Res Sci Educ (2010) 40:223–238
DOI 10.1007/s11165-008-9119-4

Questions About Physics: The Case of a Turkish 'Ask a Scientist' Website

Sevda Yerdelen-Damar · Ali Eryılmaz

Published online: 3 February 2009

Abstract The physics questions submitted to an 'ask a scientist' website were classified with respect to field of interest in physics, type of requested information in the question (factual, explanatory, etc.), and motivation for asking the question (applicative or non–applicative). In addition, differences in the number of females' and males' questions in these classifications were determined. Analysis of 995 physics questions submitted to the website indicated that modern physics questions (30.7%) were the most frequent while vibrations and wave motion questions (3.3%) were the least frequent. More than half of the questions (57.8%) were submitted to request factual information. Motivation to ask a question was inferred from the question, and was generally not related to direct and/or personal application. There were obvious differences in the number of questions asked by females and males: 84.7% of questions were asked by males while 15.3% were asked by females. However, significant gender differences were not observed in field of interest in physics, type of information requested in the question, and motivation for asking the question.

Keywords Physics education · Physics questions · Interest · Gender

Questions are vital education tools generally for all disciplines and especially for science (Dori and Herscovitz 1999). Generating questions promotes learning and comprehension (King 1992; 1990; Palincsar and Brown 1984). de Jesus et al. (2003) argued that student-generated questions are significant in the teaching and learning process, since they expand

S. Yerdelen-Damar
Yüzüncü Yıl University, Van, Turkey

S. Yerdelen-Damar (✉) · A. Eryılmaz
Faculty of Education, Department of Secondary Science and Mathematics Education,
Middle East Technical University,
06531 Ankara, Turkey
e-mail: yerdelen@metu.edu.tr

understanding and retention of what is learned, and they increase students' interest, enthusiasm and engagement.

Understanding the nature of the questions generated by students and their roles in learning are essential processes in teaching (Chin et al. 2002; Ram 1991). Chin et al. (2002) proposed that the information regarding the nature of students' questions clarifies important issues about student questioning. They argued that this information helps teachers to use students' questions in their teaching and to alter their instruction to provide individual differences in learning approaches. Although generating questions is useful for students and teachers who use these questions, the findings from research studies have indicated that students are generally unwilling to ask questions. However, many studies have revealed that students could ask meaningful, valuable, critical, and more questions when the opportunity is given to them (Colbert et al. 2007; Costa et al. 2000; Dori and Herscovitz 1999; Harper et al. 2003; Hofstein et al. 2005; Marbach-Ad and Sokolove 2000).

Several researchers have classified students' questions to make sense of them. For example, Scardamalia and Bereiter (1992) differentiated students' questions as knowledge-based questions formed before the instruction and text-based questions formed after exposure to text materials. Text-based questions are prompted by a text and are usually related to the text. On the other hand, knowledge-based questions are questions that spring from a deep interest of the child and originate from an effort to make sense of the world. The source of questions could be a gap or discrepancy in the child's knowledge or a desire to increase knowledge in some direction. Scardamalia and Bereiter (1992) claimed that they did not aim to indicate a sharp distinction between text-based and knowledge-based questions. Knowledge-based questions are often motivated by events and reading a text can be such an event. Two kinds of mental representations created during text comprehension lead to making a distinction between knowledge-based and text-based questions. These are a text base, representing the propositional content of the text, and a situational model, representing the world that relates to the text. Questions may result from either representation; however, they would not be the same questions. Scardamalia and Bereiter (1992) noticed that knowledge-based questions have higher educational value than text-based questions. Questions generated in the knowledge-based condition were judged significantly superior in their potential contribution to knowledge, in their focus on explanation instead of fact, and in requiring more complex information searches. They also observed that depending on familiarity of the topic, knowledge-based questions differed between basic questions asking for information needed for orientation to a topic and wonderment questions aimed at explanation or at resolving discrepancies in knowledge. Chin et al. (2002) argued that the type of questions that students ask can reveal their depth of thinking. Wonderment questions are related to a deep approach to learning science whereas basic information questions are associated with a more surface approach. Baram-Tsabari and Yarden (2005) categorized 1,676 science and technology-related questions submitted by Israeli children to a series of television programs using five coding schemes: field of interest, motivation for asking question, type of information requested, country-specific aspects, and source of information. The results of the study suggested that biology, technology, and astrophysics were more popular than other sciences. They also identified a change in interest and motivation for asking the question with age and various gender differences within the sample.

Student-generated questions can be used as an indicator of their understanding (de Jesus et al. 2003), knowledge and conceptions in their mind (Marbach-Ad and Sokolove 2000; Thompson 1924), their curiousness (Commeyras 1995) and their interests (Ram 1991;

Thompson 1924). However, students' interests are generally measured using Likert-type scales. Osborne et al. (2003) argued that interest inventories are common techniques used to measure science interest. These inventories generally include presenting respondents with list of items and then asking them which ones they are interested in. On the other hand, such inventories are generally restricted to the specific focus producing only a limited view of what may or may not be formative about attitudes to science. Furthermore, a great deal of research studies have focused on students' questions in classroom settings (Chin et al. 2002; Chin and Kayalvizhi 2002; Colbert et al. 2007; Costa et al. 2000; Dahlgren and Öberg 2001; de Jesus et al. 2003; Harper et al. 2003; Hofstein et al. 2005; Marbach-Ad and Sokolove 2000). However, there is little known about students' questions produced outside of the classroom settings. The present study, as in the study by Baram-Tsabari and Yarden (2005), addressed students' self-generated questions to determine students' interest, motivation for asking questions and level of thinking. Spall et al. (2004) claimed that substantial ideas about students' views about science, what might deter them from choosing to study science and what might inspire them to study science could be obtained. On the other hand, these studies may mask different attitudes to subjects within science (Woolnough 1995 as cited in Spall et al. 2004) because students generally do not view science as a homogenous subject; instead they differentiate between branches of science. Thus, interest in physics should be investigated as a discrete area from other sciences to gain more precise picture of students' interest in physics.

