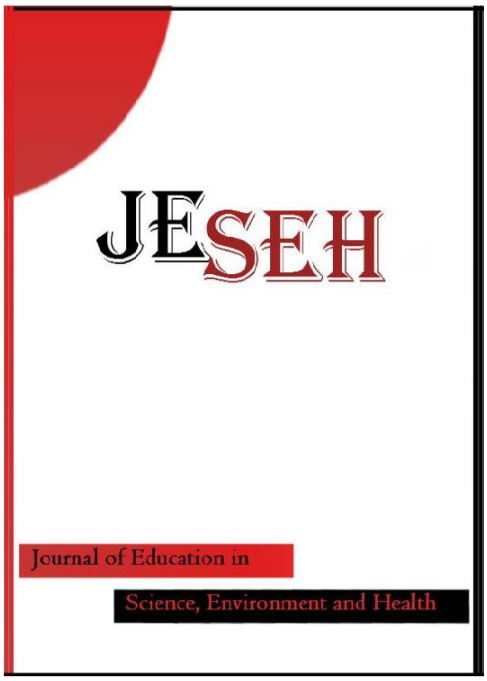

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Nature of Science Lessons, Argumentation and Scientific Discussions among Students in Science Classes- A Case Study in a Successful School

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Abstract

Argumentation is highlighted as one of the most important activities of science education by many researchers. The main aim of this research is to examine primary school students' nature of science classes and argumentation skills in terms of their academic success in primary science classes. Thus, the main interest of the study is centered on the nature of science lessons, the structure of the argument and an effort to scaffold students' understanding concerning the argument's structure. As this was considered the initial, but students have to acquire fundamental skills before dealing with the inner validity of an argument. Moreover, successful and chosen students for this study were studied carefully dense by the researchers. In that scope, the study was designed on ***qualitative*** research techniques which are detailed as explorative and fundamentally interpretation for the related topic. Since a particular school's successful students are considered in the research, it could be viewed and designed as a case study. The study is conducted with 8th graders with the age of 12-13 in a private elementary school. Focus group interviews and classroom observations during science lessons were the basic tools to obtain data. The results were grouped under the following aspects: objectives of science education, science teaching methods of teachers, teaching materials and teacher's attitudes towards his/her students during the class. Two science teachers in this school both give importance inquiry based teaching science. This research has demonstrated that even the most successful 8th graders in science classes do not necessarily understand fundamental concepts about nature and science. The science teachers in this research also mentioned that the interactive nature of information technologies can support students in carrying out inquiry-based activities, using problems, questions, and even theories that they themselves define and develop argumentation.

Keywords: Science education, Elementary science, Argumentation, Scientific discussion.

Introduction

A central idea of research in the field of science learning and instruction, with particular reference to Vygotsky and the sociocultural perspective, is that communication is the central element in linking students' views to science's way of modeling the world. From a socio-cultural point of view, communication is understood as a tool, not only as a means to delivering formation, but rather to engage students in 'talking their way' into the world of science. Furthermore, instead of evaluating the individual ability of students and teachers, educational success may be explained first by the quality of classroom dialogue (Mercer, 2007). In line with the sociocultural approach, researchers have developed the concept of 'dialogic teaching' (Alexander, 2004; Nystrand, Gamoran, Kachur, & Prendergast, 1997), understood not only as the interaction between participants in the classroom, but, especially in science, with teachers orchestrating the dialogue between daily thoughts and the view of science (Mortimer & Scott, 2003). Moreover, one of the systematic tools for enhancing scientific view among students can be called argumentation.

Argumentation is highlighted by various researchers as one of the most important activities in science education (Newton, Driver, & Osborne, 1999). Main reasons for this do not refer just to the educational value of argumentation as a skill but also to its value as a social skill (Erduran, Simon, & Osborne 2004). Despite its noted importance and the assertion that it is a skill that needs to be explicitly taught (Kuhn &Udell, 2003), argumentation is not adequately practiced in primary science education (Tytler& Peterson, 2003).

