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# *Gender Dependency and Cultural Independency of Science Interest in an Open and Distant Science Learning Environment*

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## Abstract

This study aims to describe the similarities and differences in the science interests of males and females from Israeli and Arab Middle Eastern countries, as derived from over 1,000 science questions sent to an international ask-a-scientist site. Our findings indicate that while the stereotypical gender gap in interest persists, and significant differences were found between the age groups, no significant differences were found between science questions that were sent by Israelis and Arabs. Furthermore, no correlation was found between female participation and the state of gender equity in the country, and only 1% of the questions made any reference to country-specific, local, or religious aspects. One may conclude that science interests are gender- and age-dependent but culturally independent in this asynchronous, open and distant science learning environment. Further research is needed in order to determine if this is a genuine attribute of science interest in ODL environments or an outcome of the digital divide in the region.

**Keywords**: gender; cross-cultural; informal science education; questions; ask-a-scientist; Middle East

## Introduction

The declining interest of students in pursuing higher science education and science-related careers is a major concern in many countries (e.g. The High Level Expert Group on Human Resources for Science and Technology in Europe, 2004; The National Commission on Mathematics and Science Teaching for the 21st Century, 2000). One of the reasons for this disinterest is the lack of relevance of formal science education to the lives, needs, and interests of many students, especially females. This concern is even more relevant for many students in developing countries who feel that school science is like a foreign culture because of the fundamental differences between the culture of Western science and their indigenous cultures (Aikenhead & Jegede, 1999).

*Interest* refers to a differential likelihood of investing energy in one set of stimuli rather than another (Csikszentmihalyi & Hermanson, 1995). It is a form of intrinsic motivation, which involves doing something because it is inherently interesting or enjoyable (Ryan & Deci, 2000). Interest is a powerful motivator that differs from other motivational concepts by its content specificity (Krapp, 2002). Teaching students what they want to know can be a very beneficial pedagogical strategy. Positive relationships have been reported between interest and a wide range of learning indicators (Pintrich & Schunk, 2002; Schiefele, 1998; Seiler, 2006). Interest plays a role in learning through its contribution to students' connection with the content (affective response) and maintaining that connection for sufficient time to be able to learn (persistence) (Ainley, Hidi, & Berndorff, 2002). Interest has also been found to influence future educational training and career choices (Kahle, Parker, Rennie, & Riley, 1993; Krapp, 2000; Levy, 2003; Lindahl, 2007). The issue of students' interests may also be viewed in the context of the "pupil's voice in education" movement, in which involving students in decisions about their life in school is an important moral and educational principle (Davie & Galloway, 1996). For all these reasons, the ability to identify students' interests in science plays an important role in improving existing curricula to meet their needs.

The wealth of data regarding boys' and girls' interest in science indicates that boys in general are more interested in science than are girls (Gardner, 1975, 1998; Miller, Slawinski Blessing, & Schwartz, 2006) and hold more positive attitudes towards studying and having a career in science (Kahle & Lakes, 1983; Kelly, 1978; Miller, Slawinski Blessing, & Schwartz, 2006; Weinburgh, 1995). However, a recent study which used an open distant science learning environment as a data source instead of the traditional school science setting describes a different picture. The study drew upon almost 79,000 questions sent over the course of a decade to an international ask-a-scientist site, in order to learn about the scientific interests of boys and girls of different age groups from various countries in an online, free-choice, science learning environment (Baram-Tsabari, Sethi, Bry, & Yarden, 2009). The sample demonstrated a decade-long dominance of female interest in science among K-12 students.

Another finding that emerged from the analysis was the absence of correlation between the Gender-Related Development Index[i] [GDI] of the UN and the level of female participation, i.e., countries that emphasize equity in their education policy and legislation did not have a higher percentage of K-12 female students sending questions to this science site than countries that do not promote gender equity.

In many Muslim countries, gender-based discrimination coupled with social and cultural barriers limit women's access to, and participation in, higher education; furthermore, career opportunities for female science graduates are more limited than for their male counterparts (Hassan, 2000). Nevertheless, Egypt, Iran, and Indonesia (ranked 119, 99, and 110, respectively, in the UN's GDI) displayed a female majority among contributors of science questions on the site, while Sweden, Denmark, and the Netherlands (ranked 6, 14, and 12, respectively, in the GDI) had among the lowest percentage of female contributors in the research. Israel, ranked 21 in the GDI, showed an average female participation rate. The relationship between the GDI and female participation in this site is neither linear nor inverted – it simply does not exist (Baram-Tsabari, Sethi, Bry, & Yarden, 2009).