Krapp (2005) defined interest as a specific kind or quality of person–object relationship. Interest plays a significant role in learning (Häussler and Hoffmann 2000; Hidi 1990; Hidi and Reninger 2006; Hoffmann 2002; Laukenmann et al. 2003). The development of interest should be one of the primary goals of education because it motivates meaningful learning, promotes long-term storage of knowledge, and provides motivation for further learning (Schiefele 1991). Hoffmann (2002) indicated that introductory physics instruction oriented to girls' and boys' interests instead of traditional physics lessons resulted in significantly better learning achievements for males and females. Laukenmann et al. (2003) identified that students' interests had a positive effect on their learning in physics. Moreover, Gungor et al. (2007) noted that students' situational interests had higher correlation with achievement in physics compared to other affective characteristics.

Many studies have indicated that girls are more interested in biology than physics (Chiristidou 2006; Jones et al. 2000; Miller et al. 2006; Osborne and Collins 2001; Stark and Gray 1999; Stewart 1998; Woodward and Woodward 1998). In addition to this, Trumper (2006) observed that boys demonstrated a higher interest and had more out-of-school experience in physics than girls. Dawson (2000) compared boys' and girls' interests in science in both 1980 and 1997. The results showed that overall the mean level of interest was slightly higher for boys than girls in 1980 and again in 1997. Zohar and Sela (2003) carried out a study to determine what gender issues were at play in Israeli advanced placement physics classes. They found that the ratio of girls to boys in advanced placement physics classes in Israel has not changed between 1988 and 2000, and it was roughly 1:3. Furthermore, their study indicated that the boys and girls studying advanced placement physics differed significantly with respect to future career plans. More boys than girls wanted to engage in physics related occupations. Jones and Kirk (1990) examined the type of physics applications that students were interested in learning more about at school and explored the gender differences within that choice. The students all showed that they were interested in applications that directly involved people; however, girls were more interested in medical applications.

Context of the Study

The Journal of Science and Technology published since 1967 is one of the most popular journals in Turkey. Its target readers are generally above 13 years old and it reaches almost 45,000 people in a month ('The Publications of The Scientific and Technological Research Council of Turkey', 2007). The questions sent to its website which we called 'ask a scientist' have been archived under the 'You're Curious about' link for almost 3 years according to related areas, such as physics, chemistry, biology, medical and engineering. When the people want to ask their questions, the website requests them to write their name, surname and e-mail address in addition to their questions. There are no other prompts that frame the question submission process. There is an instruction in this page which suggests to people that before submitting their questions, they should determine whether the same questions have been asked before because the same questions are not answered more than once. In addition, it is claimed in the information that the questions will be answered by experts at least within one week ('You're Curious about' 2007). This journal and website are published by the Scientific and Technological Research Council of Turkey. The Scientific and Technological Research Council of Turkey is the leading agency for management, funding and conduct of research in Turkey. It was founded in 1963 with a mission to improve science and technology, carry out research and support Turkish researchers. The Council is an autonomous institution and governed by a Scientific Board whose members are selected from prominent scholars from universities, industry and research institutions ('The Scientific and Technological Research Council of Turkey', 2007).

Purpose of the Study

This study aims to classify the physics questions submitted to an 'ask a scientist' website with respect to field of interest in physics, type of requested information in the question and motivation for asking the question, and to determine whether there are differences in these aspects between females' and males' questions.

Participants

This study focused on 723 questioners who submitted their questions to the website. Since there was no demographic information about the participants except their names, we did not have detailed information about our participants. However, because the target readers of the Journal of Science and Technology are above 13 years old, we can conclude that most of the questioners are above 13 years old. Furthermore, most of the questions gave indications regarding their owners. When these indications were considered, it was seen clearly that the questioners had various educational backgrounds and different ages. For example, questions, such as, 'I am a student in the senior class of a high school; we are learning polarization…?' gave hints about the grade levels of the questioners. Questions, such as, 'I work as a technician in a private company…?' provided indications of their occupations.

As explained before, the submitted questions are grouped under the 'You're Curious about' link according to related areas, such as physics, chemistry, biology, medical, and engineering ('The Title of Subjects' 2007). The present study considered only the questions related to physics. In the physics group, 723 questions were presented to the website until

July, 2007 in almost three years (‘Physics’ 2007). Of these questions 272 had sub-questions. These sub-questions were considered as separate items; then, the total number of physics questions was 995.

The names of the questioners were used for gender determination. In Turkey, the names of people give indication about their gender. Only a few names are given to both sexes. Since 71 questions did not contain name and six of the questioners’ gender were not determined by their names, these questions were not included in the gender analysis. From the remaining 918 questions, 778 (84.7%) were asked by males and 140 (15.3%) were asked by females.

Procedure

Types of the questions were determined with regard to field of interest in physics, type of requested information in the question and motivation for asking the question based on the categorization by Baram-Tsabari and Yarden (2005). Fifty questions sent to the website were independently classified by two researchers for inter-rater agreement. The agreement between the two researchers was 92% for field of interest in physics, 90% for type of requested information in the question, and 88% for motivation. Discrepancies between the two codings were discussed and resolved. After complete agreement was obtained, classifications of the questions were conducted in three stages.

