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IMPROVING THE QUALITY OF STUDENT QUESTIONS IN PRIMARY SCIENCE CLASSROOMS

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Abstract. *Even though student questioning is the key aspect of inquiry learning, students ask very few questions in Science classrooms. This research aimed to increase the number of high-level questions posed by primary students during science lessons. An experiment was designed in which the experimental group was taught about the taxonomy of questions that can be asked by students during a science lesson. The quality of selected student questions was discussed as a whole class throughout the implementation. In addition, the experimental group completed the textbook activities at the end of each section in groups, whereas, the control group finished these activities individually. The experiment lasted for 4 weeks (12 lessons), during the 'Microscopic Organisms and Environment' unit in two 4th-grade classrooms. After completing each section of the unit, student questions were collected. The questions were classified as either low-level or high-level questions. The findings showed that in the experimental group, there were significantly more high-level questions compared to the control group. The questions were longer and more comprehensive in the experimental group. In both groups, as students' achievement increased, so did the number of questions they asked.*
Keywords: *student questions, high-level questions, question taxonomy, primary science.*

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Introduction

In order to achieve scientific literacy, not only students but also citizens need to learn how to ask critical questions and seek answers about scientific phenomena. Student questioning has been emphasized by science education reforms around the world. When students ask questions, they are actively engaged and interested in the topic. They try to make sense of the world around them and try to construct knowledge through questioning. In science classrooms, students often find themselves in situations in which they need to conduct inquiries. Student questioning is the most crucial aspect of inquiry learning (Hofstein, Novon, Kipnis, & Mamlok-Naaman, 2005; Tan & Seah, 2011). Rather than teacher-directed materials, students' curiosity drives the lesson in inquiry learning. In this model, students are free to ask questions, collect data and analyse to answer questions (Jorgenson, Cleveland, & Vanosdall, 2004). Since students are actively involved in the processes, they hold more ownership of their learning and are thus more motivated to learn (Pedrosa-de-Jesus & Watts, 2014).

Students are naturally curious, and they bring their curiosity into classrooms (Ness, 2017). However, research demonstrates that a majority of questions in the classroom are asked by teachers (Eshach, Dor-Ziderman, & Yefroimsky, 2014; Kaya, Kablan, & Rice, 2014; Nystrand, Wu, Gamoran, Zeiser, & Long, 2003; Reinsvold & Cochran, 2012). The teacher's didactic teaching style (Cazden, 2001; Jung, Kim, Kim, & So, 2016), and her/his fear of losing classroom control (Jofili, Geraldo, & Watts, 1999; Rop, 2002), limited educational time (Chin & Osborne, 2008) and competitive and unfriendly classroom atmosphere (Jung, Kim, Kim, & So, 2016; Pedrosa-de-Jesus, Teixeira-Dias, & Watts, 2003) are the main reasons why student questions taper off in classrooms. Researchers also point out that students are not trained to ask questions in classrooms (Jung et al., 2016).

Question generation is a metacognitive process since it focuses students' attention on content and promotes deeper thinking (Chin & Brown 2002; King, 1994; Rosenshine, Meister, & Chapman, 1996). Student questions give clues about their understanding (Black et al., 2002; Chin & Osborne, 2008; Graesser & Olde, 2003) and their misconceptions regarding a topic (Etkina & Harper, 2002; Pedrosa-de-Jesus et al., 2003). They might also help teachers determine the direction of the lesson (Chin & Brown, 2002; Etkina & Harper, 2002; Keys, 1998; Pedrosa-de-Jesus et al., 2003) and view the instructional material from a different perspective (Marbach-Ad & Sokolove, 2000). Researchers state that generating questions in science improves students' problem solving skills (Dori & Herscovitz, 1999), motivation (Chin & Osborne, 2008), creativity and critical thinking skills (Cuccio-Schirripa & Steiner, 2000; Shodell, 1995) as well as trigger students' curiosity about and interest in a topic (Keys, 1998). Question generation improves students' performance in other disciplines, such as mathematics (Di Teodoro, Donders, Kemp-Davidson, Robertson, & Schuyler, 2011) and literature (Peterson & Taylor, 2012).