The main objective of this research is to examine primary school students' nature of science classes and their argumentation skills in terms of their academic success in primary school science lessons. Thus, the specific interest of the study is centered on the nature of science lessons, the structure of the argument and an effort to

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scaffold students' understanding concerning the argument's structure. As this was considered the initial, but students have to acquire fundamental skills before dealing with the inner validity of an argument. Moreover, a successful and chosen school's students for this study were studied carefully dense by authors. The purposes of the study in detail and research questions are presented in the following.

Purpose of the Study

The purpose of this study is to examine the nature of science lessons, argumentation and usage of scientific discussions of the 8th graders who are successful at science courses and Turkey's National High School Placement Test(TEOG). Moreover, the aim of the study is to explore whether there is a correlation between academic success at science classes and argumentation skills of the students. Moreover, one dimension of the research consist "Teacher's Behaviors and Student-Teacher Interaction in Science Classes"**.** It is expected that the results will highlight the importance of argumentation during scientific discussions in science classes.

In order to conduct a study about the nature of argumentation and usage of scientific discussions of the focused group in this research, the following research questions were asked:

a. How the nature of science is lessons organized in an academically successful elementary school's science class?
b. How are the teacher behaviors and student-teacher interactions in science classes?
c. Do the 8th graders who are successful in science classes and at TEOG argumentation in science lessons?
d. What is the nature of argumentation and scientific discussions in this science class?

Significance of the Study

Since the mid-90sresearch has increasingly focused on students' argumentation skills (Erduran& Jiménez-Aleixandre, 2008). Science educators not only argue that argumentation is an important aspect of science education in general; but they also assume that argumentation enhances the learning of the science content (Zohar &Nemet, 2002). On the contrary, research indicates that students' ability to argue is limited by their content specific knowledge (Means & Voss, 1996; Sadler, 2004). Even though these two arguments are present, research rarely explicitly addresses the interrelationship between argumentation (learning about science), conceptual understanding (learning of science) and academic success.

Research on argumentation often addresses the processes of students' activities (that is, their discourse about a topic or a task). Research on students' conceptual learning typically focuses on the outcomes of such processes (that is, students' conceptions at a specific point in time). Only rarely does research on students' conceptions focus on how students utilize their conceptual understanding while acting in "normal" learning settings. As a consequence, research aiming to relate argumentation and learning outcomes-academic success typically address students' conception prior and/or post to instruction which focuses on argumentation but not during this instruction (Zohar &Nemet, 2002).

Another methodological limitation in current projects is the idea of "quality" as a means to distinguish "good" from "poor" argumentation. Studies in science education typically offer at least two different approaches with either a content-oriented or a more structure-oriented focus (or a mixture of both). On the one hand, students' argumentation skills are assumed high quality when students' argumentation shows high relevance between data and claim (Means & Voss, 1996). On the other hand, the quality of an argumentation is assumed to increase when it consists of more justifications, which also rebut alternative arguments (Jiménez et al., 2005; Osborne et al., 2004; Zohar &Nemet, 2002). However, the quality of an argumentation might also differ in terms of the quality of conceptual understanding incorporated (Aufschnaiter et al., 2008). This situation should lead students' good scientific understanding and learning outcomes, so academic success.

This study is important because it aims at revealing the relation between academic success in science and nature of an argumentation and scientific discussions among elementary students. Also, it aims at helping to gain insights to readers about the issue. Academic success in this study is the achievement in science course which are measured by exam scores.

Method

The aim of this study is to examine the nature of argumentation and usages of scientific discussions of the 8th graders who are very successful at science classes and Turkey's National High School Placement Test (TEOG) in the research progress. In that scope, the study is designed on qualitative research techniques which are detailed explorative and fundamentally interpretive for the related issue. Since a particular school's successful students are focused in the research, it can be viewed and designed as a case study. *A case study* is a detailed examination of one setting, or a single subject, a single depository of documents or one particular event (Bogdan &Biklen, 2006, p. 59). According to this definition, it can be mentioned that a qualitative research design are meaningful for the explanation of a case in a private elementary school are conducted in this study.