In the first stage, the classification of the questions in terms of field of interest in physics was conducted based on the subject titles of the textbook ‘Physics for Scientists and Engineers with Modern Physics’ (Serway 1992). The reason why this textbook has been selected for classification of the questions is that it is used as a primary textbook in many Turkish universities as well as overseas. Three terms used in the field of interest in physics aspect need the clarification concerning to what they refer. The selected physics textbook includes six parts: mechanics, vibrations and wave motion, thermodynamics, electricity and magnetism, light and optics and modern physics. The field category refers to these parts. The subcategory refers to the chapters in the book. Finally, the topic refers to the topics which are covered in the chapters. The questions were categorized under the chapters according to the information needed to answer them. However, there were some submitted questions that needed information which was not covered in any chapters of the textbook being used to categorise the questions. These questions were classified under the chapters in the textbook judged to be nearest to the information asked in the questions. For example, the answer to the question ‘Why does vapour pressure not depend on atmospheric pressure?’ required the information related to ‘factors affecting vaporization’. According to our opinion, this topic should be covered under the chapter of ‘Heat and the First Law of Thermodynamics’, thus this question was categorized under the chapter of ‘Heat and the First Law of Thermodynamics’.

The categorization of the questions according to type of requested information in the question and motivation for asking the question were carried out in the second and third stage, respectively. The questions were classified in these stages by using the same categories, coding schemes and procedures carried out in the study of Baram-Tsabari and Yarden (2005). They used six coding schemes, namely, factual, explanatory, methodological, evidential, open-ended and applicative, in the type of requested information classification. The category of ‘Factual’ information contained terminological (What is…?), historical (When was …?), and confirmatory (Is it true that…?) items. The category of ‘Explanatory’ information was basically ‘Why’ and ‘How’ questions. Requested information about scientific research was coded into ‘Methodological’ and ‘Evidential’. The ‘Methodological’ information was related to scientific ways of finding things out and with scientific and technological procedures. The ‘Evidential’ information dealt with how we know what we know. The ‘Open-ended’ information was related to opinions, controversial themes, and futuristic questions that science can not answer for the time being. Finally the ‘Applicative’ information dealt with the setting where scientific and technological knowledge is being used to solve problems and challenges. In the classification of motivation for asking the question, they applied ‘Applicative’ and ‘Non-applicative’ categories. The ‘non-applicative’ category was subdivided into ‘Spectacular aspects’, ‘General curiosity’, ‘Seeking an explanation for a direct observation’ and ‘Linguistic aspects’. Spectacular aspects arose from the questions regarding the ‘biggest’, ‘fastest’, ‘smallest’ etc. Linguistic aspects were emerged from questions about why things are named the way they are. ‘Seeking an explanation for a direct observation’ stemmed from people’s personal observation. ‘Applicative’ category was subdivided into ‘Personal use’ and ‘Human health and lifestyle’.

Results

The results of field of interest in physics are presented first. Following this, the findings related to type of requested information in the question and motivation for asking the question are given. Finally, the results based on gender are summarized.

Field of Interest in Physics

The questions were classified into six main categories: mechanics, vibrations and wave motion, thermodynamics, electricity and magnetism, light and optics, and modern physics. Some examples of the categorized questions submitted to the website are presented in Table 1 (only subcategories containing above 2% of the questions were exemplified).

Thirty eight of the questions were not included in the determined categories for field of interest in physics because 16 of them were related to solar energy, 12 were related to properties of matter and 10 were related to alternative energy sources, and these topics were not involved in the selected physics textbook.

The result of field of interest in physics categorization showed that the most interested category was ‘modern physics’ (30.7%). It was followed by ‘mechanics’ (27.9%) and ‘electricity and magnetism’ (23.8%) as shown in Fig. 1. However, ‘vibrations and wave motion’ (3.3%) attracted the least interest according to the questions. The percentage and frequency of the categorized questions in all subcategories according to field of interest in physics are given in the Appendix.

When sub-categories were considered, the findings revealed that most of the questions were concerned with ‘atomic physics’ (8.6%) while ‘alternating current circuits’ (0.1%) was rarely of interest. Table 2 presents the most concerned topics and their frequencies.

Type of Requested Information in the Question

Six codes were used in this category; namely: factual, explanatory, methodological, evidential, open-ended and applicative. Table 3 shows some examples of the classified questions according to type of requested information in the question.

Table 1 Some examples of classification according to field of interest in physics

Category	Subcategory	Example
Mechanics	The laws of motion	We know that friction does not depend on the area of contact except air resistance. Well then, why is narrow iron placed under snow sled? Is the purpose of this to make sled lighter or are there other reasons? Or for reducing air resistance?
	Work and energy	Does friction cause objects to gain energy? If so, how does it happen? The reason for asking this question is due to one situation. Think that there is an object on a car and there is friction between the car and the object. When the car moves one side, the object moves opposite, thus, it gains speed which causes increase in kinetic energy of the object.
	The law of universal gravitation	The topic I wonder about is Kepler's Laws. Why do objects move in elliptical orbits instead of circular orbits?
	Fluid mechanics	Why does pressure of fluid decrease where its speed increases, and is there any similarity between this situation and the rise of an object from ground when it moves very fast?
Vibrations & Wave Motion	Sound waves	Why is sound produced when two solid objects collide, when we pour one liquid on another liquid, and when we vibrate a stick in the air?
Thermodynamics	Heat and the first law of thermodynamics	It is said in the high school books that the potential energy of the pure substance does not change when it is not in change of phase. But when we heat it, we give energy to pure substance. Thus, the force between molecules decreases, that is, molecules should diverge. Why does potential energy of the substance remain constant?
Electricity & Magnetism	Electric fields	It is seen that a charged ebonite rod loses charge after some time. Although the ebonite rod does not transmit electric charge, what are the reasons of this?
	Direct electric circuits	Where do free electrons producing current in the electric circuit, which contains only a generator, resistance and connecting cables, come from?
	Magnetic fields	Why is monopole magnet nonexistent? If it is found, what changes in our life?
	Sources of the magnetic field	Why does a permanent magnet attract an unmagnetized steel nail? Do you explain what happens in the nail?
	Electromagnetic waves	What is the speed of electromagnetic waves emitted from our mobile phone? If they have same speed as light, why don't we see these waves?
Light & Optics	The nature of light & the laws of geometric optics	The speed of light which passes from air to water decreases, but why the speed of light is equal previous speed again when the light passes from water to air?

