

Throughout the document, the new curriculum explicitly and implicitly stresses that, in learning process, students should be active and involved in the construction of knowledge. The overall role of the teacher is to guide learning.

Assessment of Learning

The last theme in the comparison of the two curricula was about their approach in the assessment of learning. The analysis revealed that there were remarkable differences between the approaches.

In line with its approach to learning and teaching, the previous biology curriculum suggested a teacher-centred, summative assessment approach which gives priority to the assessment of learning at the knowledge and/or comprehension levels in Bloom's (1956) taxonomy. The curriculum's approach to the assessment of learning and its suggestions about the ways of assessment were detailed in separate sections at the end of each unit. For instance, about the assessment approach regarding the learning outcomes of the first unit, the curriculum stated;

> *Exams can be utilized in the assessment of learning outcomes at the end of this unit.* (MNE, 1998, Unit 'Biology as a Scientific Discipline', p. 143)

As this statement implies, the aim of assessment was checking whether the learning targets have been met in a traditional way. Analysis of the example questions provided further supported this finding.

> *How many different types of muscle tissues exist in the body? Write the differences.* (MNE, 1998,Unit 'Tissues', p. 169)

The assessment tools suggested in the previous curriculum included classical written exams, multiple choice tests, fill-in-the-blank and true or false questions. This approach and tools for assessment is criticized in the new curriculum.

The new biology curriculum stresses that the assessment of learning process and the skills and attitudes developed in the process is as important as the products (MNE, 2007). It emphasizes that;

> *Today, along with fundamental knowledge, skills and attitudes, students also need to develop knowledge, skills and attitudes such as critical thinking, creative thinking, problem solving, inquiry, collaboration, scientific reasoning and interpretation, effective communication etc.* (MNE, 2007, p. 7)

The new curriculum puts forward that performance (alternative) assessment approaches and tools are needed in order to assess students' performance and progress in these domains. The new curriculum asserts that the impact of this assessment approach can be further strengthened if it is constructed in a way that engages students with meta-cognitive activities and related to real life (MNE, 2007). The assessment tools that new curriculum suggests to the teachers include anecdotal classroom records giving information about the student's performance during classes and rubrics that help the teacher to observe and assess if the student has achieve the expected outcomes. Similar to the previous curriculum, the new curriculum also suggests using traditional assessment tools such as multiple choice tests and fill-in-the-blank type questions. However, it is noted that *"these are not the only ways of assessment"* and encourages the teacher to *"observe and assess students' performances during lab work, group works and other classroom activities.*"

Conclusion, Discussion and Implications

The Magnitude of the Curriculum Change In Turkey: A Paradigm Shift?

The curriculum is one of the important components of education; each curriculum represents a choice as to how to approach the education of students. Each perspective represents a particular, coherent set of assumptions about education. These assumptions are based on how learning occurs and how it is facilitated, what objectives are worthwhile, what kind of content are most important and how should the content be organized for instruction, and how educational progress should be evaluated (Posner, 2004). In addition to these, Hwang (1996) discusses that each educational position also differs according to their responses to ontological and epistemological questions such as 'what is nature of being and reality' and 'what is the nature of knowledge'. Gallagher (1993) argues that responses to such questions reveal the 'dominant paradigm' of a curriculum.

The analysis conducted in the light of predetermined and emerged themes indicated that the responses of the previous and new biology curricula to such questions are stand in stark contrast to each other. The summary of the main findings are presented in Table 1. The dimensions that were utilized in comparing the two curricula are placed on the left hand-side column in the table. The approach of the previous biology curriculum regarding these dimensions is presented on the middle column whereas the approach of the new curriculum is presented on the right hand-side column.

As summarized in the table, the dominant paradigm of the previous curriculum reflected the aspects of the positivist-behaviourist tradition (Gallagher, 1993) which assumes that there exists a reality independent of the individual and science can reveal such reality through a systematic method. Analysis indicated that knowledge was viewed as a commodity to be transmitted to students, learning was perceived as receiving, memorizing and storing knowledge and assessment was seen as determining whether the students have been successful in acquiring knowledge in the previous curriculum.

The dominant paradigm of the new curriculum, on the other hand, appeared to bear aspects of the constructivist tradition in which scientific knowledge is perceived as produced rather than discovered. In this tradition, learning is viewed as a process where learners actively construct personal knowledge, teaching is perceived to promote students' knowledge construction through activities fostering conceptual change and, assessment is viewed as a part of learning process that aims to evaluate and promote personal development.

To conclude, the analysis indicated that the ontological, epistemological and pedagogical positions of the two curricula located at the opposing ends of a continuum. Considering these, the curriculum reform taken place in secondary biology in Turkey could be seen as a paradigm shift of Kuhnian proportion.

Implications of the Study

What this summary and detailed analysis presented earlier illustrated is that a dramatic paradigm shift has taken place at secondary level science education in Turkey. The curriculum reform experienced in Turkey has introduced a new world for teachers, which is fundamentally different from the previous one. In this new educational world, teachers face with new educational aims and objectives, new understanding of the nature of scientific knowledge, a different theory on how people learn and related teaching and assessment approaches.