Sample Group

The study will be conducted with 8th graders with the age of 12-13 in a private elementary school. This school is chosen as its students achieved successful results in National High School Placement Test. In year 2009, 2010, 2011 and 2012, students in the chosen school achieved the best scores in TEOG and ranked first among all primary schools in Ankara. When examined in detail, in terms of each section, the students' ranked first also in science section of the exam. Bearing these achievements in mind, 8th graders in this school aroused interest of the researchers and became main focus of this study. Since this study has a qualitative research design and in depth analysis of the case, maximum variation in terms of sampling will be done for the said group.

Data Collection

By this research we aim at obtaining detailed information in order to explain the correlation between argumentation skills and scientific discussion properties of successful students. Since this is a complex procedure, different types of data collection techniques were applied in the study. Q**ualitative** research methods used in order to obtain data. Focus group interviews and in-class observations during science lessons were the basic tools in order to obtain data. In that context, face to face interviews with participants are done and also data about students' argumentations were collected in a natural atmosphere. However, additional data collection tools were used when necessary such as videotaping during procedure of the study. Interviews were taped for transcription and analysis. Interview questions coincided with the answer of the research questions. After the tapes were transcribed, they were analyzed to identify prevailing themes by coding and categorizing the essential meanings of the responses. Same coding procedure was used during the observation process. Where notes were taken also on interactions in classroom by researchers in order to enrich and strengthen the obtained data.

Validity and Reliability of the Study

The major sources of data for the study were face-to-face interviews and classroom observations as mentioned above. In addition, researchers took notes during classroom interactions among students and between students and teacher. Each document underwent a qualitative analysis for identifying patterns and themes. In order to increase the reliability of the study, researchers applied peer debriefing on analysis and use data triangulation since they are important factors in ensuring the quality of a qualitative inquiry (Bogdan &Biklen, 2007). Moreover, direct quotes from teachers enhanced the credibility of the findings and conclusions. Researchers' notes on observations and the transcriptions of the science teachers' interviews are shared and discussed with the participants in order to discuss the accuracy of the records. Likewise, the content of the class notes, the transcriptions of the class discussions and the observation of the interaction among teachers' and their students were used to support the accuracy of the patterns and themes.

Results and Discussion

The main purpose of this study was to examine the nature of science lessons, argumentation and usage of scientific discussions of the 8thgraderswho achieved high success at science courses and TEOG. The main aim of the study is to explore whether there is a relation between academic success at science classes and argumentation skills of the students. At this point, elementary science teachers' supportive approach and in-class

behaviors could lead students attaining higher scientific discussion skill and so forth. So, the results and findings of this research were presented in the following sections.

Teacher Behaviors and Student-Teacher Interaction in Science Classes

This part of the study aimed at determining science teacher's behaviors and student- teacher interaction in science classes. In order to conduct the research, observations were made in the data collection process. Transcripts of the lessons were made collected and analyzed, with particular attention paid to interactions that involved questions. Many different aspects were observed and observation results were presented. The natural atmosphere of the observed class was examined and reported.

Natural Setting of the Class

There were 22 students in the class. In terms of classroom layout, there was a teacher table, a blackboard in the right hand side, and student chairs at the left side. Students were sitting two by two pupils and their faces were looking at the blackboard. There was an electronic board (smart board) next to the blackboard. Boys and girls were sitting in a mixed order. There was a classroom bookshelf behind teacher's table. Also a notice board was on the wall behind the students. Some posters and illustrations on the board were about English course. The class was enough illuminated, so it was radiant in the class.

