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SPIRAL DESIGN OF MICROSCOPE IN BOTH TURKISH SCIENCE CURRICULUM AND TURKISH SCIENCE AND TECHNOLOGY CURRICULUM

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ABSTRACT: *Reflection, refraction, light, mirror* and *lens* are needed terms for effective learning on microscope. It mainly depends on *reflection* and *refraction*. Students need to engage such scientific terms before the microscope practices. Therefore, this study investigates the contents related to the microscope in accordance with spiral curriculum. For an overall looking to *microscope* content in Turkish Science Curriculum (TSC), the official documents published by the Ministry of National Education were analyzed at part of *reflection, refraction, light, mirror* and *lens*. The contents which were listed in a comparison way used to examine whether there is a parallelism between such related terms or not. It is obvious that the K-level curriculum includes *microscope*. At 4 grade, students make simple observations using this tool. Each part of microscope are mainly introduced to the children at 6 grade. However it is clear that *light* and *lens* are needed contents to understand the microscope at 4 grade, *lens* is located in TSC at 8 grade. Although *light* is located in TSC in accordance with the spiral curriculum design, lens has not got a similar scope and sequence as it located in curriculum later than microscope practices. For further learning of such activities, it is absolutely required to be aware of the fact that *lens* and *refraction* are important basics for microscope. The result of this study also points out that there is a similar location between TSC and Turkish Science and Technology Curriculum (TSTC) in terms of spiral design of microscope use.

Key Words: Science curriculum, microscope, spiral curriculum, lens and refraction

INTRODUCTION

Microscope, the discovery of Leeuwenhoek, based on the lenses which he built into simple and one-lens one (Smith, 1959: 74). After the investigation of compound microscope in which one lens produces enlarged image that is further magnified by the second lens. The light system consists basically of a mirror and a diaphragm. An optical microscope is any device that enables us to see small details in a cell or microorganism by apparently enlarging them. It depends on the fact that light rays change direction when they pass from one lens into another (Schraer & Stoltze, 1990: 14). It is mainly based on lenses within a combination and produced image by various lenses, and mirror and the light rays which reflect it from light to ocular and objective lenses (Schraer & Stoltze, 1990: 15).

With a physical viewpoint, a mirror reflects rays and lenses refract light at their interfaces by the way light rays pass through it (Blatt, 1986: 610). Light sometimes acts a wave, sometimes like a particle. Reflection of light are wave nature of the light as the rays travel to any directions (Serway, 1992: 989). For instance, the eye is not a simple system amenable to the thin-lens approximation. It has optical properties that can be considered equivalent to those of a single lens (Blatt, 1986: 615). “Light” and “lens” are two important terms which need for deeply understanding of such device. “Mirror” can be added to these two terms because it is mainly located in the textbooks with “light” and sometimes “lens” together.

Microscope is a useful tool for the development of the manipulative skills in science education (ACSC, 1998:2; MEB, 2007: 138). It has a wide use in TSTC as quick observations for cell and microorganisms from 4 through 6 grades (MEB, 2005a: 133; MEB, 2007: 139; MEB, 2013:22). Even though science education starts at 4 grade in TSTC, pre-school curriculum includes “microscope use” for simple observations as an experimental tool (MEB, 2005b: 74). Due to the fact that it is mainly based on “light rays” and “lens”, students need to learn such

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scientific terms before the microscope use practices. Therefore this study clearly investigates the contents related the microscope regarding the spiral design of such content need to have been learnt before the microscope observations.

The previous location of microscope-use given above has an important place in elementary science curriculum. For this reason, it needs to locate in curriculum in line with the curriculum development processes such as spiral design. This is Bruner's famous curriculum development model where school subjects are situated developmentally over a number of years with increasing levels of complexity (Doll, 1993: 124). Therefore, the questions such as what shall be taught and when and how are the main concerns of the science curriculum (Bruner, 2003: 2).