Table 1 (continued)

Category	Subcategory	Example
Modern Physics	Relativity	As I know as Einstein connoted with E=mc2 formula that any object reaches the speed of light. As I know as this theory was disproved and it is approved that the object which reaches the speed of light divides into its molecules. Then, why does the object separate into its molecules?
	Quantum mechanics	What are the events where electrons exhibit wave characteristic?
	Atomic physics	Why do electrons not fall into the nucleus although electrons are negatively charged and protons are positively charged?
	Molecules & solids	Why is glass not included into solid category?
	Nuclear structure	A radioactive atom turns into a new element with one number increase in the number of its protons after beta decay. Because the produced new element is neutral, the number of its electrons raises one number, too. What is the source of the electron which partakes in new element?
	Particle physics & Cosmology	What is the exact purpose of the antiparticle? I heard that obtaining an antiparticle is expensive, is it right?

The analysis concerning type of requested information in the question indicated that more than half of the questions wanted factual information (57.8%). It was followed by explanatory information (26.1%). However, information regarding scientific research (methodological and evidential) was only 7.9% of the requested information (see Fig. 2).

Motivation for Asking the Question

The examples of the categorized questions in terms of motivation for asking the question can be seen in Table 4. The results regarding motivation for asking the questions revealed that the majority of the questions (88.2%) were asked for non-applicative reasons.

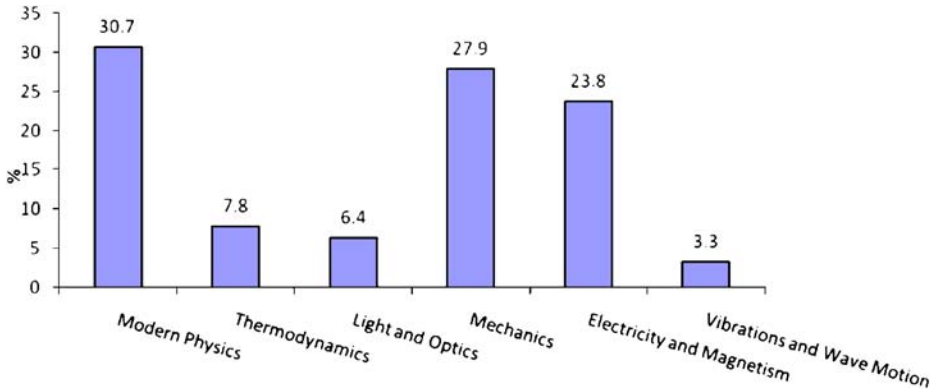

Fig. 1 Percentage of the categorized questions according to field of interest in physics

Table 2 Frequency of most interested topics

Subject	Frequency
Einstein's Principle of Relativity	36
Friction	31
Law of Radioactive Decay	10
Photon	10
X-rays	9

The findings proposed that most of the questions were asked because of general curiosity. Fig. 3 shows the percentage of the questions regarding motivation for asking the question.

Gender

In this study, 84.7% of the physics questions were asked by males. On the other hand, males asked 48% of the biology questions that were submitted to the same website. According to the Higher Education Council report ('The Higher Education Council', n.d.), there was a gender difference in the number of students accepted in the departments of physics and biology, and the departments of physics and biology education programs that train high school physics and biology teachers in Turkey. Table 5 presents the number and percentage of the students in physics and biology fields and their gender. These results suggested that females were more likely to prefer studying biology to physics while males were more likely to prefer studying physics to biology in Turkey in accord with other countries (Osborne et al. 2003; Zohar and Sela 2003).

The percentages of the categorized questions based on field of interest in physics, type of requested information in the question, and motivation for asking the question were similar for males and females, as can be seen in Fig. 4, 5 and 6. Therefore, all chi-square tests for differences were not significant (because all p values were greater than 0.05). That is, there were no significant mean differences between females and males in terms of field of interest in physics (χ^2=5.690, p=0.338), type of requested information in the question (χ^2=3.791, p=0.580) and motivation for asking the question (χ^2=5.94, p=0.312).

Table 3 Some examples of classification according to type of requested information in the question

Category	Example
Factual	What is Pascal's law? (Female)
Explanatory	Why do we write 3d orbital before 4s orbital when we write the distribution of electrons? (Female)
Methodological	How is the mass of a neutron, a proton and an electron measured? (Male)
Evidential	We were told that inertial force actually does not exist. Is inertial force not constant and real? What is evidence of this? (Male)
Open-ended	I wonder that an atom separates into quarks, leptons, and gluons. When does it stop? If separation stops, what is the source of energy of the first remaining particle? (Male)
Applicative	I am one of participants of the project about hydrogen energy. Our purpose is to store hydrogen energy using sun energy. I want to learn how I can make this using a DC supply. In addition, please share extra information that I may use in this project? (Male)

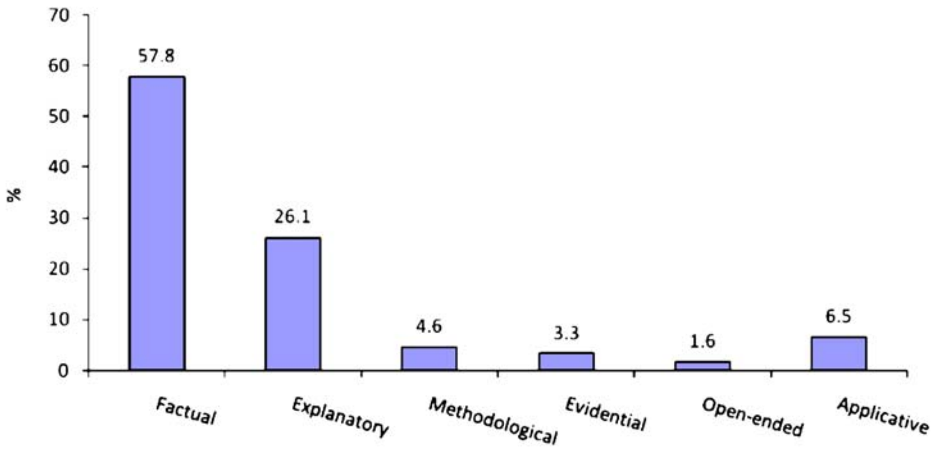

Fig. 2 Percentage of the categorized questions according to type of requested information in the question

