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The Generalizability of Students' Interests in Biology Across Gender, Country and Religion

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Abstract In order to bridge the existing gap between biology curricula and students' interests in biology, a strategy for identifying students' interest based on their questions and integrating them into the curriculum was developed. To characterize the level of generalizability of students' science interests over 600 high school students from Portugal, Turkey, England and Israel, who chose biology as an advanced subject, their interest level was ranked in 36 questions that were originally raised by Israeli students. Results indicate that students from four different countries show interest in similar science questions. The most intriguing questions were the ones that dealt with human health and new developments in reproduction and genetics. Religious affiliation had the strongest effect on students' interest level, followed by national affiliation and gender. The findings suggest that students' interest in one context is relevant to the development of interest-based learning materials in a different context. However, despite these similarities, cultural and sociological differences need to be taken into account.

Keywords Interest · Student's questions · Student's voice · Cross-cultural comparison

Introduction

Science teaching is affected by social and cultural parameters that include values, beliefs, experiences, communication patterns, epistemology, various styles of learning and other variants

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that encompass the context of learning (Calabrese-Barton 2001). This study examines one of these factors—students' interest in specific content—and its multi-cultural generalizability.

Multi-national studies from the last decade have used quantitative methods to study international trends in students' science interests (Sjøberg and Schreiner 2005) and to correlate these interests with achievements (Bybee and McCrae 2011). Additional efforts were made to study similarities and differences between students' interests from different countries based on the science questions they raise (Cakmakci et al. 2011).

In the present study, we extend these findings to test whether questions raised by students in a specific setting are interesting to students elsewhere. Specifically, we investigate whether questions that were originally raised by Israeli Jewish high school biology students elicit the same level of interest among biology students in Portugal, England, Turkey and Israeli students with different religious backgrounds. Furthermore, we explore three factors among the wide range of social and cultural parameters affecting students' interest, asking how religion, country of residence and gender explain the similarities and differences in students' level of interest. By considering the nature of this study, there are direct implications for curriculum planning and teaching in a global world. It is important for teachers and curriculum developers to know whether they can build on interest research conducted elsewhere in the world in adapting teaching materials to local students' interests.

Literature Review

Motivation and Interest in Learning

Motivation Motivation is the driving force behind a person's need to accomplish a goal. Lack of motivation among students is a major problem in the educational system (Ames 1990). Ryan and Deci (2000) discussed the spectrum between internal and external motivation. External motivation addresses the act of a deed in order to achieve a separate result, such as receiving materialistic or social benefits or avoiding punishment (Vallerand et al. 1992). Internal motivation is defined as an act that has no aspiring result other than the enjoyment of performing this act. Students who are internally motivated invest more effort in the process of learning and take on more challenging assignments (Ames 1990). Maehr and Andermann (1993) identified three characteristics of behavior that resulted from internal motivation: the choice a person makes when preferring one activity over another, the continuation of that specific activity even if some difficulties or other alternatives arise, and the continuation of that activity when it is no longer required (Maehr and Andermann 1993; Maehr and Midgley 1991, 1996). The type of motivation that drives learning may affect its quality (Ames 1990; Nisan 2006; Ryan and Deci 2000; Vallerand et al. 1992). Acknowledging that both internal and external motivation may result in cognitive outcomes; this study aims at enhancing internal motivation.

Internal motivation might be encouraged if students could address their learning outcomes as a parameter they can control, for example in terms of the effort they invest (Ames 1990). According to the *Self Determination Theory* (Ryan and Deci 2000), for students' learning to become internally motivated they must feel (1) competent (self efficiency); (2) relatedness, and (3) autonomous, which includes a sense of relevance.

Internal motivation in schools declines as students get older and most of the learning in this setting is built on external motivation (Ryan and Deci 2000). One of the reasons for the weakening of internal motivation is the gap between topics that hold genuine interest for students and the requirements of the curriculum (Baram-Tsabari et al. 2006; Deci 1992; Jenkins and Nelson 2005).

Interest The decisive criterion of the interest construct, which enables it to be clearly distinguished from several neighbouring motivational concepts is its *content specificity*. Interest is always directed towards an object, activity, field of knowledge, or goal (Krapp and Prenzel 2011). Interest refers to a differential likelihood of investing energy in one set of stimuli rather than another (Csikszentmihalyi and Hermanson 1995). One of the attributes of interest is the will to know more about the topic of interest (Krapp 2002). Although interest plays a dominant role in people's drive to learn and study in their lives, within schools individual interest is largely ignored (Edelson and Joseph 2004; Flammer 1981). Students seldom learn out of a genuine interest in the school system. This leads to a loss of students' potential and subsequent disengagement from the learning process.

Developing interest in science is one of the main goals of the science literacy movement. Its vision includes citizens who voluntarily study science in their free time guided by an internal motivation. Interest in science is not only a goal, but also a means to achieve science literacy, through its contribution to the learning experience and the learning process in formal and non-formal environments (OECD 2008). Adults and children alike invest more in studying content that interests them (Hidi 1990). Interest connects students to content for a longer period of time (Ainley et al. 2002). Thus, raising the level of students' interest is likely to affect their engagement and involvement, satisfaction, concentration, internal motivation, resulting memory and accomplishments (Hidi 1990; Nisan 2006)

A common distinction in the educational context is made between *individual* and *situational interest*: individual interest is a lasting characteristic of the individual. It relates to individual factors such as life experience and personality. Situational interest is a quality that describes a specific situation. While individual interest evolves with time, situational interest changes as external conditions alter (e.g. a change of style in text) (Hidi 1990). Individual interest affects the degree of interest that we experience when interacting with different environments, objects or assignments (e.g. "this is an interesting assignment") (Hidi 1990).

People differ in the level and stability of their interest. Although individual interest is focused on the person and situational interest is focused on the environment, the interaction between the two is critical (Hidi 1990). Hence, level of interest derives from an interaction between the learner's personality and various characteristics of the content. Thus, reform that aims at increasing interest in science needs to address various elements, such as school culture (Maehr and Andermann 1993), gender (Baram-Tsabari and Yarden 2008; Gardner 1998; Miller et al. 2006), age (Baram-Tsabari and Yarden 2008; Stawinski 1984), and religious affiliation (Lemke 2001; Loo 2001; Reiss 2009), as discussed below.

Factors Affecting Students' Interest

Students from the same class differ in terms of their individual scientific interests and the way they respond to situational interest. Furthermore, students in the same classroom may experience a different environment (e.g. the experiences of ethnic minorities and students from underrepresented groups). On a broader level encompassing different schools, different cities, cultures, languages and countries, it is logical to hypothesize that the difference in students' interest should also be increasingly different.