The word curriculum, as an educational viewpoint, is that series of things which children and youth must do directed and undirected experiences by the way of developing abilities to do the things well (Bobbitt, 1918: 42). As the distinctions are not clear and the strong combinations are naturally exist among them, the levels in curriculum are continuously changeable for any updating which includes the scope and sequences of such scientific terms. The gradual development of curriculum and textbooks is a required perspective on the contemporary curriculum development studies.

But this belief is not a constant ideology which impresses the democratic and individual learning in science education. Since the flexibility and effect of the contemporary or post-modern ideas such as democratic education, science curriculum contents and methods need to take account of the critiques of modern science and strategies for achieving a more democratic science (Gough, 1998: 194). Bruner's believing which includes the fact that it is quite possible to teach any subject "effectively in some intellectually honest form to any child at any stage of development" would encourage us to think of knowledge in a new light (Doll, 1993: 124). This perspective has a parallelism with democratic science to large degree.

With the idea of Hamilton (1990) which includes that curriculum practice is integral to modern institution of schooling (Pinar et al, 2008: 1), the science curriculum needs to be organized taking care of the internal sequence as well as external effects. This relations in curriculum provide all the parts making connections with the directed and undirected experiences in time. This effort can also be suitable for the individuals development. Therefore this curriculum based-study primarily investigates the sequences of "microscope use" with "light" and "lens" in line with spiral curriculum designing.

METHODS

For an overall looking for *microscope* content in TSC and TSTC, the official documents published by the educational authorities of Atlantic Canada, France, Washington State and Turkey were searched at part of *reflection*, *refraction*, *light*, *mirror* and *lens*. The science curricula and books were subjected to the content analysis. The identified contents which were listed by the researcher in a comparison way used whether there is a parallelism between "microscope use" and such terms or not. Therefore the content analysis of sequences examining these terms are important at part of spiral curriculum design.

Content analysis is a technique which is usually, but not necessarily, used for written contents such as archival data (Lichtman, 2010: 190). It can be used in any context in which the researcher desires a means of systematizing and often quantifying data. Documentary approach is one of the characteristics of this qualitative research design (Bogdan & Biklen, 2007: 44). Documents' content analysis technique involves the steps such as determining the objectives, defining the terms, specifying the unit of analysis, locating the relevant data, developing a rationale, developing a sampling plan, formulating coding categories, reliability and validity, analyzing the data (Frankel & Wallen, 2006: 482-490).

Content analysis of the documents was used in this study since the researcher aimed at identifying the common use of microscope in three different Science Curricula and French Science Textbooks. Microscope use in such documents is suitable and sufficient to compare the scope and sequences by using this technique. For an apparent comparison, the researcher followed and applied the steps of content analysis on data obtained from the documents as follows.

Determining The Objectives

Six kinds of documents were used to identify the relevant data about "*microscope use*" in context. Statements of French Science Textbook at 6 grade (FST) and Turkish Science Textbooks from 3 through 8 grades (TST), and the Washington State Science Standards (WSSS) and Atlantic Canadian Science Curriculum (ACSC) and TSC and TSTC were checked to explain the relevance between such documents at part of "*microscope use*" contents. The researcher made a decision to use such documents since they can be enough to reach a valuable opinion

about the use of scope and sequence of "*microscope use*". All the documents are official because they were published by government organizations.

Defining The Terms

The important terms of the study are *reflection*, *refraction*, *microscope*, *mirror*, *lens* and *light*. As these terms are the main parts of the microscope knowledge at elementary level, it is clear that one can understand the inside parts and working conditions of this complex experiment tool. But the students need to learn such concepts before the microscope activities. If the teachers clearly points out the scientific activities or experiments, students can learn the concepts without any impression of any mystery or myth during the science learning process. Furthermore, it is known that learning follows the direction from concrete to abstract concepts and microscope activities are an important step between concrete and abstract concepts in visualization of science education.

Locating the Relevant Data

In accordance with this objectives of the study, TSC, TSTC, ACSC, WSSS, TST and FST units regarding the standards/skills/knowledge/activity about the microscope-terms which are mentioned under the previous headline of methodology were used to identify the relevant data.