Conclusion and Discussion

The interests of students have generally been determined using interest inventories while this study used students' self-generated questions to identify their natural interests. The results of the study showed that most of the questions were asked by males in the physics group while females submitted more questions than males in the biology group. These results suggested that males had higher interest in physics than females, and females were more interested in biology than physics. These findings are compatible with previous studies in the literature (Chiristidou 2006; Dawson 2000; Jones et al. 2000; Miller et al. 2006; Osborne and Collins 2001; Stark and Gray 1999; Stewart 1998; Trumper 2006 Woodward and Woodward 1998; Zohar and Sela 2003). Although most of the studies found there were differences in males' and females' interests in the categories of physics topics, in this study, female and male students who submitted questions to the website and showed an interest in physics did not differ in their interests towards the physics subjects. One reason

Table 4 Some examples of classification according to motivation for asking the question

Subcategory	Example
Spectacular aspects	Is the speed of light the last point for the speed of objects? Is there bigger speed? (Male)
General curiosity	What is the relationship between photons and atoms? (Male)
Explanation for an observation	Our teacher took us to Feza Gursey science centre. There, the teacher put a candle on a metal bucket. (S)he held a charged metal knob towards the fire of candle and the fire moved towards the metal knob. What could the reason of this be? (Female)
Linguistics	The nucleus of an atom includes protons, neutrons and the forces named pi-mesons. Why were these forces named pi-mesons, that is, why pi? (Male)
Personal use	I am trying to make a device which measures distance using an ultrasonic transmitter and receiver. But my circuit is not working, is there any circuit that you can suggest? (Female)
Health & lifestyle	I am a fashion designer student. I will design a dress which contains too many magnets. I want to learn, is this harmful to human health? (Female)

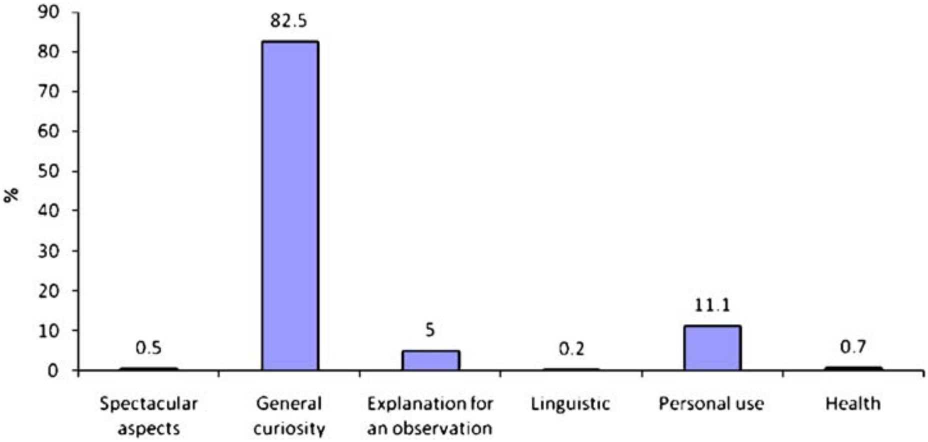

Fig. 3 Percentage of the categorized questions according to motivation for asking the question

for this result might be that there was a difference between all students and those who submitted their questions to the website since both females and males in this study have already more interest in physics.

More than half of the questioners requested factual information in their question. This finding showed that the asked questions were far away from educational desires. Similar results were also observed in other studies (Baram-Tsabari and Yarden 2005; Chin et al. 2002). Furthermore, motivation for a majority of the questions was non-applicative, as in the study of Baram-Tsabari and Yarden (2005), and general curiosity was the main reason for asking the questions.

There were some limitations of the study requiring clarification. One limitation of the study was that the sample might not represent all Turkish students because it was self-selected on the basis of interest in physics, which brought into question the external validity of the study. The sample represents the students who have more interest in physics and access to internet connection. These students might ask different types of questions from the others. We did not have any information about the questioners' age, socioeconomic status, grade level, etc., which might have some effects on the results of the study. Another limitation was that we assumed that individuals asked only their own questions. However, the categorized questions might be put to them by other people, such as, their teachers, friends, parents, etc. Furthermore, the number of the questions classified into the categories

Table 5 Number of students for physics and biology majors and their gender

Major	Gender		
	Male Frequency (Percent)	Female Frequency (Percent)	Total
Physics	13,122 (67.8%)	6,241(32.2%)	19,363
Biology	8,146 (41.6%)	11,411 (58.4%)	19,537
Physics Education	1,522 (60.8%)	983 (39.2%)	2,505
Biology Education	883 (40.3%)	1,310 (59.7%)	2,193