Such differences can be generated by students' lifestyle as affected by their immediate environment, culture and language, as well as by their fears, experience and needs, the quantity and quality of science in the media, teacher training and capabilities, career guidance in school, and students' worldview which encompasses ideology, religion and beliefs (Calabrese-Barton 2001; Basl 2011; Bucchi 1998; Fusco 2001; Sjøberg and Schreiner 2002). These elements prompt feelings, values and ideas that often affect areas of interest even more than cognitive factors (Calabrese-Barton 2001; Basl 2011; Bucchi 1998; Fusco 2001; Sjøberg and Schreiner 2002).

Studies which have explored students' self-generated questions in different environments have reported similar science interests in family and personal concerns, superstitions and media-related subjects (Baram-Tsabari and Yarden 2005; Chin and Chia 2004; Hagay and Baram-Tsabari 2011; Maskill and Pedrosa de Jesus 1997; Pedrosa-de-Jesus and Lopes 2011; Pedrosa de Jesus et al. 2004; Pedrosa de Jesus and Moreira 2009) Specifically, the effects of four main factors interacting with science interest have been reported:

Religion Much attention has been given in the educational and scientific literature to clashes between religious worldviews and scientific explanations (Glennan 2009). Some educators advocate awareness of possible differences, and suggest that conflicts between science and religion should be allowed to surface through discussions[1] (BouJaoude and Dagher 1997; Glennan 2009; Ogunniyi 1988; Reiss 2009). Students' interest in science can also be influenced by their religion simply due to the diversity of experiences they are exposed to, rather than the worldview advocated in their worship (Glennan 2009; Irzik & Nola 2009; Loo 2001).

Country of Residence A study which examined questions sent to an international Ask-A-Scientist site by students from the US and from South-East Asia found that American users were more interested in chemistry, earth sciences and astrophysics, whereas users from South-East Asia showed relatively less interest in physics and technology (Baram-Tsabari et al. 2009). Similarities were found between the topics of questions sent by users from Israel and Arab countries (Baram-Tsabari et al. 2009). A possible reason for these similarities is that discussing science inherently involves crossing over from students' cultural reality to a Western-science culture (Aikenhead and Jegede 1999). In this sense, pursuing scientific interests over the internet may act to diminish country-related differences.

The international project 'Relevance in Science Education' [ROSE] found that students' country of residence was a major factor in determining interest level in scientific topics (Sjøberg and Schreiner 2005). ROSE described similarities in interest among students from neighboring countries, and similar attitudes to science among students from countries with comparable levels of economical development (Sjøberg and Schreiner 2005). The Program for International Student Assessment [PISA] from 2006, indicated a correlation: a tendency for students from countries with average low-performance in science to show relatively high levels of interest in science. Students from countries with average high-performance in science showed relatively lower levels of interest (Bybee and McCrae 2011). Notwithstanding the negative correlation *between countries*, it is important to note that *within countries*, students' general interest in science was positively related to performance (Bybee and McCrae 2011).

Age Research indicates that students' interest in science declines significantly with age, and even more so for girls (Osborne, et al. 2003). Students' interests in the field of biology, the

[1] The important issue related to interest and acceptance of evolution had been left out of the literature review since the topics of the questions themselves did not include evolution.

focus of this paper, tend to change with age. Fewer questions are asked in the field of botany and zoology by older students, but more questions concern human biology (Baram-Tsabari et al. 2006; Baram-Tsabari and Yarden 2005, 2007). One possible explanation is the physical changes that take place at adolescence that focus attention on the body. Adults may be interested in human biology as well out of concern with practical health issues (Baram-Tsabari et al. 2009). Adolescence is considered to be a critical phase for the development of science interest, when students start to clarify their personal aims and ambitions (identity) (Krapp and Prenzel 2011).

Gender A considerable amount of data on boys' and girls' interests in science suggests that boys in general are more interested in science than girls (Gardner 1998; Miller et al. 2006). However, this far-reaching generalization is superficial. An analysis conducted by MadSci.org, an Internet-based Ask-A-Scientist site, for example, demonstrated a decade-long (1996–2006) dominance of female users among K-12 students (Baram-Tsabari et al. 2009; Hagay and Baram-Tsabari 2011). In several developing countries, it was found that girls have the same (or even more) positive attitudes and interest in science than boys (Sjøberg and Schreiner 2005).

Science is not a monolithic field. Numerous studies have shown that while biology is of greater interest to girls and chemistry is liked to a similar extent by both genders, physics and technology prove significantly less interesting to girls than to boys. These findings (or elements of them) have been reported in Scotland (Stark and Gray 1999), Australia (Dawson 2000; Kahle et al. 1993; Woodward & Woodward 1998), the USA (Burkam et al. 1997; Farenga and Joyce 1999; Jones et al. 2000), England (Murphy and Whitelegg 2006; Osborne and Collins 2000; Spall et al. 2003), Italy (Falchetti et al. 2007), Israel (Baram-Tsabari and Yarden 2005; Friedler and Tamir 1990; Trumper 2006), Turkey (Cakmakci et al. 2011; Yerdelen-Damar & Eryılmaz 2010), Germany (Hoffmann 2002), and Japan (Scantlebury et al. 2007), and in international studies such as TIMSS (Mullis et al. 2000), and ROSE (Jenkins and Nelson 2005; Sjøberg and Schreiner 2002). This gender gap in focus of interest also exists between male and female students who are interested in science and intend to continue studying in this field (Murphy and Whitelegg 2006; Zohar 2003).

Some researchers have suggested that the basis for these stereotypically gendered interests is an inborn trait rendering most girls hard-wired for empathy, while most boys are predominantly hard-wired for understanding and building systems (Baron-Cohen 2003). Other studies, however, have not found any such difference (Barres 2006; Guiso et al. 2008; Haworth et al. 2008; Linn and Hyde 1989; Spelke 2005).

Within biology, girls have been reported to show a greater interest in human biology than boys both in Israel (Tamir and Gardner 1989) and in England (Jenkins and Pell 2006; Taber 1991). An analysis of students' self generated questions regarding human biology suggests greater female interest in reproduction (Hagay and Baram-Tsabari 2011). Studies suggest that girls tend to ask more science questions that attempt to acquire practical information (Hagay and Baram-Tsabari 2011) as well as questions that relate to scientific subjects that are not introduced by the formal curriculum (Pedrosa-de-Jesus and Lopes 2011).

Measuring Interest

The traditional way to determine students' interests in science is through their reactions to subjects or questions posed by adult researchers. In most cases, broad subjects, specific topics or questions are presented in written questionnaires and the students' responses are recorded on a Likert-type scale (Dawson 2000; Sjøberg and Schreiner 2002; Stark and Gray 1999). This quantitative method allows researchers to directly investigate a subject of interest, and it makes statistical processing and distribution of questionnaires to a large number of students easier. The disadvantage, however, is that the studies are based on adults' views of what subjects should be meaningful to students.