Student achievement is highly related to the quality of questions they ask (Harper, Etkina & Lin, 2003; Kaya, 2015). Higher-level questions are more influential in constructing knowledge compared to lower-level questions (Graesser & Olde, 2003; Hakkarainen, 2003; Hofstein et al., 2005; Lee, Chan, & van Aalst, 2006; Zhang, Scardamalia, Lamon, Messina, & Reeve, 2007). Higher-level questions activate critical reasoning, synthesis and evaluation skills, thus providing a deeper level of understanding (Chin & Osborne 2008; Graesser & Person, 1994; Shodell, 1995). However, students do not ask high-level questions spontaneously (Chin & Brown, 2002). The literature recommends that teachers use various strategies to encourage and stimulate students to ask higher-order questions. First of all, teachers need to establish a safe and welcoming environment for students to raise questions. Researchers state that when teachers acknowledge and appreciate questions, students gradually develop their skills to ask deeper and more inquisitive questions (Stokhof, De Vries, Martens, & Bastiaens, 2017). Another important strategy to promote student questions is to provide exploratory (hands-on) activities where students can observe, collect and compare data (Aguiar, Mortimer, & Scott, 2009; Lin, Hong, & Cheng, 2009; van Zee, Iwasyk, Kurose, Simpson, & Wild, 2001; Zeegers, 2002). Teacher-led experiments, field trips or real-world data collection often arouse curiosity and result in a greater number of student questions (Stokhof et al., 2017). Other strategies include modeling the syntax and vocabulary of questions (Allmond & Makar, 2010; Zeegers, 2002), providing e-learning environments (Hung et al., 2014; Tan & Seah, 2011), using visual tools, such as charts, post-its, boards, diagrams and posters (Stokhof et al., 2017), offering appropriate resources, such as texts or internet sources (Ness, 2013; Tan & Seah, 2011), and prompting strategies, such as 'What would you most like to know about ...?' or 'Is there anything you would like to find out about ...?' (Harris et al., 2011).

The current research focused on two of the strategies that can improve the quality of student questions. One of them is to train students in taxonomy of questions. Studies that focused on the taxonomy of questions with the primary school students are limited in the literature. The primary years are critical in terms of developing the ability to generate questions (Chouinard et al., 2007). However, they might have difficulty in phrasing questions due to their developing vocabulary and literacy skills (Zeegers, 2002). Therefore, they need explicit training in how to ask questions (Chin & Osborne, 2008; King, 1994; Marbach-Ad & Sokolove, 2000). Students need to be informed about fact-based, lower-order questions and open-ended, higher-order questions (Chin & Osborne, 2008). Teachers can support student questioning by discussing the quality of questions together with students (Stokhof et al., 2017).

The other strategy used in this research is using group learning contexts. According to sociocultural theory, knowledge is constructed through social interactions (Chin & Brown, 2002; Vygotsky, 1978). Ideas are exchanged during group discussions, and explanations are co-constructed socially (Mortimer & Scott, 2003). Collaborative group learning contexts foster progressive inquiry (Stokhof et al., 2017). During small group interactions, "student questions occur frequently and spontaneously as students work together" (van Zee et al., 2001, p.163). An idea or question might trigger other questions, thus encouraging and motivating students to do further investigation (Chin & Brown, 2002). In these contexts, students can comfortably think, analyse, and reflect (Pedrosa-de-Jesus & Watts, 2014). Since students are more active cognitively, these contexts are more conducive to higher-order student questioning (Chin & Osborne, 2008; Hofstein et al., 2004; Marbach-Ad & Sokolove, 2000). Teachers can monitor group discussions and check the usage of higher-order questions during these processes.

Types of Questions

Content-related questions are classified differently in the literature. Some researchers classified them as 'short answer' and 'long answer' (Graesser & Person, 1994), while others classified them as 'closed ended' and 'open ended' (Erdogan & Campbell, 2008; Reinsvold & Cochran, 2012). Nystrand and Gamoran (1991) used the terms 'authentic' and 'inauthentic'; Nassaji and Wells (2000) used the terms 'known information questions' and 'negotiatory questions' to describe different levels of questions. The current research used the classification of Chin and Brown (2000). They grouped questions as 'low level' and 'high level'. Low-level questions require simple recall of information. These types of questions are mostly routine and procedural. On the other hand, high-level questions require an application or

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extension of taught ideas. Students relate new and existing knowledge and integrate divergent information from multiple sources (Chin & Brown, 2000). While low-level questions limit students' thinking and learning (Lemke, 1990), high-level questions encourage different perspectives on a topic and co-construction of knowledge (Nassaji & Wells, 2000). The current research classified student questions as low-level or high-level questions.