This finding can be viewed in light of the results from the international project, Science and Scientists (Sjøberg, 2000), which found that in most developed countries boys are more interested in learning science than girls, while in most developing countries, the opposite is true. Sjøberg and Schreiner (2005) tentatively explained this pattern with the idea that obtaining an education is a luxury in developing countries, especially for girls, while it is perceived as a burden by many students in developed countries. Another study that explored gender differences in high school mathematics achievements in the United Arab Emirates found that females outperformed their male peers. The author suggested that in Arab society female students spend more time in indoor activities, and, therefore, females might spend more time on school work than males (Alkhateeb, 2001).

We can further hypothesize that females in developed countries have a wider range of educational and occupational possibilities and therefore do not view science as a unique escape route from their traditional gender roles. It is also possible that females' interest in science is a product of their wish to impact society (Schreiner & Sjøberg, 2007) or even a form of rebellion against a limiting society (Baram-Tsabari, Sethi, Bry, & Yarden, 2009).

The Internet has tremendous potential to achieve greater social equity and empowerment (Mehra, Merkel, & Bishop, 2004), and open educational resources have helped to level the distribution of knowledge across developing and developed countries (Smith, 2009). It is widely suggested that online technologies can help address issues of educational equity and social exclusion and open up democratic and accessible educational opportunities (Gulati, 2008). Therefore, the finding regarding the female majority among research participants may indicate that the Internet has a potentially empowering and democratic role, which is especially relevant to populations that are deprived of equal opportunities to learn formal science. In this sense open and distant science learning environments may provide valuable hints regarding the genuine interests and information needs of marginalized groups in scientific fields.

This study focuses on how people from Middle Eastern countries use available media to fulfill their science information needs, using the perspective of the uses and gratifications theory. In this sense we are trying to tie people's motivations for using an ask-a-scientist site to their membership in cultural groups. The study aims to describe the similarities and differences of the science interests of male and female students from Israel and other countries in the Middle East, as mirrored by the questions sent to an ask-a-scientist site, in order to unveil the role played by gender and culture on science interest in this open, Web-based ODL environment.

# Methodology

## *Research Approach*

Interest in science has been traditionally identified using written questionnaires (e.g. Dawson, 2000; Qualter, 1993; Sjøberg, 2000; Sjøberg & Schreiner, 2002; Stark & Gray, 1999) that rely on adult-centric views of what subjects should be meaningful to students (and the public in general). It is our assumption that using spontaneous ideas and questions may be a better measure of interest than using responses to a questionnaire written by a researcher. Responses to a questionnaire are externally regulated, while asking a question is a self-regulated action (Deci, Vallerand, Pelletier, & Ryan, 1991) and therefore should be a stronger measure of interest.

Students' questions are an important part of the ongoing scientific research process and have an important educational role (Biddulph, Symington, & Osborne, 1986; Brill & Yarden, 2003; Scardamalia & Bereiter, 1992). Despite the capacity of students' questions for enhancing learning, much of this potential remains untapped (Chin & Osborne, 2008). It is hard to use children's questions for research in a classroom setting since they are so rare and seldom give evidence of genuine intellectual curiosity (Dillon, 1988). Researchers attribute this situation to a classroom atmosphere in which revealing a misunderstanding may render the student vulnerable and open to embarrassment, censure, or ridicule (Pedrosa de Jesus, Teixeira-Dias, & Watts, 2003; Rop, 2003). However, students do pose science questions in free-choice, science learning environments. Therefore, we chose to use self-generated, science-related questions submitted to an open and distant science learning environment as a data source to probe the scientific interests and needs of Middle Eastern students.

## *The Data Source*

When people are using the Internet to research their interests, some of their complex questions are better answered by experts than by a list of directories or sites. This type of service is offered on the Web by human-mediated question-and-answer sites, which are sometimes referred to as "expert services" (Janes, Hill, & Rolfe, 2001) or "ask-a" services (Lankes, 1999). Such sites usually maintain searchable public archives in which previously answered questions are returned as search results, thus making this archive a resource for their users (Pomerantz, Nicholson, Belanger, & Lankes, 2004).

Ask-a-scientist sites exist both in Hebrew[ii] and Arabic[iii]. However, these sites could not serve as the data source for this cross-cultural comparison for various reasons, such as focusing on medical issues, addressing mostly teachers' questions, and not recording background information. Therefore we chose to use the massive archives of the international Web site *MadSci Network* as a data source, noting the limitations its language demands cast on the nature of our sample.