Qualitative methods include, among others, focus groups (Osborne and Collins 2000), classroom observations and interviews with students (Lindahl 2007). Observations may minimize the researcher's involvement, and allow for a wide range of findings regarding students' interests to surface. However, the spontaneous and enthusiastic reactions of students in the classroom do not always reveal the level of individual interest in a field. Responses can be highly influenced by situational interest (e.g. result of pedagogy), or an attempt to impress the teacher or researcher. Moreover, few students are openly active during traditional classes and even fewer tend to publicly ask questions (Commeyras 1995; Dillon 1988). Class atmosphere, where asking a question might expose a student to criticism, embarrassment or even mockery is a probable cause (Pedrosa de Jesus et al. 2003; Rop 2003). Furthermore, some teachers are concerned about losing control during class (Shore 1994), or not being able to answer students' questions. The latter might be a result of a perception of the teacher's role as a tool for information transmission, one which discourages discussions and queries in the classroom (Hagay and Baram-Tsabari 2011; Woodward 1992). All these concerns might cause students not to ask questions, including those which could help them explore their interests. Therefore, classroom observations are not sufficient for studying students' interests. Open or semi-structured interviews that can avoid these shortcomings can only include a very limited number of students.

Students' Questions as Indicators of Interest Students' self-generated questions can be used to learn about students' interests (Baram-Tsabari and Yarden 2005; Chin and Chia 2004). Asking questions may help students evaluate themselves and assess their grasp of a subject while revealing their explanations, opinions and interests (Biddulph et al. 1986). The fact that a student asks a question is a reflection of her/his involvement in the subject. It can show how a student tries to create new connections with other familiar ideas. Frequently these questions arise from students' personal and family contexts. Questions can reflect the fears and hopes as well as class experiences and the impact of science in the media. Many of these questions involve human experience and the human body (Baram-Tsabari et al. 2006; Chin and Chia 2004). Questions serve as a way for students to discover something relevant about themselves within the science class.

When properly used, students' questions can guide teachers in their work, by revealing their understanding, and providing a window into their thoughts and interests (Chin and Chia 2004; Chin and Osborne 2008; Elstgeest 1985). For this reason, collecting students' questions prior to or during class may broaden teachers' pedagogical content knowledge. A large-scale study of students' questions may help pinpoint interests that are common to many students. In recent years, researchers have studied students' questions that were sent to internet sites (Horrigan 2006), magazines (Pedrosa-de-Jesus and Lopes 2011), TV programs (Baram-Tsabari and Yarden 2005), academic course sites (Colbert et al. 2007) and questions that were anonymously collected in classes (Hagay and Baram-Tsabari 2011) to identify students' science interests.

Naturally, collecting students' self-generated questions is not a silver bullet for all the methodological setbacks associated with the identification of students' interests. It might involve management problems during administration (similar to other written questionnaires) and implicitly make a promise on behalf of the teacher to answering all the questions raised. Notwithstanding these complexities, this method allows researchers to discover new fields of interest, unlike a closed questionnaire that aims at guiding the informant to react to a specific statement.

Using students' questions as a pedagogical tool to guide teaching raises a practical question: are the interests reflected in the questions generalizable to other contexts? A number of researchers have tried to gather evidence regarding the generalizability of students' interests as reflected by their questions. Hagay and Baram-Tsabari (2011) found that 36 frequently asked questions raised by one group of students were found interesting by a different group of students who had a similar background. Another study that compared questions that were sent to a scientific-internet site by Israeli and Arab students found similarities in interest, as well as the stereotypical differences between genders (Baram-Tsabari et al. 2009). Similarities were found between science questions raised in Turkey (Pedrosa-de-Jesus and Lopes 2011) and in Israel as well (A Baram-Tsabari et al. 2009). These studies provide a preliminary indication that students from different countries might be interested in similar questions.

Research Goal and Questions

In order to bridge the existing gap between biology curricula and students' interests in biology, previous work suggested building on students' individual interests, as reflected by their self-generated questions (Hagay and Baram-Tsabari 2011). The present study aims to characterize the level of generalizability of students' science interests across countries and religions. This aim is addressed through the following research questions:

- To what extent does country of residence, religion and/or gender explain any differences in the average level of interest students attach to science questions that were originally raised by another group?

If individual factors are the primary force behind students' interests, we expect that differences within groups will be greater than the difference between groups. An overall similarity between students' interests would allow teachers and curriculum developers to build on students' interests identified elsewhere, whereas a lack of such similarity would justify a specific survey of interest among each specific group of students to address students' interests.

Methodology

Research Tools

The primary research tool used to compare students' level of interests was a closed questionnaire that included 36 questions originally raised by Israeli high school students (Hagay and Baram-Tsabari 2011). It was translated into the four languages of the groups involved in the study.

Questionnaire Development

In an earlier work, students' interests were identified based on their self-generated science questions (Hagay and Baram-Tsabari 2011). The intention was to harness students' interests in topics already on the curriculum to bridge between their world and the requirements of the educational system. In that work 563 biology questions were anonymously collected from 343 Jewish Israeli 10–12th graders. The students were asked to write down biology questions that interest them in three topics: the reproductive system, the cardiovascular system and genetics. These three topics were chosen since they are all included (to some degree) in the required parts of the Israeli biology curriculum (evolution, for example, is an elective topic that many teachers do not teach).

Later on, 36 questions were chosen to represent the topical distribution and frequently asked questions from the 563 previous questions collected. These 36 questions were presented on a 5-point Likert-type scale. These were then presented to another group of students sharing the same background (Hagay and Baram-Tsabari 2011).

This Hebrew questionnaire was then translated into English, Portuguese, Arabic and Turkish by native speakers.

1. **Arabic:** The Arabic version was translated from the Hebrew original and then checked by M.Sc and PhD native speakers of Arabic who teach biology in high schools. A third Arabic-speaking biology teacher who was not familiar with the questionnaire and its content back-translated. Since Arabic speaking high school students in Israel are generally able to read Hebrew, the Arabic questionnaire printed the questions in Hebrew as well.
2. **English:** The questionnaire was translated into English by a researcher and two PhD students in the field of science education, who created a final version that was accepted by all three. In addition, it was reviewed by an English linguistic and editing expert (Appendix 1). This version was used as a source for the translation into Turkish and Portuguese.
3. **Turkish:** The English version was translated into Turkish by a science education researcher. The Turkish and English versions were examined by an individual with a PhD in biology who specializes in educational instruction, and has 6 years of high school teaching experience. The corrected version was sent to two other biology education specialists to check the clarity of the questions.
4. **Portuguese:** The English version was independently translated by three science education researchers, two of whom have biology high school teaching experience. The three compared their results and created a final version that was accepted by all.