In an observational research, Kaya and colleagues (2014) found that only 7% of questions in Turkish primary science classrooms were asked by students. Data was collected from 12 classrooms over four separate observations. On average, students asked two questions per lesson and these questions tended to be low-level or task-related. It is speculated that this is a common situation in most Turkish classrooms. Turkish education system is highly didactic and whole-class instruction is a common occurrence in all levels of schooling. Although constructivist methods are encouraged, many teachers still prefer teacher-centred methods. (Kizilçelik, 2015). This phenomenon led to conducting the current research. The purpose of this research was to find out if it is likely to increase the number of student questions asked in science classrooms, specifically high-level questions through certain strategies. There was not any similar research conducted in a Turkish context. The findings of the current research might set an example to further studies in Turkey and elsewhere. Furthermore, the research on student questioning mainly focuses on secondary school or college level students. Therefore, this research aims to contribute to the field by including primary level students. The main limitation of this research was the small sample size. Since this was a pilot trial, sampling of increased numbers of different classrooms was sacrificed for the precision in planning and implementation.

Methodology of Research

General Background

A quasi-experimental design was used in the current research. The dependent variables were the number and the level of student questions; the independent variables were the strategies used in the classroom. The experimental group was taught about the taxonomy of questions and completed the unit activities in groups. The control group was not taught about the taxonomy and they did not do group activities. The research problem was whether question-posing capabilities, enhanced through teaching the taxonomy of questions and group activities. The research was conducted during March of 2017for four weeks.

Sample of Research

The sample of research was 39 fourth grade students in two classrooms in Kocaeli district of Turkey. There were 17 females and 22 males with average age of nine. The school where the research was conducted was an urban school with average standing in terms of the nationwide standardised test scores and socioeconomic background of students. This school was preferred because the second author of this research was a teacher at this school, who was also a master's student. Since this was a pilot trial, convenience sampling method is used for practicality. Convenience sampling method provides accessibility to researchers and easy data collection.

In order to match groups, all fourth-grade classrooms at the school were administered an achievement test which was compiled from the released Trends in Mathematics and Science Study (TIMSS) questions. Two fourth-grade classrooms with similar achievement scores as well as similar demographics were selected for the research. In order to compare the achievement scores of two classrooms, non-parametric Mann-Whitney U test was conducted. This test was selected since the numbers of students in each group were less than 30. The test results are presented in Table 1.

Table 1. Mann-Whitney U test.

Group	Mean	*SD*	Mann-Whitney *U*	*Z*	*p*
Classroom A	14.10	.946	174.5	-.438	.661
Classroom B	14.16	.947			

As seen in Table 1, there was no significant difference between the mean achievement scores of two classrooms ($p > .05$). Classroom A was randomly assigned to experimental group and Classroom B was assigned to control group. There were 20 students in the experimental group and 19 students in the control group. Prior to conducting the research, permissions were granted by the district director of national education and the university's ethical committee.

Procedures and Instruments

The research lasted four weeks (12 lessons) during the unit of 'Microscopic Organisms and Environment'. Students learned about the functions of a microscope, historical development of microscope, characteristics and functions of microscopic organisms, interaction between living things and their environment, and the preservation of the environment. The experimental group received training on the taxonomy of science questions from their teacher, whereas the control group did not receive any training. In the experimental group, students also completed the textbook activities at the end of each section in groups. The experimental group was taught by the second author of this research and the control group was taught by their homeroom teacher. The lessons in the control group were monitored by the second author of the research in order to assure the research requirements.

The first author of the research was present in the classroom during training as well as the first week of implementation. She took field notes and provided feedback in order to assure that the lesson protocol is followed. In the training session, the differences between low-level and high-level questions were emphasised. Accordingly, questions that

- can be solved through rote memorization or a simple textbook and internet search,
- tend to have short answers (usually a couple of words),
- tend to have one way for solution,
- do not require deep thinking and connection to prior knowledge and experience
- are classified as low-level.
- And questions that
- cannot easily be solved through rote memorization or simple textbook and internet search,
- tend to have long answers (usually several sentences)
- can have different ways for solution,
- require deep thinking and connection to prior knowledge and experience
- are classified as high-level.
- Students practiced writing questions of both types. They were specifically encouraged to write high-level questions. For example, the teacher showed students these two questions:

1. What is a dam?
2. To what degree we can destroy natural and historical landmarks in order to build dams?

When students were asked about the difference between these two questions, many of them stated that the first question has an easy answer but that the second one has a long and difficult answer. They further stated that they could find the answer to the first question on the Internet or in textbooks. However, for the second question, they needed to discuss and evaluate different opinions. Some students might think that dams are necessary in order to provide energy, whereas others might believe that natural and historical landmarks should never be destroyed. Several low-level and high-level questions were presented to students for them to establish the differences. Table 2 shows sample questions used in the training.