MadSci Network is an independent, award-winning, nonprofit organization operating from a server in Scottsdale, AZ (see www.madsci.org). It receives 90 to 150 questions daily, most of which are answered automatically by the site's search engine. Fewer than 20% of the questions are answered by nearly 800 globally distributed volunteer scientists, usually within two weeks. Unlike most ask-a-scientist services, MadSci Network covers all branches of science and stores key demographic information as metadata, making it easier to mine the information from its archives.

## The Sample

Over 146,000 questions were sent to MadSci Network between 1996 and the first half of 2006. Almost 79,000 of the surfers disclosed their grade level and country of origin and filled in the name and question's subject fields. Of these, 1,289 questions were submitted by people who indicated their country of origin as one of the following: Afghanistan, Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Palestine National Authority, Qatar, Saudi Arabia, Oman, Syria, Tunisia, Turkey, and United Arab Emirates. Afghanistan, Iran, and Turkey are not Arab countries, but they were included as Middle Eastern for geographical and cultural reasons. These questions were used in our analysis, after removing duplications, non-scientific, and ambiguous questions, which resulted in a sample size of 1,102 questions. For an age and gender split of the sample, see Table 1. Throughout this paper, Israel is compared to all other countries in the region. The rationale behind this grouping is the cultural differences with regard to religion, language, and political situation.

Table 1

*Demographic Characteristics of the Sample*

| | **Israel** | | | **Middle Eastern countries**[1] | | | **Full Sample** |
|---|---|---|---|---|---|---|---|
| | **Males** | **Females** | **Unknown** | **Males** | **Females** | **Unknown** | |
| **K-3rd graders** | 2 | 0 | 0 | 11 | 1 | 1 | 15 |
| **4th-6th graders** | 1 | 1 | 0 | 7 | 3 | 5 | 17 |
| **Middle school** | 2 | 7 | 2 | 24 | 33 | 8 | 76 |
| **High school** | 17 | 8 | 8 | 113 | 100 | 31 | 277 |
| **Undergraduates** | 58 | 8 | 4 | 97 | 46 | 17 | 230 |
| **Graduates** | 57 | 32 | 6 | 153 | 74 | 59 | 381 |
| **Teachers** | 9 | 9 | 2 | 54 | 16 | 16 | 106 |
| **Sum** | 146 | 65 | 22 | 459 | 273 | 137 | 1102 |

[1]The list includes the following Middle Eastern, Arab and Muslim countries: Iran, Turkey, Egypt, United Arab Emirates, Lebanon, Oman, Saudi Arabia, Qatar, Palestinian National Authority, Kuwait, Iraq, Jordan, Bahrain, Morocco, Syria, Libya, Afghanistan, Algeria and Tunisia

## Gender Identification

Gender identification was based on the research participant's first name. Initial classification was done semi-automatically using an English name gender finder. Next, the names that were not automatically classified were analyzed manually. Some names that could be associated either with a male or a female (e.g., the Israeli name "Tal" and the Arab name "Nur") were classified as "unknown" and accounted for 14% of the sample.

## *Question Classification*

Textual analysis of the questions was performed with coding schemes that were previously used for students' science question classification (Baram-Tsabari, Sethi, Bry, & Yarden, 2006; Baram-Tsabari & Yarden, 2005, In Press).

### *Topic of the question: Subject and sub-subject.*

Questions in this coding scheme were placed in one of the following categories: biology, physics, chemistry, earth sciences, astrophysics, nature of science (NOS) inquiry, and technology. NOS inquiries were general questions about how scientists develop and use scientific knowledge (Ryder, Leach, & Driver, 1999) without reference to a specific scientific context. Technology questions were categorized by defining technology as the development, production, and maintenance of artifacts in a social context, as well as the artifacts themselves (Gardner, Penna, & Brass, 1996). Questions in the field of mathematics and questions that did not have a science topic were not included in our sample. Each of the categories (except for NOS) was further divided into sub-subject, resulting in a total of 65 sub-subjects: 20 in biology, 6 in physics, 13 in chemistry, 8 in earth sciences, 6 in astrophysics, 1 in NOS, and 11 in technology. An effort was made to classify the questions using the research participant's perspective. For example, the question "Plz Tell me about problems made by Masturbation in male and females," sent from Iran, was classified as "Sickness, disorders, and medicine" since this is the way the issue was framed and categorized when originally submitted to the Web site's system. For examples of the application of the categories in this coding scheme, see Table 2.