Research Sample

The questionnaire was distributed to a convenience sample of 604 biology high school students in four countries: England ($n=87$), Portugal ($n=109$), Turkey ($n=100$) and Israel ($n=308$), which are the authors' countries of residence. These students were not supposed to represent their nations' interests in biology, rather to display (or not) an interest in students' interests identified elsewhere. While the countries are all part of the same geo-economical space, they vary with regard to economical development, educational achievements, religion and other factors (Table 1). In Israel the study included three different sectors: Jewish, Arab-Muslim and Arab-Christian[2] (Table 2).

[2] Results from Israel include all three sectors unless otherwise indicated.

The results were broken down in terms of country of residence, gender and religion. Information on religion was included in the analysis of questionnaires from Turkey (Muslims),[3] Portugal (Christians),[4] and Israel (Muslims, Christians and secular Jews).[5] Data on religion were not included in the analysis of questionnaires from England, due to the multicultural nature of the schools involved.

All the participants in the study had chosen to study advanced biology as part of their high school curriculum and attended the 11th or 12th grade at the time of the research.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS 16.0) program. Since a normal distribution could not be assumed, non-parametric tests were used. Mann–Whitney (Wilcoxon) tests were used to test for significant differences between two independent groups (e.g. males and females from the same country). Kruskal—Wallis tests were used to test for significant differences between three or more groups.

In order to rank the importance of the three variables (gender, religion and country) a MANOVA was performed. This test could be used despite the non-normal distribution of the data since the sample was large and there was no significant difference in variance between the groups. Eta squared represents the percentage of explained variance of each of the independent variables based on Wilk's Lambda (the calculated value was multiplied by 100 to convert results into percentages). The MANOVA involved only 513 subjects—87 students from England with no knowledge of their religion background and four students from Turkey who did not indicate their gender were omitted from the sample.

Similarities among countries and religions were tested with a Pearson correlation test. The statistical analysis was calculated on the results of the Likert scale. Factor analysis [FA] divided the 36 questions into eight factors. Working with eight rather than 36 questions reduces the risk of false positives due to large number of variables and tests (Table 3, left column).

Internal consistency, which is a form of reliability, was tested using Cronbach's alpha. Individual country results matched the overall interest levels among all countries for specific questions (36 items); therefore a high level of consistency was observed for the entire study (0.909), as well as for each individual country (Israel 0.909, Turkey 0.762, England 0.940, and Portugal 0.896). Internal consistency was tested for Portuguese and Israeli Christians (0.912), as well as Israeli and Turkish Muslims (0.704).

[3] Based on general demographics of the country. Turkey is a democratic and secular country. The majority of Turkish citizens are Muslims (99%) (Eurydice 2010).

Source: http://eacea.ec.europa.eu/education/eurydice/documents/eurybase/structures/041_TR_EN.pdf

[4] Based on general demographics of the country, the majority (87%) of Portuguese citizens are Christian (http://www.indexmundi.com/portugal/demographics_profile.html).

[5] In the Israeli educational context Jewish students may enroll in an independent orthodox education school, religious state-run school, or a secular state-run school. All the Jewish students in this sample enrolled in secular schools. Muslim and Christian students belong to the Arab sector in Israel. The Christian students in this sample enrolled in a Church run school, while the Muslims enrolled in a state-run school. Both serve students with differing levels of religiosity.

Table 1 Demographics of the four countries participating in the study

	TIMSS Rank[a]	PISA Rank[b]	UN Human development index[c]
Portugal	n/a	37	40
Turkey	31	44	83
UK[d]	5	14	26
Israel	25	39	15

[a] TIMSS 2007 8th grade science rank out of 49 countries

[b] PISA 2006 science section among 15 year old students rank out of 57 countries

[c] UN Human development index 2010, rank out of 169 countries

[d] PISA 2006 evaluated UK schools; the 2007 TIMMS only considered England (not the whole of the UK)

Results

Over 600 students from four countries who had chosen biology as an advanced subject in their curricula were asked to rank their interest level on questions about three biology subjects that were originally raised by Israeli students.

Students' Declared Interest in Biology

The participants were asked to indicate their interest level in biology in general, and in the cardiovascular system, reproduction and genetics in particular on a 1–5 scale. When asked to estimate their interest in different subjects, the responses of students from different countries showed a similar pattern. All four scientific subjects were given an average score of over three on the Likert scale: biology (4.24), the cardiovascular system (3.84), reproduction (3.85) and genetics (3.77). Thus, the data support the interest of all students in the scientific field.

Table 2 Sample demographics: 604 students majoring in biology

Country	Students' age	No. schools/classrooms	Girls	Boys	Total
Portugal	17–18	2/5[a]	68	41	109
Turkey	17	1/3[b]	49	47	100[d]
England	17–18	5/5[c]	41	45	87[d]
Israel—Jewish sector	16–18	6/9[e]	88	74	162
Israel—Muslim sector	16–18	1/3[f]	60	34	94
Israel—Christian sector	17–18	1/2[g]	21	31	52
Total	Range 16–18	17 school and 26 classrooms	327	272	604

[a] Urban school, medium/high achievements, medium/high socio-economic state

[b] Urban upper secondary school, a mixture of socioeconomic status (i.e. low to middle or high income)

[c] Urban schools of an average and slightly below average socio economic status. A class from each school was selected by the contact teachers with the criteria of having students taking Biology as a subject. Students were of mixed ability

[d] Four Turkish students and one English student did not indicate their gender

[e] Secular urban and agriculture state run schools, medium socio-economic state

[f] Urban state run schools, three classes that took advanced biology were included, medium socio-economic state