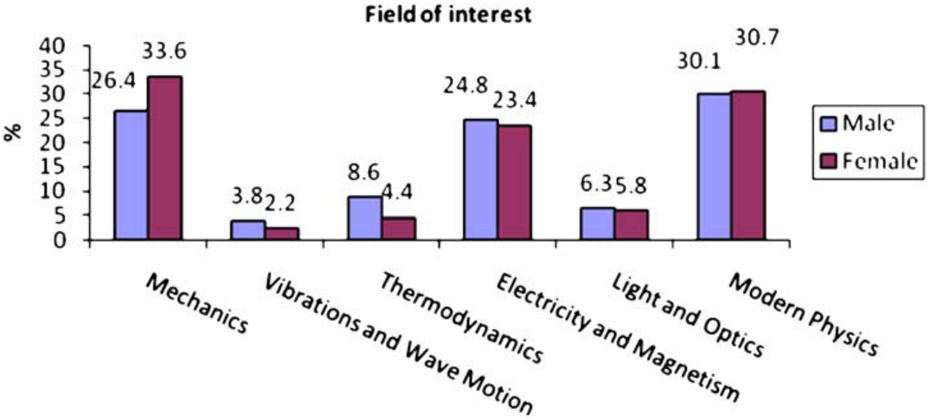

Fig. 4 Percentage of the questions of males and females according to field of interest in physics

with respect to field of interest in physics might also depend on the amount of information in each category. Since some categories have more information than the others, the classification based on field of interest in physics should be interpreted with caution. Finally, the questions were classified only on the basis of the words and phrases used in the submitted questions. Because we did not have any chance to ask the students to explain what motivated them to submit their questions, their motivation for asking the questions might be different from our inference from the questions.

Implications

The same limitations identified above apply to the implications of the study for physics instruction. Notwithstanding these limitations, the results from this study could inform improvements to physics teaching, the curriculum and textbooks.

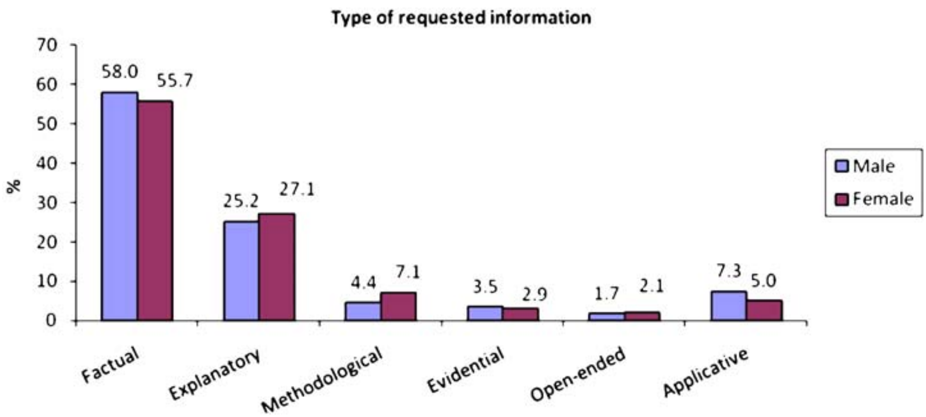

Fig. 5 Percentage of the questions of males and females according to type of requested information in the question

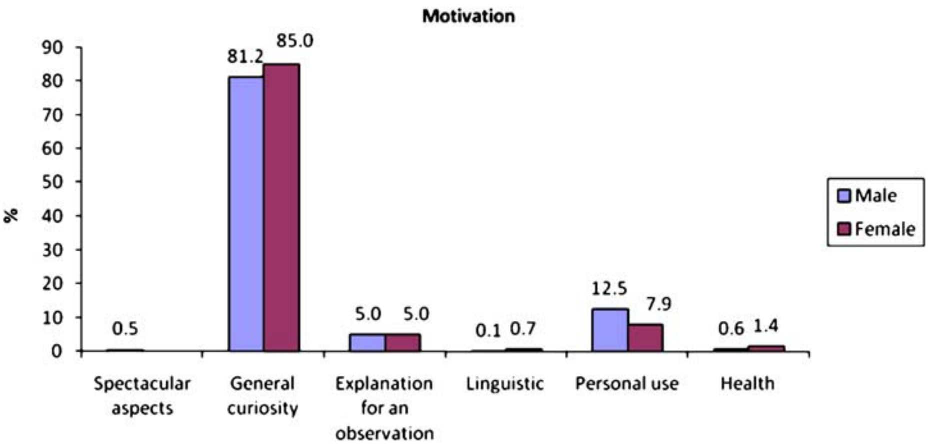

Fig. 6 Percentage of the questions of males and females according to motivation for asking the question

The questions asked by the students indicate what they are interested in and what they know; therefore, teachers should student-centred learning environments to promote students' question generating skills. Scardamalia and Bereiter (1992) suggested that one of the goals of instructions should be to encourage students to ask questions that are usually asked by teachers and textbooks.

Teachers should be aware of the gender differences with regard to interest in physics and how to handle them. Hoffman (2002) proposed that the observed differences in interests and attitudes towards physics are encouraged by teachers treating females and males differently. It is recommended that teachers should avoid instruction that increases the gap between males' and females' interests, and they should design a learning environment likely to interest both female and male students. Enhancing females' interests in physics leads to an increase in the number of people from various backgrounds who engage in physics which promotes the development and quality in research studies, discoveries and inventions. To facilitate students' learning, teachers can encourage students to send their questions to the websites where the questions are answered by experts and encourage them to read the answers of their questions. Teachers can also use these questions in their teaching as cases for initiating discussions and increasing students' motivation and interest.

The design of physics curricula and textbooks should be based on students' interests to enhance their learning. The curriculum designers can use the information obtained from the analysis of the questions asked outside of classroom settings such as, 'ask a scientist' websites, to create meaningful and relevant curricula for students. However, this does not mean that essential topics in physics education should not be covered because they are rarely asked by the students. Similarly, it can not be said that a student's interest in a topic is identical to a willingness to make the intellectual effort and commitment necessary for adequate understanding (Jenkins and Nelson 2005). However, little interest in some essential topics requires further investigations and curricular interventions to explore reasons for lack of interest in these topics and make them more interesting and meaningful to students. Masculine activities, topics and images should be de-emphasized in the curriculum. Since females are more interested in biology than physics, a curriculum providing the integrated science like biophysics could be useful to attract their interests towards physics.