Table 2

*Examples of the Questions Analyzed According to their Topic and their Frequency within Various Subjects*

| **Subject** | **Sub-subject** | **Example[1] (gender[2], age group, country)** |
|---|---|---|
| Biology (36.6%, 405)[3] | Physiology and anatomy (3.5% , 39)[3] | What is the mechanism which produces the sensation of thirst? (f, high school, United Arab Emirate) |
| Chemistry (20.8%, 230) | Phases of matter (1.1% , 12) | What form of matter does fire come under? Is it solid, liquid or gas? (f, middle school, Kuwait) |

| | | |
|---|---|---|
| Physics (14.5%, 161) | Modern physics (1.3% , 14) | Let's say we find a way to accelerate matter to the speed of light, and let's say a bus is driving at the speed of light, with someone sitting at the back of it. Then, while the bus is at the speed of light this person gets up and walks forward in the bus. Isn't he going faster than the speed of light? (m, high school, Israel) |
| Technology (12.5% , 139) | Aeronautics (1%, 11) | Can a helicopter fly freely in a tunnel? (m, graduate, Israel) |
| Astrophysic s (5.6% , 62) | The solar system (2.3% , 26) | How many days does it take for the moon to make one revolution? (m, middle school, Egypt) |
| Earth science (3.2% , 36) | Atmosphere (1% , 10) | How would Earth look like from space if it didn't have an atmosphere? (m, high school, Israel) |
| Nature of Science ( 1.2% , 13 ) | – | What are the characteristics of a scientist? (m, high school, Lebanon) |

[1] These are verbatim quotes. In some cases only a part of the question is shown.
[2] Where data is available, m = male; f = female; NA = not available.
[3] Percentage of questions in this subject or sub-subject out of the total sample, followed by the absolute number of questions.

### *Magnitude.*

The order of magnitude of the object in question was noted. This scheme was inspired by the concept of "level of organization," which is abundantly used in biology education research (e.g. Knippels, 2002; Songer & Mintzes, 1994; Verhoeff, 2003). The levels chosen for this scheme were population, macroscopic, microscopic, molecular, and nano-metric scale. This classification was relevant to only 79% of the questions, mostly in the fields of biology, chemistry, and physics. For examples of the application of the categories in this coding scheme, see Table 3.

### *Object of interest.*

Many questions were embedded in the context of human biology, zoology of non-humans, botany, or unicellular entities. This classification was relevant to only 36% of the questions, mostly biology questions. For examples of the application of the categories in this coding scheme, see Table 3.

Table 3

*Examples of the Questions Analyzed According to the Object of Interest and its Magnitude and their Frequency*

| **Magnitude: organization level** | **Object of interest** | **Example[1] (gender[2], age group, country)** |
|---|---|---|
| Population (11.1% , 123)[3] | Zoology (4.8% , 53)[3] | How can birds find their way home? Do they have a magnetic compass? (m, teacher, Turkey) |
| Macroscopic (25.6% , 283) | Human (25.3% , 280) | My baby 8 months old when crying no tears are coming out till now why? (f, NA, Kuwait) |
| Microscopic (4.6% , 51) | Not mentioned (64% , 707) | Can you tell me why are the nervous system cells non-compensate? (NA, high school, Saudi Arabia) |
| Molecular (13.6% , 151) | Human | Does DNA get updated as a person grows up? (m, high school, Israel) |
| Nanometric scale (14% , 155) | Not mentioned | How does light travel through vacuum? (NA, undergraduate, Lebanon) |

[1] These are verbatim quotes. In some cases only a part of the question is shown.
[2] Where data is available, m = male; f = female; NA = not available
[3] Percentage of the questions in this subject or sub-subject out of the total sample, followed by the absolute number of questions. Percentages do not add up to 100% since not all categories are represented in the table.

### *Psychological distance.*

Bar-Ana, Liberman, and Trope (2006) describe four dimensions of psychological distance: (a) spatial – how distal in space is the target from the perceiver? (b) temporal – how much time (past or future) separates the perceiver's present time and the time of the target event? (c) social – how distinct is the social target from the perceiver's self (e.g., self vs. others, friend vs. stranger)? (d) hypothetical – how likely is the target event to happen, or how close is it to reality, as construed by the perceiver? The zero-anchoring point of all four dimensions is the perceiver's direct experience, the stimuli sensed in the here and now, whereas psychologically distal entities are objects and events that are not part of the perceiver's direct experience. We added another dimension to the psychological distance, which is scale. Objects that are too small or big to be experienced with our senses can be considered as psychologically distal. The questions were coded into three levels according to the psychological distance of the research participant from the object of the question:

1. Myself. Example: How does caffeine affect us?
2. Direct environment. Refers to objects that the research participant may observe and interact with. Example: How can I detonate a hydrogen balloon safely?
3. Distant environment. Refers to objects that the research participant may not observe and interact with. Example: Is there more chance for life in galaxies that are in a non crowded space?