[g] Urban private school, high achievements

Table 3 Students' average level of interest in questions raised by other students expressed on a 1–5 Likert-type scale and listed in order of popularity

f [a]	Question	All	Israel		Portugal		Turkey		England	
			F [c]	M	F	M	F	M	F	M
4	12. How does cancer develop and how can it be treated?	4.2	4.4	4.1	4.1	4.1	4.3	4.0	3.8	3.8
5,6	6. Can humans be cloned and how could it be done?	4.2	4.2	4.3	4	3.8	4.7	4.2	3.7	4
6	9. How can a DNA sample identify a person?	4.1	4.4	4.2	4	3.5	4.3	3.9	3.7	3.7
4	11. How can a heart attack be prevented?	4.0	4.2	4.0	3.9	3.9	4.2	4.1	3.5	3.7
5	21. Will we be able to create humans with perfect health in the future?	4.0	4.0	3.9	3.8	4.0	4.1	4.1	3.8	4.1
6,3	2. What happens if human semen inseminates the ovum of another animal?	3.9	4.1	3.9	4.1	3.7	4.5	3.8	3.2	3.5
7	13. Does my blood type say anything about me?	3.9	4.0	3.6	4.2	3.8	4.2	3.8	4.0	4.0
2,5	34. Can organs for transplant be created using genetic engineering?	3.9	3.9	4.0	3.7	3.8	4.5	4.2	3.4	3.7
5	19. Is it possible to know in advance which traits pass from parents to their offspring and prevent them from being passed, or change those traits?	3.9	4.2	3.8	3.8	3.6	4.3	4.0	3.3	3.4
6	5. What can be done with genetic engineering today?	3.8	3.9	4.2	3.6	3.6	4.1	3.5	3.2	3.8
5	14. In the future, will we be able to choose how our baby will look?	3.8	4.1	3.8	3.7	3.5	4.3	3.6	3.7	3.2
	23. Are personality characteristics genetic?	3.7	3.8	3.5	3.8	3.7	3.9	3.9	3.6	3.7
4	18. If my grandfather had a heart attack, does that increase the chances that I will have one too?	3.7	3.9	3.7	3.8	3.6	3.7	3.8	3.4	3.5
8	36. If I inject myself with more red blood cells, will I be able to run faster?	3.7	3.6	3.8	3.8	3.6	4.0	4.2	3.29	3.5
2	33. Is the immune system influenced by psychological factors, and to what extent?	3.7	3.7	3.6	3.7	3.5	3.8	4.0	3.5	3.5
6	1. What is mutation and what causes it?	3.7	3.7	3.8	3.6	3.4	4.0	3.5	3.1	3.6
2,4	20. How do you treat a person whose blood does not clot?	3.7	3.7	3.4	3.9	3.3	4.0	3.6	3.6	3.7
7	24. Are body type and height hereditary?	3.7	3.8	3.5	4.0	3.3	3.6	3.8	3.4	3.5

Table 3 (continued)

f[a]	Question	All	Israel		Portugal		Turkey		England	
			F[c]	M	F	M	F	M	F	M
3	28. Are sexual preferences hereditary?	3.6	3.9	3.6	3.7	3.2	3.2	3.7	3.3	3.5
4	7. How does vaccination work, and how can you make someone immune to a disease?	3.6	3.8	3.4	3.8	3.5	3.6	3.5	3.5	3.4
8	32. What is the difference between a carrier and an AIDS patient?	3.6	3.9	3.6	3.7	3.0	3.2	3.6	3.4	3.5
1	16. Can I know, in advance, if I am sterile?	3.6	4.1	3.3	3.7	3.2	3.4	3.3	3.3	3.3
	4. Which has more influence - nature or nurture?	3.5	4.0	3.5	3.5	3.4	3.0	3.3	3.5	3.1
3	17. When does life start – when the ovum and sperm meet or when the baby is born?	3.5	3.7	3.3	3.8	3.0	3.9	3.5	3.2	3.4
2	29. How do you clean a blood vessel that is blocked by fat?	3.5	3.5	3.4	3.9	3.1	3.6	3.6	3.4	3.3
3	25. Are all male penises suitable for all female vaginas?	3.5	3.5	3.5	3.6	3.4	3.3	3.6	2.9	3.4
2	26. How does the body handle allergies?	3.5	3.6	3.3	3.7	3.3	3.5	3.4	3.4	3.3
7	30. Is athletic ability hereditary?	3.5	3.5	3.6	3.6	3.3	3.0	3.5	3.0	3.6
1	8. Is there is a difference in the number of genes that the offspring receives from the mother and father?	3.4	3.7	3.3	3.7	3.1	3.6	2.9	2.9	2.9
8	3. Why is smoking unhealthy?	3.3	3.6	3.4	3.5	2.9	3.3	3	2.9	2.9
2,8	31. What is high/low blood pressure?	3.3	3.5	3.2	3.4	3.1	3.1	3.0	3.4	3.5
1,3	35. What is IVF?	3.3	3.6	3.1	3.5	3.1	3.4	3.3	3.1	2.8
1	15. How are infertility treatments done?	3.3	3.6	3	3.7	2.9	3.4	2.9	3.3	2.9
1	10. Can a woman's stock of ovum run out?	3.3	3.7	2.8	3.7	2.8	3.6	2.8	3.1	2.6
2	27. How do sound and smell influence the courting process?	3.2	3.4	3.1	3.5	3.0	3.2	3.0	3.2	3.1
1	22. If a woman does not give birth, can she still produce milk and breastfeed?	3.2	3.5	2.9	3.5	2.9	3.1	3.1	3.1	2.8

f[a]refers to the factor number to which the question was assigned by factor analysis

[b]Significant differences ($p<0.05$) between genders are marked in grey

[c]'F' indicates female and 'M' indicates male

A Mann–Whitney test for unpaired samples was used to compare the five fields of interest (general biology, cardiovascular system, reproduction, genetics and after- hours science involvement). The results showed that in two fields (cardiovascular and reproduction) girls indicated a higher level of interest than boys ($p<0.05$).

Table 4 Gender, religion and state as explanatory variables of students' scientific interest. Calculated based on a Multivariate Linear Model

Dependent variable:	Specific interest of questions (n=513, by 8 sub-gruops)	
Independent variable	P value	% explained (Partial eta Squared)
National affiliation	0.000	15.8
Gender	0.000	12.0
Religious affiliation	0.000	21.1

Interest in Specific Students' Questions

Within the framework of the study, science students from Israel, England, Turkey and Portugal were asked to what extent they would like to know the answers to 36 questions that were posed by other high school students (Appendix 1). The students did not know the questions were originally asked in Israel.