Developing a Rotionale

The data sources are related to the objectives because such curricula and textbooks are indicators of *microscope use* in each country. Since the curricula and textbooks which are based on the standards/skills/knowledge/activity of each country include the scope and sequences of *microscope-use* from 3 through 8 grades. This relations is crucial to explain the TSC and TSTC whether the microscope content is located in the curricula or textbooks for a better understanding of the *microscope activities* during the school practices. As each searching examines whether such terms are located in each countries' curricula or textbooks or not, it easy to compare with Turkish ones and others in an easy way.

Developing a Sampling Plan

Both curricula of three countries and textbooks of two countries are sampled from K through 8 grades as such words *reflection*, *refraction*, *light*, *mirror* and *lens*. Both *purposive* and *convenience sampling* which are two of the nonrandom sampling method are used to develop a sampling plan. The researcher selected 6 related documents as they can clearly explain the scope and sequence of *microscope- use* in TSC and TSTC and they are convenient for a comparison from K through 8 grades (Frankel & Wallen, 2006: 103). Sometimes convenience sampling is not very credible and is likely to produce information-poor rather than information-rich cases as selection based on the identified data alone is not enough (Merriam, 2009: 79). In this study, since valuable documents content the related terms, the searching and checking processes of the curricula and textbooks at part of the previous words, has a parallelism with the aim of this study. Therefore the study has the ability of explaining the such relations. As the data of this study can be described and it is clear that how and when the data were collected and the data is related to the paradigmatic assumption of the study and the research questions are answerable given the data described (Hatch, 2002:144; Bogdan & Biklen, 2007: 65), this technique is clearly and easily applied on this study.

Formulating Coding Categories

The researcher identified the *coding categories* after the *defining terms* searching on the six kinds of documents regarding curricula and textbooks. *Coding units* were identified in accordance with the grades from 3 through 8 to compare the age level of teaching and learning of *reflection*, *refraction*, *light*, *mirror* and *lens* in such documents. The TSC and TSTC documents from K to 8 grades were subjected to the content anlysis to find whether there is a parallelism between microscope activities and optic concepts. Both microscope activities and optic concepts such as lens and light were listed in line with the grades from K through 8. You can also see a comparison of TSCand TSTC with WSSS and ACSC and FST in line with this list.

RESULTS and FINDINGS

Microscope Use in NSES and WSSS

National Science Education Standards (NSES) of the USA present criteria which can be made by state and local personnel and communities, helping them to decide which curriculum, staff development activity, or assessment program is appropriate (NSES, 2010: 12). The experiences and activities about life science in grades K-4

provide a concrete foundation for the progressive development in later grades of one of the major biological concept cell. They can learn living things with their environment by the way of various animals survive (NSES, 2010: 129). In grades 5-8, in which represents middle-school years in Turkey, students should develop understanding of cellular structure of living things. Students in grades 5-8 also have the fine-motor skills to work with a light microscope interpreting accurately what they see (NSES, 2010: 155).

Preparation to the learning of cellular structure and microscope use in life science, NSES provides to learn *light* before the 5-8 grades term. As the abstract ideas of science such as atomic structure of matter, energy, observation is an important process during the period of K-4. All of the three terms explaining the microscope, such as *mirror* and *lens* and *light* need to located in standards in grades K-4 (NSES, 2010: 127). This location of such concepts in USA leads us to the idea that pupils in grades 5-8 are ready to learn *microscope activities* as they were aware of the primarily relevant knowledge about *microscope* mentioned above. Yet, according to the 2000 National Science Education Standards (NRC), K-4 students develop simple skills using microscopes and magnifiers to observe the finer details of living and nonliving things (NRC, 2008: 162). But this is a simple observation and *light* and *lens* and *mirror* and *microscope* terms are located in the standards with a parallel situation to describe the organisms simply without mentioning the cellular structure of them (NRC, 2008: 168).