### *Country-specific and religious aspects.*

Particular attention was given to questions with a local, national, or religious emphasis. The number and nature of such questions serves as an indication of the cultural dependence of the science and technology-related interests of people from Middle-Eastern countries, as mirrored by their questions.



## *Reliability*

In order to establish reliability, 120 questions were classified independently by two researchers in order to establish an acceptable level of reliability. For the first preliminary trial, 20 questions were coded independently. Problematic issues were then discussed and refined. For the second trial, another 40 questions were coded; disagreements were resolved by discussion among the researchers, and the coding system was adjusted as necessary. In the third trial, the remaining 60 questions were coded and compared. Agreement between the researchers for the third trial was as follows: gender identification, 100%; subject, 96%; sub-subject, 95%; magnitude, 83%; object of interest, 100%; psychological distance, 90%; local/religious aspects, 100%.

## *Statistical Analysis*

Significant differences were determined according to a cell chi-square test. Pearson correlation index was used for finding linear correlations. All p-values reported are two-sided.

# Results

In order to investigate the role played by gender and culture in an open and distant science learning environment, 1,102 questions submitted to an international ask-a-scientist site by students and teachers from Middle Eastern countries were analyzed.

## *Grade Level, Gender, and Geographical Distribution of Participants*

Most of the questions (80%) in the sample were sent by high school, undergraduate, and graduate students (Table 1). The questions that originated in Israel represented 21% of the sample, and the rest were sent from Arab countries in the region. Of the 943 gender identifiable questions, only 36% (338) were sent by females. However, among the questions sent by K-12 students, 46% (153) of the gender identifiable questions were sent by female students (Table 1). The greater participation of females among K-12 age groups compared with older age groups mirrors trends found in other regions in the world, such as the US and Western Europe (Baram-Tsabari, Sethi, Bry, & Yarden, 2009).

## *Interactions between Scientific Interests, Grade Level, and Gender*

Overall, the questions in the sample referred to the following scientific disciplines, appearing here in their order of popularity (Table 2): biology (36.6%), chemistry (20.8%), physics (14.5%), technology (12.5%), astrophysics (5.6%), earth science (3.2%), and nature of science (1.2%). The most popular sub-subjects for questions were sickness, disorders, and medicine; electricity and magnetism; biochemistry; light, heat, sound (radiation); sex, genetics, and reproduction; computers and Internet; botany; chemical reactions; cell biology; mechanics; and neurobiology and the mind.

A significant difference ($p < 0.001$) was found between boys and girls in the distribution of question topics: Boys were more interested than girls in learning about physics and technology, while girls were more interested than boys in biology. This was true for Israelis ($p < 0.001$) and for Arabs ($p < 0.001$) as well as for the whole sample. This stereotypic gap in gender interest has been described previously in many countries, both in formal and informal learning environments (e.g. Baram-Tsabari & Yarden, 2008; Dawson, 2000; Jenkins & Nelson, 2005; Jones, Howe, & Rua, 2000; Murphy & Whitelegg, 2006; Yerdelen-Damar & Eryılmaz, 2009). A significant difference ($p < 0.001$) was also found between the age groups as far as the distribution of question topics: interest in biology decreases with age while interest in technology increases.

Many of the questions that were coded for order of magnitude ($n = 759$, Table 3) asked about macroscopic entities ($n = 283$). Many other questions referred to population, molecular, and nano-metric organization levels. With students' increasing age, the order of magnitude of the objects in question deviated from macroscopic scale to organization levels that are not obvious to the naked eye ($p < 0.01$).

Of the questions that were classified for object of interest ($n = 395$, table 3), most dealt with human biology ($n = 280$), and a few concerned zoology, botany, and microbiology. On the other hand, over two thirds of the questions (67.6%) related to objects that are not experienced directly by the research participant but are found in his/her distant environment; 25.5% of the questions dealt with objects found in the research participant's immediate environment; and 6.9% concerned themselves. A significant difference ($p < 0.01$) was found in the likelihood of males and females to ask about objects that cannot be directly experienced: females asked more about their direct environment, while males asked more about the distant environment. A significant difference ($p < 0.01$) was also found with regard to age: interest shifts from the direct to the indirect environment of the participants with age.

## *Interactions between Scientific Interests and Country of Origin*

Questions submitted from Israel and from other Middle Eastern countries displayed no significant differences with regard to subject, order of magnitude, object of interest, or psychological distance (Table 4).