Table 2. Sample low-level and high-level questions.

Low-level Questions	High-level Questions
1. How does a light bulb work?	1. Do you think the precautions for earthquakes in our country are adequate? Why?
2. What is the unit of mass?	2. What kind of innovations could genetic engineering bring to humanity in the future?
3. Can you show the parts of the eye on the model?	3. If you were to develop an illumination device that is environment-friendly, how would it work and what would it look like?
4. Who discovered vaccination?	4. How could we reduce our dependency on fossil fuels?

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Students were encouraged to use 'How', 'Why' and 'What would happen if' phrases as much as possible when writing questions. 'How' and 'Why' questions usually elicit higher order cognitive skills (Nystrand et al., 2003); however, these questions were classified as 'low level' if they required a single answer that can be easily found in the textbook. For example, 'How do we see microorganisms?' or 'How do we know plants are living things?' After the training, students were asked to work in groups and write low-level and high-level questions about the previous science units. After the group work, questions from each group were collected, and each group discussed as a whole class whether the questions were low-level or high-level.

For increased student interaction, in the experimental group, the unit activities were conducted in groups. There were four students in each group and the achievement levels of students in groups were heterogeneous. At the end of each section in the Science textbook, there was an activity to reinforce concepts and conduct further investigation. Students completed a total of four activities. They prepared a report about how to protect ourselves from harmful microorganisms, they completed posters about microorganisms, they prepared an album of living things and their environment by using newspapers and magazines and finally, they came up with a project for the preservation of the environment. In the control group, students completed these activities individually. Each activity lasted approximately 40 minutes. In both classrooms, the teachers monitored students' progress from afar and provided feedback when needed.

In the experimental group, at the end of each unit objective, students were given time to write questions on pieces of paper. They were allowed to discuss in their groups before writing their questions. Individual questions were collected in a box, and at the beginning of the following lesson, sample questions were selected and discussed in class. Students decided whether each question was classified as a low-level or high-level question. In the control group, individual student questions were also collected, and sample questions were discussed in class. However, the questions were not classified as low-level or high-level. Student questions were regularly recorded in a Microsoft Word document by the researchers.

Achievement Test

A science achievement test was developed by using released Trends in Mathematics and Science Study (TIMSS), fourth grade questions. TIMSS questions were preferred because they were developed by a panel of experts and they measure several cognitive process skills, such as classifying, comparing, interpreting, analysing, synthesising and drawing conclusions (Martin et al., 2008). There were 24 questions in the achievement test, 12 of which were in multiple-choice format and 12 in open-ended format. Each question was worth 1 point; therefore, the highest possible score was 24. There were eight questions from each of the following cognitive domains: knowing, applying and reasoning. The test duration was 40 minutes.

The achievement test was field tested with 317 fourth grade students from five different primary schools for another research conducted by the first author. KR20 reliability value was computed as .70. According to Fraenkel and Wallen (2008), KR20 reliability coefficient of a test should be .70 and above to acquire reliable scores. Therefore, the multiple choice test was considered reliable. For open-ended items, inter-rater reliability was used. The items were scored by two researchers independently. For the consistency of scoring, Cohen's Kappa statistic was computed as .88. This value indicates a high inter-rater reliability.

Student Questions

The dependent variable of this research was student questions. After completing each section of the unit, student questions were collected. Students wrote the questions on a piece of paper with their names on it during the last 20 minutes of the lesson. Students were encouraged to write all the questions they had in mind, and they were told that each question was important.

For classification of the student questions, one science education and one curriculum development professor from the university were consulted. Accordingly, short-answer, memorization questions that can be found in many textbooks were classified as low-level. On the other hand, questions that require deep thinking and research with long answers were classified as high-level. Student questions were coded as low-level or high-level questions by three researchers independently. The Cohen's Kappa coefficient, which determines coding consistency, was computed as 0.82. This value was considered sufficient for reliability. Disputes were resolved through discussion.