With a detailed use of NSES in Washington State, the standards do not contain microscope use and its combinations except *light* and general-visual classification of living-and nonliving things in grade K-1. 2-3 grades standards contain "light" as well. Bacteria and fungi as the members of microorganisms are located in the standards in 4-5 grades in Washington State Science Standards (WSSS, 2009: 60). This required the microscope use for a better understanding of such microorganisms and knowledge including the cellular structure of the plants and animals. Microscope and its similar example known as telescope and lens are used in observations in grade 3-5 in WSSS (WSEALR, 2005: 48). Light is a preparation for learning the previous scientific terms in WSSS (WSEALR, 2005: 36)

Microscope Use in ACSC

Microscope and telescope and other tools provide the learners to explore the complex classification system in the world (ACSC, 1998: 35). The first unit "Growth and Development" at second grade in ACSC suggests making observations in which the students may use various equipment such as magnifying lenses, microscope viewers and digital cameras (ACSC, 2005: 118). Before this level, the curriculum includes the use of *mirror* inside a box as a valuable tool to teach children related concepts in the first unit *Students as Individuals* at Kindergarten grade (ACSC, 2005: 14). This grade includes also *light* in a visual viewpoint and concretely as well as *mirror* (ACSC, 2005: 30). At 4 grade ACSC contents microscope in another viewpoint which categorize the optical devices to investigate the development of them in the past, present and future. Additionally this level of ACSC includes the working conditions which means that microscopes make visible objects that are too small to be seen with the naked eye and binoculars extend our ability to see far away objects. In this chapter, it is a useful organization for a curriculum development as it clearly and deeply includes *microscope* with *light* and *mirror* and *lens* together (ACSC, 2002: 40). Briefly, the ACSC organized knowledge of *light* and *mirror* and *lens* which are the basics of understanding the microscope functions clearly.

Microscope Use in FST

Science education in France from 11 to 12 years of age highlights the need to strongly link all scientific disciplines together with technology. This integrated science teaching is a basics for inquiry based learning at the primary level of French science education. Even if the disciplines which are Biology and Chemistry-Physics are separately are being handled, Just as other conceptual understanding in context, *Microscope-use* is located in science education textbooks with this interdisciplinary viewpoint.

For example, bacteria are observed using microscope device under the different magnifying conditions of each binocular and students measures and compares the diameter of the such samples being observed at 6 grade biology textbook (Duco, 2008: 84). This deep understanding of *microscope* at 6 grade probably based on the previous learning from kindergarten to 6 grade level.

Microscope Use in TSC

Microscope is located in TSC from 4 through 6 grades. At K level children can make simple observations with this learning tool (MEB, 2005b: 74). At elementary level in TSC, microscope is used for the purpose of simple observations at 4 grade (MEB,2013:12). It is used aiming at investigating the microorganisms (MEB,2013:18). Students learn the inside part of microscope at 6 grade (MEB,2013:22). The related knowledge such as *reflection*, *refraction*, *light*, *mirror* and *lens are* located in TSC. This location is seen on Table 1 year by year.

Table 1. Reflection, refraction, light, mirror and lens in TSC (MEB, 2013)

Grade	Skills including "microscope"	
	Number of Units and Name	**Contents of Related Skills**
3	3.4 Light and Sound	Natural Light Resources Light Reflectors
4	4.3 Introduction to The Substance	Light has no mass
7	7.4 Absorbment of Light	Pollution of luminous energy
8	7.6 Electricity	Colour Chart
	8.4 Light and Sound	Light energy
		Transformation of light and electricity
		Refraction and Lens

As seen on Table-1 students learn *light, reflection* and *mirror* before the microscope practices at 6 grade. They do not unaware of the *lens* and *refraction* to understand the working conditions of light microscope at this level because both terms are located in TSC at 8 grade.