Table 1. Summary of the comparison of the two curricula

Dimensions	*Previous Biology Curriculum*	*New Biology Curriculum*
Curriculum Emphasis	Correct Explanations Everyday Coping	Structure of Science Science Technology & Decisions Scientific Skills Development
Nature of Scientific Knowledge	Existing truth or reality Science as body of knowledge Science as collection of facts Verification Objective Scientific knowledge as factual and absolute Cumulative progress in science	Explanations about natural phenomena Testable and falsifiable Contextual Subjective All scientific knowledge is tentative Cumulative and Paradigm Shift
Theories of Learning	Behaviourism Memorizing scientific truths Experiments as a process of verification Transfer of Knowledge Teacher-centred	Constructivism Conceptual change Concept maps Construction of knowledge Student-centred
Models for Teaching	Teacher as a expert Provide clear definition Give accurate explanations Present scientific truths	Teacher as a facilitator Pay attentions students' misconceptions Interacting with students
Assessment	Summative Assessment of products Traditional assessment tools End of unit assessment	Formative Assessing processes and products Alternative assessment tools In process assessment

Similar large scale reform movements in education take place almost everywhere in the world (Avenstrup, 2007; Kennedy, 1996). However, words like "reform" and "change" have become so popular and sloganized in education that, as Fullan (1991) criticized, we rarely stop to think what change really means and brings as we are experiencing it at the personal level. Due to this ignorance, often, such movements fail to meet with their aims as they face strong resistance from the practitioners in the field. Majority of the studies investigating this failure and resistance on the teachers' side attribute to factors such as the top-down nature of the reforms, lack of training, leadership, communication, etc. as the reasons. Without a doubt these factors constitute a major barrier in implementing large scale reforms; however the analysis conducted in this study also indicates that the paradigmatic shift that the reform movement brought about may also constitute an important barrier for successful implementation.

Continuing with Kuhn analogy, such paradigm shift would trigger a resistance on the practitioners' side. It can be argued that the major reason for the resistance to change on teachers' side could be the difficulty (if it is not impossibility) for teachers to comprehend the conceptual framework of the reform (or the new paradigm) as this requires denying the previous educational context in which they established themselves in. Fullan (1991) argues that the core values developed by individuals overtime regarding various aspects of education are difficult to change as such values are *'often not explicit, discussed, or understood, but rather are buried at the level of unstated assumptions'* (p:42). Considering the fact that the majority of the current biology teachers in Turkey, or teachers experiencing similar large-scale educational reforms elsewhere in the world, completed their pre-service education in the framework of the previous curriculum and established themselves and their practices using the theories and approaches embedded in it, they, more than probably, will resist to implement the new education program with its new approaches. Utilizing Kuhn's (1970) perspective, it can be argued that the greatest resistance would come from the more experienced whereas the new teachers may be more open-minded. Indeed, a research study by Gallagher (1991) with a group of 40 middle school science and mathematics teachers revealed that change process was slow and arduous. Although the study reported some success and many members of the group were able to make the change, this required substantial support, both internally from colleagues in their schools and externally from university researchers.

The aim of this discussion and tentative conclusions produced is not to draw a pessimistic or discouraging picture about the future or success of reform attempts. Rather, it is to provide a perspective about the meaning and psychology of educational change for an individual teacher. New courses of action are required to destabilize currently held views of teachers to promote accommodation and implementation of concepts and practices that educational reform brought about. We are aware that such a discussion requires evidence and research in this field is needed. However, we believe that viewing change as paradigm shift can be a useful conceptual and methodological approach for a better understanding the implementation process of and teacher resistance to large-scale educational reform (Schmidt & White, 2004).

Acknowledgements

This study was supported by the Scientific Research Projects Coordination Office of Marmara University, Istanbul/Turkey. Contract Grant Number: EGT-C-YLP-171209-0346.

References

Aitheide, D. L. (1996). *Qualitative Media Analysis.* Thousand Oaks, CA: Sage.

Anderson, R. D., & Helms, J. V. (2001). The ıdeal of standards and the reality of schools: Needed research. *Journal of Research in Science Teaching,* 38(1), 3-16.

Avenstrup, R. (2007). The challenge of curriculum reform and ımplementation: Some ımplications of a constructivist approach. *Ministry of National Education.*

Bickhard, M.H. (1997). Constructivism and relativisms: A shopper guide. *Science & Education,* 6(1-2), 29-42.

Bloom, B. S. (1956). *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain.* New York: David McKay Co Inc.

Crocker, R. K. (1983). The functional paradigms of teachers. *Canadian Journal of Education,* 8(4), 350-361.

Fullan, M. G. (1991). *The new meaning of educational change.* London: Cassell Educational Limited Wellington House.

Gallagher, J. J. (1991). *Framing the science support teacher program: context, history, assumptions, training and technical assistance.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, Fontana, WI.

Gallagher, J. J. (1993). Secondary science teachers and constructivist practice. In K. Tobin (Eds), *The practice of constructivism in science education.* Hillsdale, New Jersey: Lawrence Erlbaum Associates. pp.181-191

Hurd, P. D. (1998). Scientific literacy: New minds for a changing world. *Science Education,* 82, 407-416.