Data Analysis

The science achievement test scores of experimental and control groups were compared through Mann-Whitney *U* test in SPSS program. Frequencies and percentages for low-level, high-level and total student questions were reported for each group. To test the differences between the experimental and control groups in terms of the question count, a chi-square test was conducted. Furthermore, to determine if there was a correlation between students' achievement scores and the number of questions they asked, a correlation analysis was conducted.

Results of Research

A total of 160 student questions were collected during the Microscopic Organisms and Environment unit, which lasted for 12 lessons. Fifty-seven per cent of the questions were asked by the experimental group and 43% were asked by the control group. Of these questions, 66% were low-level and 34% were high-level questions. Table 3 shows the question counts in the experimental and control groups. A total of 91 questions were produced by students in experimental group and 69 questions were produced in control group. Forty-four per cent of the questions in the experimental group were high-level questions; this ratio was 20% in the control group (see Figure 1).

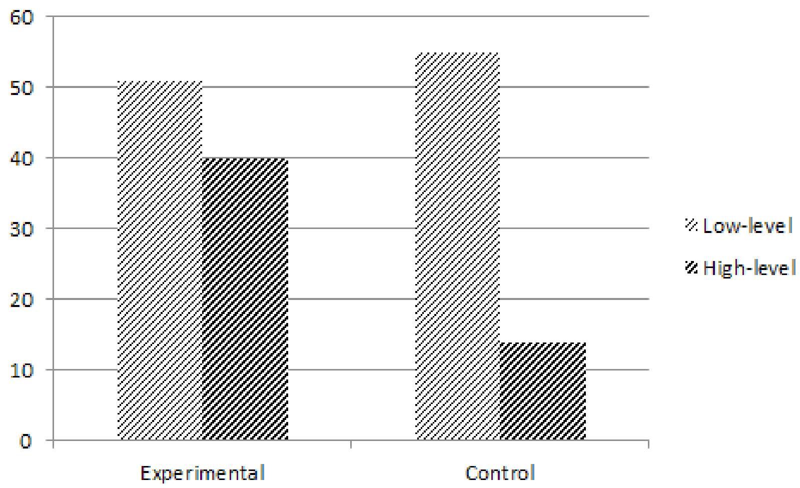

Figure 1. Questions in the experimental and control groups.

The number of questions per student in each group was found by dividing the total number of questions by the number of students in each group. The experimental group produced between four and five questions per student and the control group produced between three and four questions per student. In the experimental group, there were two high-level questions per student, whereas this number was less than one in the control group (see Table 3).

Table 3. Questions in the experimental and control groups.

Group	Low-Level	High-Level	Total	Questions per Student
Experimental	51 (56%)	40 (44%)	91 (57%)	4.55 (2 high-level)
Control	55 (80%)	14 (20%)	69 (43%)	3.63 (.7 high-level)
Total	106 (66%)	54 (34%)	160 (100%)	

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In order to examine the difference between the groups in terms of student questions, chi-square and Cramer's V tests were conducted. According to Table 4, the *p* value for the chi-square test is .002, which indicates a significant difference between the groups. In other words, more high-level questions were produced in the experimental group compared to the control group. Similarly, the ratio of low-level questions was higher in the control group compared to the experimental group.

Table 4. Chi-square and Cramer's V tests.

	Value	Asymp. Sig. (*p*)
Pearson Chi-Square	9.83	.002
Cramer's *V*	.25	.002

The Cramer's *V* value, which shows the size of the association between the groups and the type of questions, was found to be .25. Cramer's *V* values are reported between 0 and 1, and they are interpreted as correlation coefficients (McHugh, 2013). Between 0 and .3, the association is weak, and above .6 (or .7) the association is strong. In the current research, it is considered that there is a small to medium association between the groups and the types of questions produced in groups.

Table 5 displays some of the questions produced by the experimental and control groups. As can be seen from the sentence structures, the control group students preferred shorter sentences. Though this was not one of the dependent variables of the research, the questions in the experimental group tended to be longer and more comprehensive.

Table 5. Sample questions produced by the experimental and control groups.