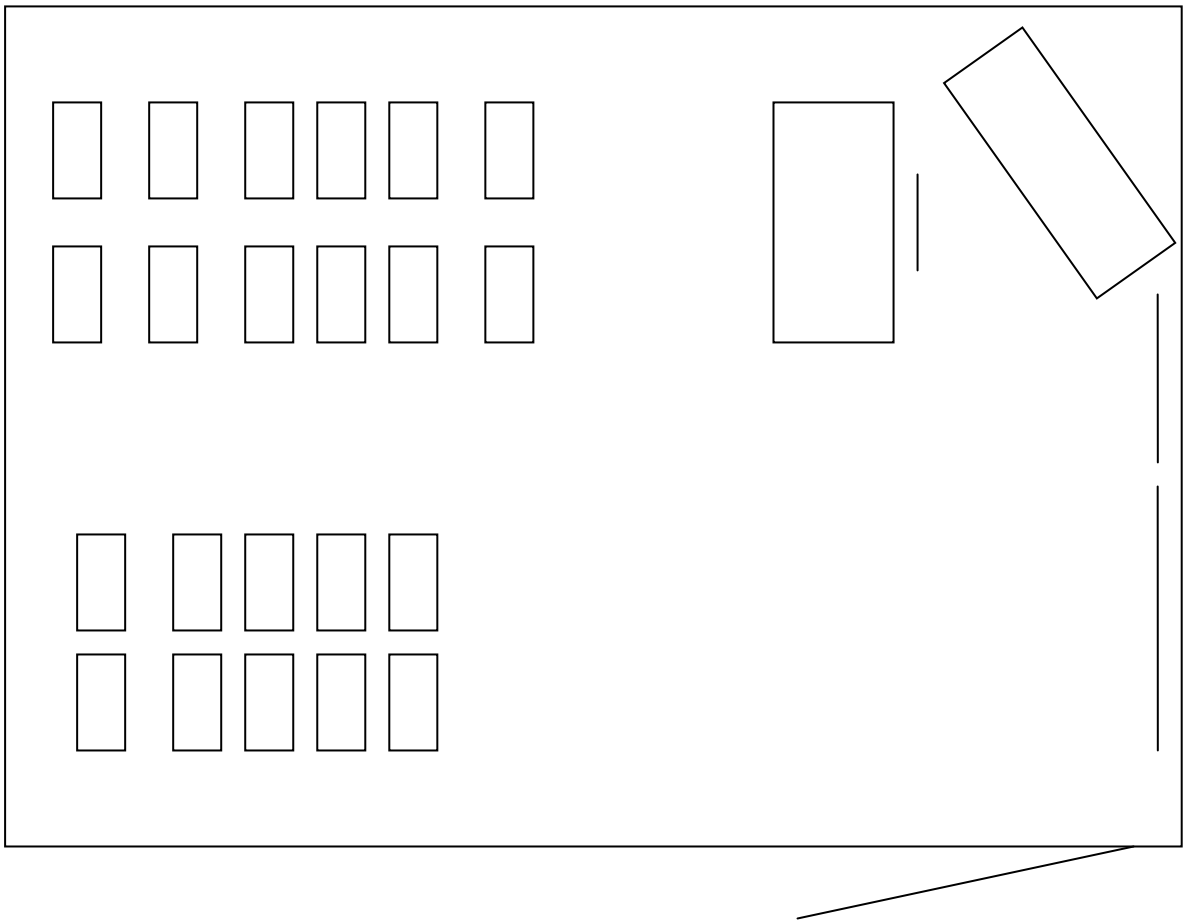

Figure 1: Natural setting of the science class

Evaluation of Teacher Behaviors and Interaction in the Class

The results of the observations were included the relationship between teacher's classroom management behaviors, student engagement and achievement of elementary science students. It was found that particular

management behaviors and class norms which were correlated with achievement and engagement by science teacher are:

- ✓ Identify students who do not understand directives and helps them individually,
- ✓ Maintain learner involvement in lessons,
- ✓ Reinforce and encourage the efforts of learners to maintain involvement,
- ✓ Attend to routine tasks,
- ✓ Use instructional time efficiently,
- ✓ Provide feedback to learners about their behavior,
- ✓ Manage disruptive behavior among students.

Another focus of the observations was the interrelationships among three major components of classroom teaching: subject matter's content knowledge, classroom management and instructional practices. The study involved elementary school science classes of different achievement levels taught by the same female teacher. Findings indicated that teacher's limited approach on student-centered teaching of science content.

Teacher's strict classroom order resulted in heavy dependence on the textbook and teacher's individual activities and avoidance of whole-class activities (e.g., discussion).