Table 4

*Significance of Interactions between Characteristics of Science Questions and Characteristics of the Research Participants*

| | ***Gender*** | ***Grade level*** | ***Country of origin*** |
|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| **Subject** | $p < 0.001$ | *** | $p < 0.001$ | *** | $p = 0.1$ | NS |
| **Magnitude** | $p = 0.28$ | NS | $p < 0.01$ | ** | $p = 0.2$ | NS |
| **Object of interest** | $p = 0.41$ | NS | $p = 0.07$ | NS | $p = 0.08$ | NS |
| **Psychological distance** | $p < 0.01$ | ** | $p < 0.01$ | ** | $p = 0.06$ | NS |

NS = not significant



The same cultural independence of science interests was observed using the *Country-specific and Religious Aspects* coding scheme. Only 11 questions out of 1,102 (1%) referred to local or religious aspects (Note: gender, grade level, and country of origin are in brackets):

1. What about nuclear future in Egypt? (m, high school, Egypt)
2. What is the probability of a B+ blood type person to be an Arab or African? (m, graduate, Qatar)
3. [Looking for] References/Web sites on Nile pollution (f, teacher, Egypt)
4. What is the name of the dye which is present in mehndi (henna) leaf? (f, high school, Saudi Arabia)
5. What are the activities recommended for a future taxonomist living in Kuwait? (f, middle school, Kuwait)
6. Was Isaac Newton a Jew? (m, undergraduate, Israel)
7. How […] present is the possibility of the earth quake in Tehran? (f, high school, Iran)
8. At what time will the eclipse occur in Israel, how much will we see? (m, graduate, Israel)
9. Formula to convert between calendars [Hebrew and Christian]. (m , graduate, Israel)
10. Is it possible that a Kuwaiti can be an astronaut with average grades? (m, middle school, Kuwait)
11. The definite causes of the Egyptian great pyramid effects and mysteries? (m, graduate, Egypt).

These exceptional examples demonstrate the general and global, rather than local, nature of the science-related interests of people from Middle-Eastern countries, as mirrored by the majority of questions submitted to MadSci Network.

## *Interactions between Gender and Country of Origin*

The percentage of female contributors varied greatly between countries, from 25% in Turkey to 85% in Jordan. The countries with the greatest ratio of posts made by women were Jordan, Kuwait, and Lebanon. Saudi Arabia and Egypt also demonstrated a higher number of female than male contributions among K-12 students (Table 5). Some of the results reported by Baram-Tsabari, Sethi, Bry, and Yarden (2009), notably the higher number of female participants observed in Iran (52%), were not reproduced here, probably due to methodological differences. The former study used an automatic classification, while here almost 200 questions were eliminated because a textual analysis found them to be unscientific or ambiguous with regard to their subject.

However, the absence of correlation between the percentage of submissions by females and the UN's gender-related developmental index that was described earlier, using an international sample dominated by English speaking countries (Baram-Tsabari, Sethi, Bry, & Yarden, 2009), was repeated in this Middle Eastern sample. No correlation was found between the percentage of submissions by females, either K-12 students or all age groups, and the GDI of the specific country (Table 5). Further, no correlation was found between any of the indicators for digital access and the overall number of questions submitted from any specific country (Table 5).

Table 5

*Country Characteristics with Regard to General and Female Participation, Gender Equity, and Digital Divide*

| Country[1] | Number of questions | % of female submissions[2] | % of K-12 females submissions[2] | Gender-related development index[3] | Internet users per 100 inhabitants[4] | Digital access index[5] | Networked readiness[6] |
|---|---|---|---|---|---|---|---|
| **Israel** | 233 | 31% (65) | 38% (16) | 21 (0.927) | 27.7 | 0.70 | 18 (5.18) |
| **Iran** | 222 | 29% (55) | 44% (24) | 83 (0.750) | 25.5 | 0.43 | -------- |
| **Turkey** | 168 | 25% (30) | 30% (13) | 78 (0.763) | 16.6 | 0.48 | 55 (3.96) |
| **United Arab Emirates** | 111 | 40% (36) | 44% (21) | 43 (0.855) | 36.7 | 0.64 | 29 (4.55) |
| **Egypt** | 93 | 35% (32) | 55% (17) | ------ | 8.0 | 0.40 | 63 (3.74) |
| **Saudi Arabia** | 71 | 48% (26) | 67% (18) | 69 (0.783) | 18.6 | 0.44 | 48 (4.07) |
| **Kuwait** | 46 | 66% (29) | 73% (24) | 32 (0.884) | 29.5 | 0.51 | 52 (4.01) |
| **Lebanon** | 42 | 54% (21) | 62% (8) | 80 (0.759) | 26.3 | 0.48 | -------- |
| **Oman** | 22 | 45% (9) | 40% (4) | 66 (0.788) | 12.2 | 0.43 | 53 (3.97) |
| **Jordan** | 18 | 85% (11) | 75% (3) | 79 (0.760) | 13.7 | 0.45 | 47 (4.08) |
| **Iraq** | 16 | 31% (4) | 0% (0) | ------ | 0.16 | -------- | -------- |
| **All sample[1]** | 1102 | 36% (338) | 46% (153) | -------- | -------- | -------- | ------- |