Experimental Group	Control Group
1. Are there any negative effects of humans on the environment? (low-level)	1. What causes pollution? (low-level)
2. Are there any positive effects of humans on the environment? (low-level)	2. Which living things does pollution affect? (low-level)
3. How do technological developments affect the relationship between humans and the environment? (high-level)	3. What would happen if we do not protect the environment? (high-level)
4. Why do people build bridges and thermal plants even though they have adverse effects on the environment? (high-level)	4. Why do humans pollute the environment? (high-level)

The achievement scores used at the beginning of the research were matched with the numbers of low-level, high-level and total questions asked by each student. Correlation analysis was conducted in order to test for a relation between student achievement and the number of questions they ask. Since the sample size was small, non-parametric Spearman correlation coefficients were reported.

Table 6. Correlations between achievement and question count.

	Low-Level	High-Level	Total Questions
Achievement	.308	.477**	.485**
Low-Level		.424**	.703**
High-Level			.932**

$^{**}p < .01$

Based on the results in Table 6, there was not a significant correlation between students' science achievement scores and the number of low-level questions they asked (r_s = .308; p > .05). On the other hand there were significant correlations between the science achievement and the number of high-level (r_s = .477; p < .01) and total questions (r_s = .485; p < .01) produced by students in classrooms. In other words, students with higher science achievement scores, ask more high-level and total questions in science classrooms. The correlations were moderate (between .3 and .7). This finding implies that student questions in science give clues about their performance in this subject.

Discussion

This research aimed to increase the number of high-level questions posed by primary students during science lessons. An experiment was designed in which the experimental group was taught about the taxonomy of questions that can be asked by students during a science lesson. The quality of selected student questions was discussed as a whole class throughout the implementation. In addition, the experimental group completed the textbook activities in groups, whereas, the control group finished these activities individually. The findings showed that in the experimental group, there were significantly more high-level student questions compared to the control group. The questions were longer and more comprehensive in the experimental group.

In a similar study, Di Teodoro and colleagues (2011) taught Canadian primary school students about 'surface' and 'deeper' questions. They described deeper questions as questions that provide students the opportunity to create, analyse or evaluate. Students completed question sorting activities and later, they discussed the question criteria as a whole class. Using this strategy was highly supportive of students and the percentage of 'deeper' student questions rose from 16% to 70%. Di Teodoro and colleagues suggest starting the teaching of questioning early in the school year and building up throughout the year.

King (1994) states that different types of questions allow constructing different knowledge structures. For example, a question such as 'How does … affect …?' helps students connect and integrate several ideas and a question such as 'What would happen if …?' induces creative thinking. In order to prompt students to link the new material to their prior knowledge, a question such as 'How does … tie in with … that we learned before?' could be useful. King further notes that primary level children can be trained to generate these kinds of complex questions and they can also be taught how to formulate explanations.

Another finding of the research was that there were significant correlations between student achievement and the number of high-level questions they generated. This finding was consistent with previous studies that were conducted at various levels of schooling (Cuccio-Schirripa & Steiner, 2000; Harper et al., 2003; Kaya, 2015). Hofstein and colleagues (2005) state that the content of a question indicates the level of thinking of the person who raised it. The challenge is that making student questions a common component of science lessons and having all students to be able to ask high-level questions. Classroom implementations could focus on low-achieving students. This and other previous research showed that high-achievers ask more high-level questions compared to low-achievers. Strategies could be adapted to the needs of low-achieving students and different scaffolding techniques can be utilised to promote high-level science questions (Kaya, 2015).

Since teachers are the key to reinforce student questioning, they need to be informed about how to ask high-level questions and strategies that may trigger high-level student questions. Current science education practices put the learner in the centre rather than the teacher. Teachers are expected to encourage students to ask questions and let these questions direct instruction (Marbach-Ad & Sokolove, 2000). Marbach-Ad and Sokolove (2000) point out that in order for students to appreciate the importance of questions in science classrooms, teachers should respond to students' questions as much as possible. Even though teachers may find it difficult to provide an active learning environment for students, they can hold a 'question session' periodically to find answers to student questions. This way, students can ask their questions in a non-threatening environment. Teacher can model for students by asking her/his own questions in order to stimulate students' deep-thinking skills. Asking high-level questions requires deep thinking, which sometimes takes time. Therefore, pre-planning for high-level questions is important for teachers in order to use instructional time more efficiently (Di Teodoro et al., 2011).