Additionally, one purpose of this study was to develop an analytical framework that represents in-class discussion and questioning in science, find out how teacher use questioning to engage their students in thinking about conceptual content. Enabling the construction of knowledge and identify the various forms of feedback were provided by teachers in the follow-up move of the initiation-response-follow-up format of teaching exchange. As Mercer (2007) highlights, instead of evaluating the individual ability of students and teachers, educational success may be explained first by the quality of classroom dialogue. Thus, lessons were observed across a variety of lesson structures such as expository teaching, whole-class discussions, and hands-on practical work. Unfortunately, there were any hands on practice in the lesson. Interactional issues related to ways of speaking and questioning that encourage student responses and thinking were addressed during the observation.

Classes were mostly thought with a teacher-centered method since the teacher preferred to instruct and explain the subject generally by herself. However, she used different types of questioning in the lesson. She asked open and close ended questions frequently. Sometimes she directed the question at a specific student or sometimes answered her own question by herself. She also used a known-answer question and controlled the dialogue. Teacher's feedback in the questioning process is crucial. Four different types of feedback were identified. They were; approving and disapproving, repeating students' responses with no feedback and providing manipulative feedback. Many times teacher told the students what to do.

The Nature of Science Lessons and Teacher Views in an Academically Successful School- Interview Results

An exploratory study was implemented about science teaching in a school which has high academic performance. One of the groups that are focused was science teachers of the school. Interviews were conducted with the teachers and obtained data were analyzed. Many aspects of science teaching in classroom were examined according to the results. Then results were grouped according to the following aspects: aim and objects of science education, science teaching methods of these teachers in their science class, materials used while teaching and teachers' approaches for being successful in science classes. Below the data analysis results and discussions for them are presented by teachers' views. The common framework of science learning outcomes described the goals of science education that these teachers mentioned are: A scientifically literate individual needs; to acquire certain knowledge, skills, and attitudes; to develop inquiry, problem-solving and decision-making abilities; to become a lifelong learner; and to maintain a sense of curiosity about the world.

Memorization of information emphasizes teaching the conclusions of others: "schools are reinforcing the message that science education is about remembering the results of other's research 'facts' rather than developing the ability to conduct one's own". Teaching of science as a body of irrefutable knowledge does not provide students with knowledge and understanding that will be useful for them in their lives; in fact, this erroneous perception simply reinforces a trend of either blind acceptance or mistrust of scientific research. Furthermore, a typical feature of science education has been that teachers rarely or never go beyond science content in their instruction, and do not relate content to other domains of scientific literacy to provide a larger context (Lederman, 1992). As pointed out by Lederman, "the most sophisticated view of knowledge available to

us today says that it is a falsification of the NOS to teach concepts outside of their social, economic, historical, and technological contexts".

Teachers in this school were both giving importance to inquiry for teaching science. They mentioned that developing inquiry skills should be one the most important aims of science teaching. The teaching of science in the K-12 (the sum of primary and secondary education) classroom has been less than successful. Students typically do not develop science literacy and do not understand the role and relevance of science in society. As one of the science teacher said:

"I think inquiry-based learning promises to improve science teaching by engaging students in real exploration, thereby achieving a more realistic conception of scientific endeavor as well as providing a more learner-centered and motivating environment. It can also be used to support teaching the nature of science. The inquiry approach is still not prevalent in the classroom, and is often misused. This may be the result of multiple factors, such as the duration of class hours, lack of effective means for students to conduct independent research, the difficulty of incorporating abstract concepts with inquiry, and lack of teacher expertise and experience. But in our school we are trying to do in this way."

Teachers argued that in support of the conclusion that students at the elementary, middle and high school levels do not develop a sound understanding of science that is useful for their everyday lives. Teachers have suggested that students do not see how science applies to everyday life, and thus there is very little integration of science with everyday thinking among students. This research has shown that according to teachers' views; even students with a higher success in science classes do not necessarily grasp fundamental concepts about nature and science.