[1] Only countries with 15 submissions or more are listed.
[2] Percentages calculated of the total of gender identifiable questions.
[3] http://hdrstats.undp.org/indicators/268.html
[4] United Nations Statistics Division. http://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=608
[5] The Digital Access Index (DAI) measures the overall ability of individuals in a country to access and use new ICTs, built around four fundamental vectors: infrastructure, affordability, knowledge and quality, and actual usage of ICTs. Issued by the International Telecommunication Union on 2003. www.itu.int/ITU-D/ict/dai
[6] Networked Readiness Index 2007–2008 rankings are issued by the World Economic Forum as part of The Global Information Technology Report. www.weforum.org/pdf/gitr/2008/Rankings.pdf

## Discussion

When studying science, students move between the culture of their everyday life-world and the culture of Western science (Aikenhead & Jegede, 1999). An open and distant science learning environment, such as an ask-a-scientist site, might be viewed as a mechanism of cultural border crossing. This is especially true for traditionally marginalized groups in Western science, such as females and non-Westerners (of all genders). Such an ODL environment allows an investigation of one's own interests and genuine needs in the context of science. Thus, ask-a-scientist sites may serve as a data-source about children's science interests, which could ultimately inform classroom science teaching and enhance the attractiveness and relevance of science curricula and informal science learning environments (Baram-Tsabari, Sethi, Bry, & Yarden, 2006; Baram-Tsabari & Yarden, 2005).

The sample used in this study, which originates from the culturally, economically, and politically diverse Middle East region, did not demonstrate correlation between the percentage of science questions sent by females and the gender equity of specific countries. Contrary to expectation, gender differences with regard to interest in science are not smaller in technologically advanced countries, which foster mass education and equity legislation (Steinkamp & Maehr, 1984). It is an example of cultured technology, in which communities reshape a technology and make it a part of their culture, while at the same time changing their customary ways of life and unwritten laws to adapt to it (Barzilai-Nahon & Barzilai, 2005). In this case study, the Internet serves as a potential bypass for traditional gender inequities by allowing girls to pursue their science interests through an open and distant science learning environment even when their direct environment does not necessarily encourage such interests.

This is a specific example of the more general notion of the Internet as a facilitator of free thought. Rinnawi (2002) expressed this idea with regard to political issues in Arab countries:

> Arabs have and continue to use the Internet, for reshaping the public sphere through expanding the margins of freedom of expression. In the circumstances of very narrow margins of freedom of expression and regime controlled mass media, as in the Arab World, the Internet is proving its ability to increase opportunities for individuals and groups to discuss and make political and socio-cultural issues more renowned. (Page 1)

Our results also show that the stereotypical gap in male and female science interests crosses borders and cultures: boys' greater interest in physics and technology and girls' greater interest in biology was evident for both Israelis and Arabs. This finding is mirrored by an analysis of questions submitted to a Turkish ask-a-scientist site, which found that only 15% of the physics questions were submitted by females compared with 52% of the biology questions (Yerdelen-Damar & Eryılmaz, 2009). The Science and Scientists (SAS) project, too, found strong similarities between the lists of Norwegian and Japanese science topics favored by boys and girls, despite the strong cultural differences between these two countries (Sjøberg, 2000). In addition, significant shifts in interest related to age were found, from biological to technological questions as well as diversification of the organization level of objects to the psychological distance of the object of interest from the research participant.