The average score for all the questions ranged from 3.2 to 4.3 (out of 5). Thus students from the four countries found the questions asked by Israeli students to be interesting. Despite the individual differences in personalities and identity in the groups, there were obvious trends in the ranking of the questions (Table 3). A common denominator among popular questions was the subject of new developments in genetics. These include: "How can a DNA sample identify a person?", "Can humans be cloned and how could it be done?", "Will we be able to create humans with perfect health in the future?" Other popular themes were unnatural reproduction process ("What happens if human semen inseminates the ovum

Table 5 Gender, religion and country as explanatory variables of students' interest in eight clusters of students' questions

		Religious affiliation (n=513)		National affiliation (n=513)		Gender (n=513)	
Independent variable		Sig.	% explained (Partial eta Squared)	Sig.	% explained (Partial eta Squared)	Sig.	% explained (Partial eta Squared)
1	Reproduction issues	0.000	9.9	0.000	5.7	0.000	1.9
2	Problems in the intravascular system (vaccination, blood vessels, allergies).	0.000	2.6	0.020	1.1	0.007	1.5
3	Problems and interventions in the reproductive system	0.000	9.8	0.000	6.1	0.000	2.4
4	Family health (cancer, heart attack, immune system, cardiac arrest, blood clotting)	0.006	1.4	0.012	1.2	0.000	2.6
5	Artificial creation of humans and organs	n.s		n.s		0.028	0.9
6	Implications of technology for the future of the human race	0.002	1.9	0.000	5.1	n.s	
7	Heredity of human body features	0.000	12.6	0.037	0.9	0.023	1.0
8	Personal health (smoking, AIDS, blood count, blood pressure)	0.000	2.6	0.000	9.4	0.023	1.0

Table 6 Interest in eight clusters of student generated questions according to country, gender and religion. The clusters are indicated by number and are listed in rank order

All	England			Turkey			Portugal			Israel			Israel -Jews			Israel -Christians			Israel -Muslims		
	all	M	F	all	M	F	all	M	F	all	M	F	all	M	F	all	M	F	all	M	F
599	86	45	41	96	47	49	109	41	68	308	129	179	162	74	88	52	21	31	94	34	60
5	7	6	4	5	5	5	4	5	4	6	6	5	5	5	5	6	6	6	6	6	6
6	4	7	5	6	4	6	5	4	7	5	5	6	6	6	4	5	5	7	5	5	5
4	5	4	7	4	6	4	6	6	6	4	4	4	4	4	6	4	4	4	4	4	4
7	6	5	2	7	7	2	7	7	5	7	7	3	7	7	7	7	3	5	3	3	3
3	2	2	6	3	3	3	3	2	3	3	8	7	2	2	3	3	7	3	7	7	7
2	8	8	8	2	2	7	2	3	2	8	3	1	3	8	2	8	2	1	2	2	2
8	3	3	3	8	8	8	8	8	1	2	2	8	8	3	1	2	8	8	8	8	8
1	1	1	1	1	1	1	1	1	8	1	1	2	1	1	8	1	1	2	1	1	1

[a] The grey line indicates sample size

Cluster names:

1. Reproduction issues
2. Problems in the intravascular system (vaccination, blood vessels, allergies)
3. Different functions of the reproductive system
4. Family health (cancer, heart attack, immune system, blood clotting)
5. Artificial creation of humans and organs
6. Implications of technology for the future of the human race
7. Heredity of the human body
8. Personal health (smoking, AIDS, blood count, blood pressure)

of another animal?") and human health ("How does cancer develop and how can it be treated?", "How can a heart attack be prevented"?).

The least popular queries were ones that dealt with informative science ("How are infertility treatments done"?, "What is high/low blood pressure?", "Can a woman's stock of ovum run out?", "Is there a difference in the number of genes that the offspring receives from the mother and father?"), animals ("How do sound and smell influence the courting process?") and a question related to the hazards of smoking. Many popular questions were open-ended and invited discussion, whereas the least popular questions tended to ask for an explanation or a state of fact. All male groups from all countries ranked questions dealing with pregnancy and female reproduction at the bottom of their lists whereas girls ranked these queries higher ("How are infertility treatments done?" "Can a woman's stock of ovum run out?", "If a woman does not give birth, can she still produce milk and breastfeed?").

In 21 out of the 36 questions (58%), a significant difference was found between boys' and girls' ranking. Girls exhibited higher levels of interest, regardless of religion or country of origin (Table 3). Thus overall, girls showed more interest than boys in specific biology questions, confirming findings in the literature (Baram-Tsabari and Yarden 2008). In Turkey, for example, the majority of questions related to reproduction and to the genetic contributions of males and females yielded greater interest on part of the girls. In Portugal (17 questions out of 36) and in Israel (16 out of 36) noticeable differences between boys and girls were found. In England and Turkey fewer contrasts among girls and boys were found (4 out of 36).

Grouping the Questions into Eight Factors

Based on students' ranking patterns, factor analysis divided the 36 questions into eight sub-groups (Table 3, left column). The sub-groups were given titles by the researcher, based on common themes:

Two sub-groups dealt with reproduction (factors 1 and 3). The first included six questions referring to fertility and fertility problems (e.g. "How are infertility treatments done?"). It was a relatively unpopular set of questions. The second sub-group dealt with five questions about various functions of the reproductive system (e.g. "Are all male penises suitable for all female vaginas? "). It was rated in the middle of the table with regard to popularity.

Two sub-groups dealt with the cardiovascular system (factors 2 and 4). One included seven questions, many of them referring to the intravascular system and all were rather unpopular (e.g. "How do you clean a blood vessel that is blocked by fat?"). The second sub-group included five popular questions about diseases such as heart attacks and cancer (e.g. "How can a heart attack be prevented?").

Three additional sub-groups (factors 5, 6 and 7) dealt with genetics.[6] The sub-group "Artificial creation of humans and organs" included five very popular questions (e.g. "Will we be able to create humans with perfect health in the future?"). Another sub-group revolved around the consequences of technology on the future of humanity. It included five popular questions (e.g. "Can humans be cloned and how could it be done?"). Sub-group 7 included three items, with heterogeneous popularity, about the heredity of human body features (e.g. "Is athletic ability hereditary?").

The eighth sub-group included four less popular questions about common diseases such as blood pressure, smoking and AIDS.

[6] Two questions did not locate to any of the sub-groups. Both were general questions about heredity: "Which has more influence—nature or nurture?" and "Are personality characteristics genetic?"

Explaining the Variance in Students' Interest

All three factors—gender, country of residence and religion—explain the variation in students' interest, both in general topics and specific science questions (Table 4).

Variance in students' interest in general topics (e.g. cardiovascular system) was best explained by their national affiliation, followed by gender and religion. Variance in students' interest in specific questions was best explained by their religious affiliation (a strong affect), national affiliation and then gender. The ranking of each of the eight sub-groups was further examined with regard to the effect of religious affiliation, national affiliation and gender (Table 5).

Religion Religion was found to significantly explain the variation in ranking of seven of the eight sub-groups (Table 5). It had the strongest effect on the sub-group of questions dealing with the heredity of human body features (sub-group 7).

Religious affiliation accounted for interest in sub-group 3, which encompasses questions about human embryology, mating of humans with other species, and homosexuality. This set of questions was ranked 7th among Jewish boys and 1st among their Israeli-Christian peers.