"In a society increasingly permeated with developments in science and technology, an understanding of the nature of science enables students to be more informed consumers of scientific information. The majority of students do not, however, possess adequate conceptions of the science. Not surprisingly, then, science is said to be poorly taught in schools. Several aspects of traditional school science teaching may be responsible for this. Schools have typically employed a didactic approach, with an emphasis on transmitting the content of scientific theories to students: teachers dispense knowledge to passive student audiences, with textbooks alone constituting the science curricula; students are rarely involved in direct experiences with scientific phenomena. This approach does little to motivate real learning, and reflects the antiquated notion that students learn by being asked to memorize information.

These teachers argue that the learning environment created by science teachers play an important role in shaping students' perceptions of the way science is practiced and how new knowledge is created: *"Many teachers are exploring a constructivist approach to teaching which recognizes that each individual's existing knowledge and attitudes affect their learning.* This suggests that a constructivist approach to learning science may also make it easier to get students to learn how to "think scientifically". Inquiry-based learning, when authentic, complements the constructivist learning environment because (as) it allows the student to tailor his own learning process.

They also mention that the interactive nature of information technologies can support students in carrying out inquiry-based activities, using topics, questions, and even theories that they themselves define and develop. Thus, teachers have to become better equipped to act as a guide and facilitator, allowing student to engage in a more realistic scientific inquiry experience. In addition, they said that; computer-supported learning environments make it easier for students to propose their own research focus, produce their own data, and continue their inquiry as new questions arise, thus replicating scientific inquiry more realistically.

"It can support the teacher in focusing more on supporting and sustaining the teaching process."
"Furthermore, students who are permitted to use their own resources in developing, implementing and evaluating projects are likely to find, with little doubt, need for considerable revision."

By enabling, facilitating and supporting inquiry-based learning in the classroom, computer technology can also improve the teaching of science. It may be unrealistic to strive for a complete and thorough understanding and discussion of science in the elementary classroom, but teaching towards a basic understanding on science is possible. So, teachers can use computer technology in different ways to support their representation of elements of science.

Unlike the impression created by textbook learning, which is that science consists of fixed, unchanging facts, internet can much more effectively represent the fluid character of knowledge by its ability to revise information continuously and to provide access to various sources. Computer technology and media can also facilitate the manipulation of variables in experiments and models. Students can thus predict, observe, and explore the effects of experimental parameters on dependent variables in more complex experiments than it could ordinarily be replicated in the classroom.

"I like using simulations in my lessons very much. Simulations can also be used to further an understanding of the nature of science by facilitating the use of different methods to investigate the same issue."

The use of simulations can also assist teachers in shifting the emphasis to thinking, conjecture and talk about scientific method, about the reasons, limitations and benefits of carrying out controlled experimentation, and about qualitative interpretation of evidence. According to teachers; models are another important tool used in science investigations, and are valuable means of expressing an understanding of a process and of constructing knowledge. Research suggests that when using computer simulations and modeling, students tend to develop new strategies for solving problems and they complete tasks of greater cognitive complexity, test personal hypotheses by making predictions, develop higher-order thinking skills, and engage in complex causal reasoning. It is important to note that the use of simulations has certain potential drawbacks as well, and must be incorporated into the classroom with care.

However, one of the teachers warns that computer simulations should not be used to replace real experiences, but rather to support them. The limitations of virtual representations should be pointed out by the teacher, and an appropriate context should be provided to students. Lastly, the success in science lessons is discussed. Both of the teachers focused on motivation and told that it is a "necessity". They argue that teachers should obtain a positive feedbacks in-class atmosphere and should motivate students. When you talk about success in science: *"a successful student in science makes arguments and can discuss…"*

*"A successful student should be a good problem solver, makes inquiry and transfers the knowledge to his/her daily life and real life situations…".*One teacher described the successful student also reach the success in The National Exam. She told that the students who got high grades in TEOG can also be counted as a successful student.

Conclusion

The purpose of this study is to examine the nature of science lessons, argumentation and usage of scientific discussions of the 8th grade elementary students who have high academic success at science courses and TEOG. Meantime, the aim of the study is to explore whether there is a relationship between academic success at science and argumentation skills of students. Our results demonstrate that, firstly the natural environment of the science classes is accentuated. Then, results of the observations were included in the relationship among teacher classroom management behavior, student engagement, and student achievement of elementary science students. It was found that there are particular management behaviors and class norms which were correlated with achievement and engagement by science teacher. These are mostly identifying students who do not understand directives and helps them individually, reinforcing and encouraging the efforts of learners to maintain involvement in lessons, providing feedback to learners about their behavior and managing disruptive behavior among students.