This research showed that interaction among students is another factor to improve the quality of student questions. As researchers point out, small group work facilitates better learning compared to individual learning (Johnson & Johnson, 2009). Specifically, high complexity level questions are generated when there are student-student interactions (Dori & Herscovitz, 1999). Knowledge building is a collective effort and it is believed that different ideas and questions are triggered during group discussions. In terms of the achievement grouping,

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Kaya (2015) did not find a difference between homogeneous and heterogeneous groups in terms of the level and number of student questions produced within groups. Therefore, teachers can modify groups based on the topic and students' interest. Common interest grouping might yield better results compared to achievement grouping. When students have similar excitement and motivation levels about a topic, they might encourage each other to think deeper and ask high-quality questions.

Researchers suggest other simple techniques to promote student questions, such as 'question brainstorming' at the beginning of a topic where students produce as many questions as possible. Another technique can be a 'question box' inside the classroom into which students put their questions to be answered by other students (Watts, Gould, & Alsop, 1997). 'Question journals' or 'question homeworks' where students are rewarded for asking good questions could be other ways to use in order to develop question-writing behaviour in students. Tan and Seah (2011) recommend online forums where student ideas are investigated, revised and rebuilt through open-ended tasks introduced by teacher. These online discussions help participants deepen their understanding of the topic.

Above all, teachers need to create a welcoming atmosphere for student questions since good questions are generated in receptive classrooms. Unwelcoming classrooms negatively affect the questioning behaviour of students with low self-esteem (Pedrosa-de-Jesus & Watts, 2014). Pedrosa-de-Jesus and colleagues (2003) state that students' questioning is related to their learning styles and personality. Some students cannot handle uncertainty and ask questions to receive satisfying answers, whereas others prefer to live with uncertainty without explicit questions and answers. However, asking good questions can be taught and improved in a receptive and comfortable classroom atmosphere.

Even though the findings of the current research are encouraging, they need to be taken with caution due to some limitations. The apparent limitation of this research was the small sample size. The experiment included only two classrooms in a primary school. There is room for research in the area of student questions in science classrooms that includes larger groups. Another limitation was the length of the treatment. The treatment in this research lasted for four weeks. It is important to sustain these strategies and turning questioning into a classroom tradition for improved student questions.

The third limitation has to do with data collection. This study used students' written questions as a data source for practical reasons. However, in doing so it might have sacrificed authenticity. Some students might not be motivated to generate questions when specifically asked to do so. Future studies on student questioning can focus on oral questions generated by students in more authentic contexts. Audio or video recording might provide rich data of classroom conversations. Various aspects of student questioning could be examined through audio or video data, such as complexity of questions and explanations, teacher's responses as well as gender and achievement level issues.

Conclusions

This research showed that learning about and discussing the taxonomy of questions, as well as group activities significantly increased the number of higher-order questions asked by students in primary science classrooms. Students in the experimental group asked almost three times as many high-level questions as those in the control group. There was hardly any similar research conducted in a Turkish context where education is highly didactic and teacher-centred. This research shows that through small modifications, even in teacher-centred classrooms, it is possible to stimulate students to ask questions. The findings suggest that teachers need to pay special attention to teaching about and modelling for students how to formulate good questions. The teaching needs to include taxonomy, language and grammar of questions. Furthermore, as part of the science curriculum, teachers can explicitly teach low-level and high-level questions. Teachers are recommended to include interactive group activities more frequently for high-level student questioning.

Science, by nature, triggers student questions easier compared to other subjects. It is worthwhile to investigate how to improve student questions in subjects such as Reading and Social Studies. Though anecdotal, the teacher of the experimental group mentioned that, after the treatment, his students started asking more high-level questions in other lessons as well. He also mentioned that when students have a problem inside the classroom, they started asking questions such as "How can we solve this problem?" rather than "Who/What caused this problem?"

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Finally, the current research focused on the number and quality of questions produced by students during Science lessons and not the discussions that followed. Some researchers argue that, as well as the quality of questions, their function within the context is also important. Some low-level questions may stimulate deeper thinking as much as high-level questions. Therefore, it is worth to examine whether student questions lead to educationally fruitful classroom discussions and which type of questions elicit more interested responses and elaborated explanations. In the current research, students in the experimental group asked longer and more comprehensive questions compared to the control group. It is likely that they can formulate more comprehensive explanations when trained.

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