Hwang, A.S. (1996). Positivist and constructivist persuasions in instructional development. *Instructional Science,* 24, 343-356.

Irez, S. (2009). Nature of science as depicted in turkish biology textbooks. *Science Education,* 93(3), 422-447.

Kennedy, C. (1996). Teacher role in curriculum reform. *English Language Teacher Education and Development,* 2(1), 77-89.

Könings, K. D., Brand-Gruwel, S., & Van Merrienboer, J. J. G. (2007). Teachers' perspectives on ınnovations: ımplications for educational design. *Teaching and Teacher Education,* 27, 985-997.

Kuhn, T. (1970). *The structure of scientific revolutions.* Chicago: University of Chicago Press.

Lakatos, I. (1970). Falsification and the methodology of scientific research programmes. In I. Lakatos and A. Musgrave. (Eds), *Criticism and the growth of knowledge*. (pp.91-196). New York: Cambridge University Press.

Masterman, M. (1970). The Nature of a Paradigm. In I. Lakatos and A. Musgrave (Eds), *Criticism and the growth of knowledge*. New York: Cambridge University Press. pp. 59-89.

Matthews, M. R. (1997). Introductory comments on philosophy and constructivism in science education. *Science & Education* 6(1-2), 5-14.

Ministry of National Education (MNE). (1998). Lise Biyoloji 1, 2, 3 Dersi Ögretim Programı (Secondary School Biology Curriculum 1-3rd grades). *Tebligler Dergisi,* 61(2485).

Ministry of National Education (MNE). (2007). *Talim ve Terbiye Kurulu Başkanlıgı, Ortaöğretim 9-12. Sınıflar Biyoloji Dersi Öğretim Programı* (Board of Education, Secondary School Biology Curriculum 9-12 grades). Ankara: MEB Basımevi.

Osborne, J. F. (1996). Beyond constructivism. *Science Education,* 80(1), 53-82.

Posner, G. J. (2004). *Analyzing the curriculum. (3rd ed.).* New York: McGraw Hill.

Roberts, D. A. (1982). Developing the concept of "curriculum emphases" in science education. *Science Education,* 66(2), 243-260.

Roehrig, G. H., Kruse, R. A., & Kernl, A. (2007). Teacher and school characteristics and their ınfluence on curriculum ımplementation. *Journal of Research in Science Teaching,* 44(7), 883-907.

Schmidt, M., & White, R. E. (2004). Educational change: Putting reform into perspective. *Journal of Educational Change.* 5, 207-211.

Tsai, C.-C. (2002). Nested epistemologies: Science teachers' beliefs of teaching, learning and science. *International Journal of Science Education,* 24(8), 771-783.

Wendy, P. (1991). *Resistance to Change in Education: Themes in the Literature*. Graduate Student Paper, Syracuse University. ERIC Identifier ED330307.

Authors

Serhat İrez is an associate professor in Biology Education Department at the Marmara University. His research interests include the teaching and learning of the nature of science, the use of the history of science in biology teaching and, the professional development of teachers.

Çiğdem Han is a research assistant in Biology Education Department at the Marmara University. Her current research interests include educational reforms, teacher personal theories and, the teaching and learning of the nature of science. **Correspondence:** Marmara Universitesi, Goztepe Kampusu, Ataturk Egitim Fakultesi, Biyoloji Egitimi ABD, 34722, Kadikoy/Istanbul, Turkey.
E-mail: cigdem.han@marmara.edu.tr

Paradigma kayması olarak eğitim reformları: Eğitimsel değişimin doğasını ve öğretmen direncini anlamak için Kuhn'un bakış açısını kullanmak

Alanda yapılan çalışmalar eğitim reformlarına öğretmenler tarafından direnç gösterildiğini ortaya koymaktadır. Bu çalışma eğitim reformlarına öğretmenler tarafından gösterilen bu direnci Thomas Kuhn'un "Bilimsel Devrimlerin Yapısı" analojisini kullanarak açıklamaya çalışmaktadır. Bu amaçla geniş ölçekli eğitim reformlarının nasıl yeni bir kavramsal çatı ortaya koyduğunu göstermek için Türkiye'deki eski ve yeni biyoloji öğretim programları analiz edilmiştir. Bu çalışmada nitel araştırma yaklaşımı benimsenerek eski ve yeni biyoloji öğretim programları amaç ve vurgular, bilimsel bilginin doğası, öğrenme teorileri ve yaklaşımları, öğretim modelleri ve değerlendirme yaklaşımları açısından analiz edilmiştir. Çalışmanın sonuçları eski ve yeni biyoloji öğretim programları arasında paradigma kayması olarak değerlendirilebilecek felsefi yaklaşım farklılıkları olduğunu göstermektedir. Bu sonuçlar ışığında yeni programın ortaya koyduğu yeni kavramsal çatının anlaşılmasının zorluğu eğitim reformunun başarılı bir şekilde uygulanmasının önündeki en önemli engel olarak görünmektedir.

Anahtar kelimeler: eğitim reformu, paradigma kayması, öğretmen direnci