Findings indicated that the teacher's limited approach on student-centered teaching of science content and her strict classroom order resulted in heavy dependence on the textbook and teacher centered activity and avoidance of whole-class activities (e.g., discussion) similarly. Lessons were observed across a variety of lesson structures such as expository teaching, whole-class discussions, and hands-on practical work. Unfortunately, there weren't so many hands on practice in the lesson. Interactional issues related to the ways of speaking and questioning that encourage student responses and thinking were addressed during the observation.

Teacher's feedback in the questioning process is crucial. Four different types of feedback were identified. They were; approving and disapproving, repeating students' responses with no feedback and providing manipulative feedback. Many times teacher told the students what to do. The results were grouped according to following aspects: aim and objectives of science education, science teaching methods of these teachers in their science class, materials used while teaching and teachers' approaches for being successful in science. The common framework of science learning outcomes described the goals of science education that these teachers mentioned

are: A scientifically literate individual needs to acquire certain knowledge, skills, and attitudes; to develop inquiry, problem-solving and decision-making abilities; to become a lifelong learner; and to maintain a sense of wonder about the world.

Secondly; teachers in this school are both give importance to inquiry for teaching science. They mentioned that developing the inquiry skills should be one the most important aims of science teaching and enriching argumentation skills. Students typically do not develop science literacy and do not understand its role and relevance of science in society. Teachers argued that in support of the conclusion that students at the elementary, middle and high school levels do not develop an understanding of science that is useful for their everyday lives. Teachers have suggested that students do not see how science is applied to the everyday life, and that there is very little integration of science within everyday thinking among students.

This research has shown that according to teachers' views; even students with the most 8^{th} grade success in science do not necessarily grasp fundamental concepts about nature and science. This result suggests that a constructivist approach to learning science may also make it easier to get students to learn how to "think scientifically". Inquiry-based learning, when authentic, complements the constructivist learning environment because it allows the individual student to tailor their own learning process. Science teachers in this research also mentioned that the interactive nature of computer technology can support students in carrying out inquiry-based activities, using topics, questions, and even theories that they themselves define and develop argumentation. By facilitating and supporting true inquiry in the classroom, computer technology can also improve the teaching of science. It may be unrealistic to strive for a complete and thorough understanding and discussion of science in the elementary classroom, but teaching towards a basic understanding is possible. Thus, as a result, we believe that teachers can use computer technology in different ways to support their representation of elements of science. The use of simulations can also assist teachers in shifting the emphasis to thinking, conjecture and talk about scientific method, about the reasons, limitations and benefits of carrying out controlled experimentation, and about qualitative interpretation of evidence. According to teachers; models are another important tools used in scientific studies, and are a valuable means of expressing an understanding of a process and of constructing knowledge. So usage of modeling for science concepts can develop students' scientific discussion and argumentation kills.

Recommendations

Recommendations for educators and researchers according to this research results are given below:

Development of scientific discussion and argumentation skills of elementary students requires a complex approach and education program. It can show a yearly progress for a student. A constructivist approach to learning sciences may also make it easier to get students to learn how to "think scientifically". Inquiry-based learning, when authentic, complements the constructivist learning environment because it allows the individual student to tailor their own learning process.

Teachers should illustrate a comprehensive approach on student-centered teaching of science content and also give importance to inquiry for teaching science. Improvement of the inquiry skills should be one the most important objective of science teaching and gathering argumentation skills.

The use of simulations and IT can also assist the teacher in shifting the emphasis to thinking, assuming and talk about the scientific method, about the reasons, limitations and benefits of carrying out controlled experiments , and about qualitative interpretation of evidence. Also usage of modeling for science concepts can develop students' scientific discussion and argumentation kills.

The results of this study are focused in-class-environment and activities of a specific school. Similar researches can be done within different stages of education via studying different type and level.

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