Appendix

Table 6 The percentage and frequency of the categorized questions according to subcategories of field of interest in physics

Category	Subcategory	Frequency	Percent
Mechanics	Physics & Measurement	7	0.7
	Vectors	7	0.7
	Motion in One Dimension	5	0.5
	Motion in Two Dimensions	8	0.8
	The Laws of Motion	75	7.8
	Circular Motion & Other Applications of Newton's Laws	16	1.7
	Work & Energy	21	2.2
	Linear Momentum & Collisions	13	1.4
	Rotation of a Rigid Object About a Fixed Axis	4	0.4
	Rolling Motion & Angular Momentum.	18	1.9
	Static Equilibrium & Elasticity	2	0.2
	Oscillatory Motion	11	1.2
	The Law of Universal Gravitation	24	2.5
	Fluid Mechanics	53	5.5
Vibrations & Wave Motion	Wave Motion	7	0.7
	Sound Waves	25	2.6
Thermodynamics	Temperature Thermal Expansion & Ideal Gases	16	1.7
	Heat & the First Law of Thermodynamics	51	5.3
	Heat Engines. Entropy. & the Second Law of Thermodynamics	9	0.9
Electricity & Magnetism	Electric Fields	30	3.1
	Gauss' Law	8	0.8
	Electric Potential	10	1.0
	Capacitance & Dielectrics	2	0.2
	Current &Resistance	31	3.2
	Direct Electric Circuits	3	0.3
	Magnetic Fields	24	2.5
	Sources of the Magnetic Field	56	5.9
	Faraday's Law	19	2.0
	Inductance	2	0.2
	Alternating Current Circuits	1	0.1
	Electromagnetic Waves	43	4.5
Light & Optics	The Nature of Light & the Laws of Geometric Optics	48	5.0
	Geometric Optics	10	1.0
	Diffraction Patterns & Polarization	2	0.2
Modern Physics	Relativity	36	3.8
	Introduction to Quantum Physics	9	0.9
	Quantum Mechanics	31	3.2
	Atomic Physics	82	8.6
	Molecules & Solids	24	2.5
	Superconductivity	15	1.6
	Nuclear Structure	37	3.9
	Applications of Nuclear Physics	19	2.0
	Particle Physics & Cosmology	43	4.5

References

Baram-Tsabari, A., & Yarden, A. (2005). Characterizing children's spontaneous interests in science and technology. *International Journal of Science Education*, *27*(7), 803–826. doi:10.1080/09500690500038389.

Chin, C., & Kayalvizhi, G. (2002). Posing problems for open investigations: what questions do pupils ask? *Research in Science & Technological Education*, *20*(2), 269–287. doi:10.1080/0263514022000030499.

Chin, C., Brown, D. E., & Bruce, B. C. (2002). Student-generated questions: a meaningful aspect of learning in science. *International Journal of Science Education*, *24*(5), 521–549. doi:10.1080/09500690110095249.

Chiristidou, V. (2006). Greek students' science-related interest and experiences: gender differences and correlations. *International Journal of Science Education*, *28*(10), 1181–1199. doi:10.1080/09500690500439389.

Colbert, J. T., Olson, J. K., & Clough, M. P. (2007). Using the web to encourage student-generated questions in large-format introductory biology classes. *CBE Life Sciences Education*, *6*, 42–48. doi:10.1187/cbe.06-07-0171.

Commeyras, M. (1995). What can we learn from students' questions? *Theory into Practice*, *34*(2), 101–106.

Costa, J., Caldeira, H., Gallástegui, J. R., & Otero, J. (2000). An analysis of question asking on scientific texts explaining natural phenomena. *Journal of Research in Science Teaching*, *37*(6), 602–614. doi:10.1002/1098-2736(200008)37:6<602::AID-TEA6>3.0.CO;2-N.

Dahlgren, M. A., & Öberg, G. (2001). Questioning to learn and learning to question: structure and function of problem-based learning scenarios in environmental science education. *Higher Education*, *41*, 263–282. doi:10.1023/A:1004138810465.

Dawson, C. (2000). Upper primary boys' and girls' interests in science: have they changed since 1980? *International Journal of Science Education*, *22*(6), 557–570. doi:10.1080/095006900289660.

de Jesus, H. P., Teixeira-Dias, J. J. C., & Watts, M. (2003). Questions of chemistry. *International Journal of Science Education*, *25*(8), 1015–1034. doi:10.1080/09500690305022.

Dori, Y. J., & Herscovitz, O. (1999). Question-posing capability as an alternative evaluation method: analysis of an environmental case study. *Journal of Research in Science Teaching*, *36*(4), 411–430. doi:10.1002/(SICI)1098-2736(199904)36:4<411::AID-TEA2>3.0.CO;2-E.

Gungor, A., Eryılmaz, A., & Fakıoğlu, T. (2007). The relationship of freshmen's physics achievement and their related affective characteristics. *Journal of Research in Science Teaching*, *44*(8), 1036–1056. doi:10.1002/tea.20200.

Harper, K. A., Etkina, E., & Lin, Y. (2003). Encouraging and analyzing student questions in a large physics course: meaningful patterns for instructors. *Journal of Research in Science Teaching*, *40*(8), 776–791. doi:10.1002/tea.10111.

Häussler, P., & Hoffmann, L. (2000). A curricular frame for physics education: development, comparison with students' interests, and impact on students' achievement and self-concept. *Science Education*, *84*, 689–705. doi:10.1002/1098-237X(200011)84:6<689::AID-SCE1>3.0.CO;2-L.

Hidi, S. (1990). Interest and its contribution as a mental resource for learning. *Review of Educational Research*, *60*(4), 549–571.

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, *41*(2), 111–127. doi:10.1207/s15326985ep4102_4.

Hoffman, L. (2002). Promoting girls' interest and achievement in physics classes for beginners. *Learning and Instruction*, *12*(4), 447–465. doi:10.1016/S0959-4752(01)00010-X.