There is a similar location of such scientific terms related to microscope in TSTC. As seen on Table 2, the comparison data in relation to *microscope* such as *reflection, refraction, light, mirror* and *lens* were listed to understand the scope and sequences. Here are the data obtained from TSTC:

Table 1. Reflection, refraction, light, mirror and lens in TSTC

Grade	Skills including *microscope*		Skills including *reflection, refraction, light, mirror* and *lens*	
	Number of Units and Name	**Contents of Related Skills**	**Contents of Related Skills**	**Number of Units/Name**
4	6. Visiting and Recognizing The Kingdom of Living Things	Observing the microorganisms without making connections with cellular structure and parts (MEB, 2005a: 133)	Transparent-Opaque and lighted-mat substance (MEB, 2005a: 74)	2. Introduction to the Substance
			Mirrors reflect the "light rays produced by various light-source (MEB, 2005a: 105)	4. Light and Sound
5	6. Visiting and Recognizing The Kingdom of Living Things	Observation for the classification of microorganisms (MEB, 2005a: 217)	Reflection of light (MEB, 2005a: 223).	7. Light and Sound
6	1. Reproduction, Growth and Development of Living Organisms	Observation and comparison of plant and animal cells using microscope (MEB, 2007: 90). Observing the stomata in plant leaves using microscope (MEB, 2007: 146).	Reflection of light on plane mirror and spheroid mirror. (MEB, 2007: 115)	7. Light and Sound
7	6. Human and Environment	Making observations and investigations for various ecosystems using microscope (MEB, 2008: 311)	Relations between eyes' visual problems and eye-lens (MEB, 2008: 44).	1. Systems of Human Body
			Finding the focal point of convex and concave lenses (MEB, 2008: 218)	5. Light

With the result of the comparison data on Table 2, it is clearly understood that TSTC includes *microscope* from 4 through 6 grades. The biology topics in these grades in orderly include *simple microorganisms' observations* at 4 grade, *classifying the microorganisms in line with microscope observations* at 5 grade, *using microscope becoming aware of functions of each part* at 6 grade. The TSTC includes understanding the *cellular structure* of the living things at 6 grade and therefore TSTC does not content the *cell observation on microscope* at 4 and 5 grade. Even though *microscope use* begins with pre-school science education in Turkey, the real use of it begins at 6 grade as this level includes learning the functions of each part of this experimental tool.

Each part of microscope are mainly introduced to the children at 6 grade. However it is clear that *light* and *lens* are needed contents to understand the microscope at 4 grade, *lens* is located in TSC four years later. Although

light is located in TSC in accordance with the spiral curriculum design, *lens* has not got a similar scope and sequence as it located in curriculum after the microscope-practices. For further learning of such activities, it is absolutely required to be aware of the fact that *lens* and *refraction* are important basics for microscope.

As compared with the TSTC, microscope has a similar location in TSC. It is clearly point out that *light* is a topic at K grade and *mirror* at 4 grade and *lens* at 7 grade. Though a complex topic called as eyes' visual problems such as myopia, hypermetropia and astigmatism are located in textbooks at 7 grade, the basic concept *lens* which needs for identification of them in a scientific viewpoint is located at 7 grade after four units. This is similar problem with the microscope content at 6 grade for a deep understanding of functions of each part.

This study aims to identify the place of *microscope use* in TSC and TSTC comparing with ACSC, WSSS and FST. As *microscope* can be learnt with its content mainly based on *reflection*, *refraction*, *light, mirror* and *lens* together, the science curricula need to include them in line with *spiral curriculum* design. Apparently, these terms are basics of learning *microscope*. Therefore comparison of such topics in various curricula or textbooks is a useful strategy to point out the *microscope content* considering the spiral curriculum design of TSTC (MEB, 2005a: 29) and TSC.

As a result of this comparison data obtained from the tables mentioned above, it is obvious that the TSC and TSTC include *microscope* at K level and from 4 through 6 clearly. At four grades students make simple observations just as K level regarding microorganisms. The parts of microscope device mainly introduced to the children in both TSC and TSTC at 6 grades. However it is obvious that *light* and *lens* are needed contents to understand the related microscope activities at 4 grades, *lens* is located in TSTC at 7 grade and in TSC ad 8 grade.