For Israeli students 61% of the questions showed significant differences in ranking as a function of religious affiliation (data not shown). For example, "What is the difference between an HIV carrier and a patient?" ranked high in interest for Israeli Christians, as opposed to their Muslim and Jewish peers. The question: "Are all male penises suitable for all female vaginas?" was controversial. At first, the Portuguese teachers and Israeli Christian teachers did not want to distribute the questionnaire due to its presence. However, it attracted high interest among Israeli Christian boys, more than their non-Christian counterparts. The Jewish students group differed from the other two, based on the ANOVA of all questions (data not shown).

The results for correlations of (1) Christians from Israel and Christians from Portugal and (2) Muslims from Israel and Muslims from Turkey—indicated no significant correlation in interest. This was a surprising finding in the context of the major role of religious affiliation as an explanatory factor (see discussion below).

National Affiliation Country of residence accounted for students' interest in seven of the eight sub-groups. Its strongest effect was seen for the personal health sub-group (Table 5, factor 8). This sub-group dealt with smoking, HIV and blood pressure, and was rather unpopular. Interest levels in these questions were best explained by country but also by gender and religion.

Gender Gender significantly accounted for seven of the eight factors. Its strongest effect was on the first factor that dealt with fertility and fertility problems. Questions making up this factor were much more interesting to girls than to boys. Additional factors that were best accounted for by gender were family health, which was the most interesting factor for girls, and artificial creation of humans and organs, which was more interesting to boys than to girls (Table 6).

An interaction between religion and gender was found: among the different religious groups, the level of gender differences varied. There were almost no gender-related differences among the group of Israeli Muslims, and differences in 29% and 22% of the questions among Jewish students and Israeli Christians, respectively.

Discussion

In the following discussion we will review our findings in light of the literature, and especially a series of recent studies that were devoted to the analyses of the data from PISA 2006 representing students' interest in science.

PISA 2006 conceptualized interest in science as responses that: (1) Indicate curiosity in science and science-related issues and endeavors. (2) Demonstrate willingness to acquire additional scientific knowledge and skills, using a variety of resources and methods, and (3) Demonstrate willingness to seek information and have an ongoing interest in science, including consideration of science-related careers (Bybee and McCrae 2011). Our cross-national study explored students' interest in biology in different countries based on their response to science questions raised by other students. Wanting to learn about specific questions could be seen as indicating curiosity, and to some degree also as demonstrating willingness to acquire additional scientific knowledge and information.

The results of this study indicate that students from four different countries show interest in similar science questions. Questions that were raised by Israeli high school students also interested Turkish, Portuguese and English high school biology students (an average of 3.2–4.2 on a scale of 1–5).

Concurring with the literature, the most intriguing questions were the ones that dealt with human health and new developments in reproduction and genetics. The PISA 2006 findings indicate that this is indeed the norm: students in 52 of the 57 participating countries were more interested in learning about human biology than any of the other broad topics presented to them. In general, students expressed the most interest in learning about health or safety issues that they might encounter personally (Bybee and McCrae 2011).

Another characteristic of the popular questions in this study was their nature: they were all open questions that invited discussion and exploration, as opposed to others that asked for a fact and/or an explanation. This finding is supported by previous studies in Israel (Hagay and Baram-Tsabari 2011) and Turkey (Cakmakci et al. 2011).

A test for the explanatory power of gender, national and religious affiliation indicated that all three elements had some level of influence on students' interest levels. For specific questions, religious affiliation had the strongest effect, followed by national affiliation and gender.

Given this result, we assumed a strong correlation would be found between Muslims from Israel and Turkey and between Christians from Israel and Portugal. However, we found no such correlation. Instead, we found a strong and positive connection between the ranking of Christians and Muslims living in Israel and between Israeli Jews and Turkish Muslims. It may be the case that intensity of belief rather than specific religion accounts for this strong effect. Arab Muslims and Christians in Israel viewed themselves as more religious than their Jewish secular peers (Central Bureau of Statistics 2010). Furthermore, both Christians and Muslims in Israel share a common Arab nationality. This cultural identity is a social parameter that impacts attitudes to science (Aikenhead and Jegede 1999; Carter 2004; Solano and Nelson 2001). Indeed, the world values survey (Inglehart and Baker 2000) found that differences between the values held by members of different religions within given societies are much smaller than are cross national differences.

Another strong effect on cultural identity was country of origin. The ROSE project points to the significance of national affiliation in determining interest and attitudes in science (Sjøberg and Schreiner 2005). However, ROSE examined countries with differing levels of development, whereas the present study involved Western countries with a very high to high human development index. This might account for the relative agreement across students from various countries.

Boys and girls ranked more than half of the questions differently. In most cases girls expressed a higher level of interest than boys. This finding supports the notion of girls' greater interest in biology, regardless of religious or cultural identity (Baram-Tsabari and Yarden 2008; Pedrosa-de-Jesus and Lopes 2011). Questions concerning reproduction were influenced most by gender preferences, due to the higher ranking of girls from all countries (Tables 3 and 6). This finding might reflect interests and concerns among girls at this age. In PISA 2006, as well, females expressed much more interest than males in learning about health-related issues in general. In part this is probably due to some of the issues (e.g. milk components, ultrasound examinations) which are regarded by females as having more personal relevance (Bybee and McCrae 2011).

These findings indicate that adolescents from various countries express scientific interests in similar fields. These include human health and reproduction. However, the results also indicate that in the case of specific questions, fields of interest are dependent on the religious, cultural and gender identities of the participants which are mediated by individual interests and specific forms of group membership (Beck et al. 1995; Hidi 1990). Despite the fact that the source of the individual preferences is the person herself and the source of the factors examined in this study are either innate (gender) or environmental (country, religion), it is the interaction between them that is important (Hidi 1990). This interaction should guide pedagogy that takes students' interests into account.

Limitations

As pointed out earlier, taking students' interest into account is a powerful guide to science teaching. Findings of this study shed light on our ability to generalize students' interests from different countries. Although it explored generalizability, this study involved only four countries and 604 high school biology students. More research is needed to generalize the findings to other countries, age groups and subjects. The convenience sample of students from each country is too small to reflect the interest profile for these countries. However, it is important to iterate that the aim of this comparison was not to reveal the interests of students, but to demonstrate their interest in questions asked elsewhere.

Our 'conservative' choice of countries was based on previous research that had pointed to the clustering of interest in science with regard to geo-economical space. On the one hand we allowed a large degree of heterogeneity with regard to culture, language, religion, economic developmental and educational achievements, but on the other hand stayed in the sphere of European influence. Indeed, adding additional countries, especially from non-western cultures could be a valuable follow-up research.

Furthermore, our measure of interest was cognitive. We asked students how interested they were in learning about something. This measure did not include affective and value domains.