However, no significant differences were observed between the science interests of Israeli and Arabs, as inferred from their questions. One might have expected such differences, due to culture-related indigenous knowledge, beliefs, and values. Semali (2004), for example, pointed to the importance of cultural identity at a time of economic and educational globalization. Another reason to expect a difference is that culture-specific beliefs (such as sense of time or preference for face-to-face versus electronic meetings) are thought to have a downstream effect on the use of the Internet (Loch, Straub, & Kamel, 2003). A survey among computer-savvy Arabs, for example, listed culture conflict among the discouraging factors for the acceptance of the Internet in the Arab world (Loch, Straub, & Kamel, 2003). A culture conflict may emerge, for example, because in the virtual realm interaction patterns between male and female students cannot be controlled and religious barriers collapse (Al-Hunaiyyan, Al-Huwail, & Al-Sharhan, 2008). An empirical examination of ultra-Orthodox Jewish communities in Israel found them to conceptualize the Internet as a threat (Barzilai-Nahon & Barzilai, 2005).

Nevertheless, our findings indicate that while the stereotypical gender gap persisted, and an age related shift in science interest was also observed, no significant differences were found with regard to country of origin (Table 4); no correlation was found between female participation and the UN's gender-related developmental index (Table 5); and only 1% of the questions made any reference to country-specific, local, or religious aspects. One may conclude that science interests are gender- and age-dependent but culturally independent in this asynchronous open and distant science learning environment.

This finding might be a genuine attribute of science interest in ODL environments, but also it might be an outcome of the great digital divide in the region, which spans from 0.2% penetration in Iraq to 52% in Israel (Internet World Stats, 2008 and Table 5). Caswell, Henson, Jensen, and Wiley (2008) crown new distance education technologies as enablers to achieving the universal right to education and as social transformers. However, this social transformation depends on access to adequate technology, which is still more ideal than real (Huijser, Bedford, & Bull, 2008). E-learning does have the potential to meet the educational needs of masses of poor people in developing countries; however, the present IT provisions in developing countries are limited to the elite (Gulati, 2008). Notwithstanding the widely expanding access to the Internet, the research sample might have been far less heterogeneous than the general population in the region because the sample is characterized by access to the Internet and reasonable fluency in English.

There are a variety of barriers that make it difficult for many Arabs to freely access the Internet, including language and the cost of equipment, software, and Internet connections (Rinnawi, 2002). Many Arab countries also lack the infrastructure required to enable wide-scale data transmission over their phone lines. Government prohibitions have resulted in the Internet not being available to the public in Iraq and Syria, for example. In other countries, such as Tunisia, state monitoring may also turn away potential users. In Bahrain, UAE, and Saudi Arabia, all Internet traffic passes through a single government-controlled gateway (Rinnawi, 2002). Therefore, the cultural differences observed might have been smaller than among the general population in the region.

Additionally, *country of origin* was used as a single indicator for cultural affiliation, although a large minority of Arabs live in Israel, and they use the Internet in different ways (Avidar, 2009). In order to address these problems, future research on the interplay of culture and ODL in the context of science interest should identify comparable ask-a-scientist applications in Hebrew, Arabic, and Farsi.

Another drawback of this study is the limited sample size, which made it impossible to control for age and gender while comparing results according to country of origin. Future research should take advantage of bigger samples in order to control these variables. Furthermore, as in the case of other ODL environments, the sample is self-selected and constituted of students who are initially more interested in learning (in this case, science) than the general population.

## Conclusion

This attempt to unveil the role played by gender and culture in pursuing scientific interests in an open, Web-based ODL environment found that an interest in science is gender- and age-dependent but culturally independent. It seems that the Israeli and Arab contributors to our sample were quite similar with regard to their interests, curiosities, and needs. It is tempting to say that common interest in science provides scaffolding for an educational bridge over the troubled Middle Eastern water. However, further research is needed in order to determine if this is a genuine attribute of science interest in ODL environments or an outcome of the digital divide in the region.

Smith (2009) notes two challenges to open educational resources: the extent of use in the developed and developing worlds and the question of effectiveness. This study makes a contribution to the first challenge. Knowing more about the cultural and gender characteristics of users of open and distant science learning environments will help make them a more reliable data source, a better research tool, and a more relevant and effective learning environment for different groups of learners.

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# Endnotes

[i] Human development reports, Technical Note 1: The gender-related development index (GDI) adjusts the average achievement of a country to reflect the *inequalities* between men and women using three basic dimensions of human development: (1) A long and healthy life, as measured by life expectancy at birth, (2) Knowledge, as measured by the adult literacy rate (with two-thirds weight) and the combined primary, secondary and tertiary gross enrollment ratio (with one-third weight), (3) A decent standard of living, as measured by GDP per capita.

[ii] e.g. www.bashaar.org.il ; www.weizmann.ac.il/zemed/net_activities.php?cat=1639&incat=1412

[iii] e.g. www.panmedsa.com ; www.6abib.com ; www.hawahome.com ; www.md4a.net ; www.raneem.net