As compared with WSSS, microscope with *lens* and *light* is a useful learning tool after the 6 grades. It begins at 2 grade in ACSC including both *microscope* and *magnifying lens* observations. FST content learning microscope with *light* and *lens* to understand such observations sufficiently. Additionally, TSTC includes direction change of *light rays* in *magnifying lens* after the *people's vision problems* at 7 grades. The current location of *lens* in TSC is a similar problem to learn the *eyes' visual problems* for the reason that both *lens* and *eye* have not got a spiral design. The current TSC needs a review including the *reflection*, *refraction*, *light, mirror* and *lens* in line with this curriculum development model. Teachers need to know the scope and sequence of *microscope use* and *eye* for effective and meaningful learning.

CONCLUSION

The light microscopes were aged, heavy, and had obvious signs of wear and tear due to many years of student use. Some showed signs of age and use such as low luminescence scratched lenses, and limited field of view. The teacher had been told that the schools could not afford replacements and the teachers had to do *the best* with what they had in their classrooms (Dickerson & Kubasko, 2007). Even though such device is very simple as compared with the digital ones or online systems, It has a wide use in science laboratories (Yeşilyurt, 2005). The direct control of the light microscopes and easy-use of parts are some advantages of learning process.

The compound light, or optical, microscope uses two magnifying lenses in series to make things appear much larger to the eye than would be possible with a single lens (Moreno et al, 2008: 1). Physically, lenses refract light at their interfaces by the way light rays pass through it (Blatt, 1986: 610; Serway, 1992: 989). As seen in eye-lens example (Blatt, 1986: 615), some natural event inside or outside the body can be explained by the use of such technological device.

Students are expected to use appropriate technology such as microscope and lens and mirror togather, analyze and interpret data. Children read about scientific events and investigate scientific ideas and use technology to any further development for their understandings (Loughran, Smith & Berry, 2011: 23). As a guide primarily for teacher, science curriculum need to include the gradual learning of *microscope*. Bruner's developmental model (Doll, 1993: 124) is critical to circulate the knowledge (Bruner, 2003: 2) which the children learn gradually.

The idea of Hamilton (1990) which identifies the integration role of curriculum practice (Pinar et al, 2008: 1) is one of the basics of the gradual state of it. Because the relations in curriculum provides the teachers making connections with various situation, this curriculum based-study apparently identifies the sequences of *microscope use* with *reflection*, *refraction*, *light, mirror* and *lens* to make valuable connections with such terms in TSC and TSTC.

Microscope use in TSC and TSC has lack of parallelism with *refraction* and *lens* at this viewpoint. Although 6 grade TSC and TSTC include the understanding of microscope's functions, the most important concept related to such experiment tool is located in the curriculum at 8 and 7 grade. In fact, students need to have learnt such

knowledge before the 6 grade. It is easy to cope with this curriculum based problem by explaining the *reflection*, *refraction*, *light*, *mirror* and *lens* which can be used by the children with an active participation from K through 6 grade. This simple and clear problem based on the TSC and TSTC from K through 6 grades may stem from the lack of parallelism with the curriculum from 6 through 8 grades. If these concrete topics are located in the curriculum in line with Bruner's spiral curriculum design, eliminating the obstacles originated from the content of *microscope use* in TSC and TSTC can be possible.

RECOMMENDATIONS

These concrete topic *reflection*, *refraction*, *light*, *mirror* and *lens* is a useful one in the process of learning science as it appeals cognitive and emotional and psychomotor abilities of individuals. Though it is a complex device, children use its main feature known as magnifying and enlarging the particles which can not be seen with naked eye. Yet it can be an interesting strategy for them to understand such topics effectively, it is surely as a poor learning, but at elementary level children are suitable for realizing only simple observations under a microscope. For further learning of microscope content, it is required to be aware of its functions especially *reflection*, *refraction*, *light*, *mirror*, *lens* as they can be basics for learning of microscope functions.

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