Similarly, Ainley and Ainley (2011) found important differences in the ways that the essential components of interest in science (e.g. knowledge, affect and value) are connected and that these differences can reflect contrasts in students' broad cultural backgrounds. They concluded that models of interest in science developed in Western traditions may not always fit the pattern of relations that develop in different cultural contexts (Ainley and Ainley 2011).

Another limitation that might affect the results is the differences among Christian sub-groups related to doctrine. Portugal, for example, is mainly Roman Catholic, and differences with the interests of Israeli-Christians might be attributed to difference in Christian faiths rather than country of residence. However, it is important to rehearse that the goal of this study was not to quantify the differences in interest or to correlate specific interests with a specific faith. On the contrary—we were trying to establish the feasibility of generalizing biology student's interests between cultures, countries and religions, keeping in mind that there is almost no limit to the number of variables that may affect interest.

Finally, similarities in interests between groups may be a result of other factors as well. A group of students from different countries (such as Jews from Israel and Muslims from Turkey) may share more similarities than groups from the same country (e.g. Jews and Arabs in Israel). This may be due to additional factors (nationality, intensity of belief, etc.) that were not specifically examined in this study.

Implications

The key question guiding this study was whether questions raised by students in a specific setting are of interest to students elsewhere and how do factors, such as religion, country of residence and gender, explain the similarities and differences in students' level of interest. As mentioned in the limitations, there may be other factors which explain even more of the variance, which were beyond the scope of this study.

One might claim that comparing students' interests across religion, gender, and country is not important, since there is no world-wide curriculum that addresses interests of students living far away. However, the issue of students' interest is studied with an international perspective by many scholars, in order to identify similar and different trends and hypothesize their reasons. In this study, the practical motivation for pursuing this question was the need to adapt teachers' pedagogical content knowledge to students' interests on the basis of evidence collected in various contexts.

Implementing the findings on students' interests in science depends on understanding how students' responses are influenced by their culture. The findings of this study suggest that evidence regarding students' interests in one context is relevant to the development of learning materials in a different context. This is an important insight both theoretically and practically, which also supports the rationale behind international cooperation in science education research.

Despite these similarities, there are cultural and sociological differences that need to be taken into account (Aikenhead 2001; Jegede 1996; Lee et al. 2005; Solano and Nelson 2001). When using findings from another country, religion or gender, information regarding the interests of specific students is lost.

One of the ways to address these issues in curriculum planning is to integrate students' individual interests while accounting for different environmental factors. By doing so, teachers can incorporate students' cultural identities as well as the culture of science (Costa 1995). A good, sensitive teacher will adapt lesson content to the interests of the students by bridging between the technical, social and scientific worlds (Lee et al. 2005; Solomon and Aikenhead 1994).

To use an analogy—if teaching biology is like looking through a microscope, then interest based teaching which is informed by research done elsewhere is similar to the course focus. The interests of the specific students provide the fine focus of the teaching.

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Appendix 1: The Questionnaire (English Version)

I believe that if the content of biology studies interested you more, you would learn, remember and enjoy classes more. Therefore I would be grateful if you could take a few minutes to answer this questionnaire. It will help me match the biology syllabus to students' interests. I have chosen to focus on three subjects in biology: the intravascular system (cardiovascular, coagulation and immune systems), the reproductive system, and genetic engineering.

Thank you for participating.

A. Background information

Gender: M/F Year: 12 13

	Not at all				Totally
I am interested in topics related to biology	1	2	3	4	5
I am interested in topics related to the intravascular system (blood, heart, immunization, and clotting)	1	2	3	4	5
I am interested in topics related to the reproductive system	1	2	3	4	5
I am interested in topics related to genetic engineering	1	2	3	4	5
In my free time, I sometimes read or watch popular science	1	2	3	4	5

B. Questions that interest me

The following questions were asked by high school students. For each question, please mark the extent to which you would be interested in getting an answer to that question in biology class: 1—not interested, 5—very interested.

Question					
1. What is mutation and what causes it?	1	2	3	4	5
2. What happens if human semen inseminates the ovum of another animal?	1	2	3	4	5
3. Why is smoking unhealthy?	1	2	3	4	5
4. Which has more influence—nature or nurture?	1	2	3	4	5
5. What can be done with genetic engineering today?	1	2	3	4	5
6. Can humans be cloned and how could it be done?	1	2	3	4	5
7. How does vaccination work, and how can you make someone immune to a disease?	1	2	3	4	5
8. Is there a difference in the number of genes that the offspring receives from the mother and father?	1	2	3	4	5
9. How can a DNA sample identify a person?	1	2	3	4	5
10. Can a woman's stock of ovum run out?	1	2	3	4	5
11. How can a heart attack be prevented?	1	2	3	4	5
12. How does cancer develop and how can it be treated?	1	2	3	4	5
13. Does my blood type say anything about me?	1	2	3	4	5
14. In the future, will we be able to choose how our baby will look?	1	2	3	4	5

15. How are infertility treatments done?	1	2	3	4	5
16. Can I know, in advance, if I am sterile?	1	2	3	4	5
17. When does life start—when the ovum and sperm meet or when the baby is born?	1	2	3	4	5
18. If my grandfather had a heart attack, does that increase the chances that I will have one too?	1	2	3	4	5
19. Is it possible to know, in advance, which traits pass from parents to their offspring and prevent them from being passed, or change those traits?	1	2	3	4	5
20. How do you treat a person whose blood does not clot?	1	2	3	4	5
21. Will we be able to create humans with perfect health in the future?	1	2	3	4	5
22. If a woman does not give birth, can she still produce milk and breastfeed?	1	2	3	4	5
23. Are personality characteristics genetic?	1	2	3	4	5
24. Are body type and height hereditary?	1	2	3	4	5
25. Are all male penises suitable for all female vaginas?	1	2	3	4	5
26. How does the body handle allergies?	1	2	3	4	5
27. How do sound and smell influence the courting process?	1	2	3	4	5
28. Are sexual preferences hereditary?	1	2	3	4	5
29. How do you clean a blood vessel that is blocked by fat?	1	2	3	4	5
30. Is athletic ability hereditary?	1	2	3	4	5
31. What is high/low blood pressure?	1	2	3	4	5
32. What is the difference between a carrier and an AIDS patient?	1	2	3	4	5
33. Is the immune system influenced by psychological factors, and to what extent?	1	2	3	4	5
34. Can organs for transplant be created using genetic engineering?	1	2	3	4	5
35. What is IVF?	1	2	3	4	5
36. If I inject myself with more red blood cells, will I be able to run faster?	1	2	3	4	5

C. Your comments

Please indicate your comments on these questions, other questions you have, and the reasons for your interest (or disinterest) in biology.

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