Hofstein, A., Navon, O., Kipnis, M., & Mamlok-Naaman, R. (2005). Developing students' ability to ask more and better questions resulting from inquiry-type chemistry laboratories. *Journal of Research in Science Teaching*, *42*(7), 791–806. doi:10.1002/tea.20072.

Jenkins, E. W., & Nelson, N. W. (2005). Important but not for me: students' attitudes towards secondary science in England. *Research in Science & Technological Education*, *23*(1), 41–57. doi:10.1080/02635140500068435.

Jones, A. T., & Kirk, C. M. (1990). Gender differences in students' interests in applications of school physics. *Physics Education*, *25*, 308–313. doi:10.1088/0031-9120/25/6/304.

Jones, G. M., Howe, A., & Rua, M. J. (2000). Gender differences in students' experiences, interests, and attitudes toward science and scientists. *Science Education*, *84*(2), 180–192. doi:10.1002/(SICI)1098-237X(200003)84:2<180::AID-SCE3>3.0.CO;2-X.

King, A. (1990). Enhancing peer interaction and learning in the classroom through reciprocal questioning. *American Educational Research Journal*, *27*(4), 664–687.

King, A. (1992). Comparison of self-questioning, summarizing, and notetaking-review as strategies for learning from lectures. *American Educational Research Journal*, *29*(2), 303–323.

Krapp, A. (2005). Basic needs and the development of interest and intrinsic motivational orientations. *Learning and Instruction*, *15*, 381–395. doi:10.1016/j.learninstruc.2005.07.007.

Laukenmann, M., Bleicher, M., Fuß, S., Gläser-Zikuda, M., Mayring, P., & von Rhöneck, C. (2003). An investigation of the influence of emotional factors on learning in physics instruction. *International Journal of Science Education*, *25*(4), 489–507. doi:10.1080/09500690210163233.

Marbach-Ad, G., & Sokolove, P. G. (2000). Can undergraduate biology students learn to ask higher level questions? *Journal of Research in Science Teaching*, *37*(8), 854–870. doi:10.1002/1098-2736(200010)37:8<854::AID-TEA6>3.0.CO;2-5.

Miller, P. H., Blessing, J. S., & Schwartz, S. (2006). Gender differences in high school students' views about science. *International Journal of Science Education*, *28*(4), 363–381. doi:10.1080/09500690500277664.

Osborne, J., & Collins, S. (2001). Pupils' views of the role and value of the science curriculum: a focus group study. *International Journal of Science Education*, *23*(5), 441–467. doi:10.1080/09500690010006518.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education*, *25*(9), 1049–1079. doi:10.1080/0950069032000032199.

Palincsar, A. S., & Brown, A. L. (1984). Reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. *Cognition and Instruction*, *1*(2), 117–175. doi:10.1207/s1532690xci0102_1.

Physics. (2007). Retrieved 25 July, 2007, from http://www.biltek.tubitak.gov.tr/merak_ettikleriniz/index.php?kategori_id=4.

Ram, A. (1991). A theory of questions and question asking. *Journal of the Learning Sciences*, *1*(3&4), 273–318. doi:10.1207/s15327809jls0103&4_2.

Scardamalia, M., & Bereiter, C. (1992). Text-based and knowledge-based questioning by children. *Cognition and Instruction*, *9*(3), 177–199. doi:10.1207/s1532690xci0903_1.

Schiefele, U. (1991). Interest, learning, and motivation. *Educational Psychologist*, *26*(3 & 4), 299–323. doi:10.1207/s15326985ep2603&4_5.

Serway, R. A. (1992). *Physics for scientists and engineering with modern physics* (3rd ed.). Philadelphia: Saunders College Publishing.

Spall, K., Stanisstreet, M., Dickson, D., & Boyes, E. (2004). Development of school students' constructions of biology and physics. *International Journal of Science Education*, *26*(7), 787–803. doi:10.1080/0950069032000097442.

Stark, R., & Gray, D. (1999). Gender preferences in learning science. *International Journal of Science Education*, *21*(6), 633–643. doi:10.1080/095006999290480.

Stewart, M. (1998). Gender issues in physics education. *Educational Research*, *40*(3), 283–293.

The Higher Education Council, Student Selection and Placement Center. The statistic book of 2006–2007 academic year. (n.d). Retrieved 13 August, 2007, from http://www.osym.gov.tr/BelgeGoster.aspx?F6E10F8892433CFF1A9547B61DAFFE2A4334B67836F053C0.

The publications of The Scientific and Technological Research Council of Turkey. (2007). Retrieved 3 September, 2007, from http://www.tubitak.gov.tr/home.do;jsessionid=4A7969263A447672A127E9A61C058214?ot=1&sid=531.

The Scientific and Technological Research Council of Turkey.(2007). Retrieved 3 September, 2007, from http://www.tubitak.gov.tr/home.do?ot=1&sid=554&pid=547.

The title of subjects. (2007). Retrieved 3 September, 2007, from http://www.biltek.tubitak.gov.tr/merak_ettikleriniz/.

Thompson, L. H. (1924). Children's questions. *Educational Research Bulletin*, *3*(16), 347 + 350–352.

Trumper, R. (2006). Factors affecting students' junior high school students' interest in physics. *Journal of Science Education and Technology*, *15*(1), 47–58. doi:10.1007/s10956-006-0355-6.

Woodward, C., & Woodward, N. (1998). Girls and science: does a core curriculum in primary school give cause for optimism. *Gender and Education*, *10*(4), 387–400. doi:10.1080/09540259820826.

You're curious about. (2007). Retrieved 25 July, 2007, from http://www.biltek.tubitak.gov.tr/merak_ettikleriniz/soru_sor.php.

Zohar, A., & Sela, D. (2003). Her physics, his physics: gender issues in Israeli advanced placement physics classes. *International Journal of Science Education*, *25*(2), 245–268. doi:10.1080/09500690210126766.