

Ibn Sina Steps Out: Exploring Arabic Attitudes Toward Humanoid Robots

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Abstract. As humanoid robot technology makes its way into the global economy, it is important for robot designers to try to understand the variety of cultural attitudes that exist throughout the world. However, to our knowledge, no one has yet surveyed Middle Eastern attitudes on this topic. We aim to try to bridge this gap. In particular, we wanted to understand how Arabic people might view having humanoid robots in their daily lives, and developed a questionnaire to understand these views. We also built an end-to-end Arabic conversational system on our humanoid robot Ibn Sina, and brought the robot to a mall in the United Arab Emirates. At the mall we encouraged people to interact with the robot as well as complete our questionnaire. With 131 respondents from 21 countries, our findings show significant regional differences in overall attitudes (people from the Gulf viewed humanoid robots more favorably than people from Africa), as well as an effect from college education (people with college degrees viewed humanoid robots less favorably than people without college degrees).

Category: Exploratory studies (*E*)

1 Introduction

As humanoid robot technology starts to make a foray into the global economy, it is important for robot designers to try to understand the variety of cultural attitudes that exist throughout the world. To date, a number of studies have examined cultural attitudes toward humanoids, but they focused mainly on western (USA, Mexico, Western Europe) and far eastern (Japan, Korea, and China) populations [3, 7, 12]. However, we are not aware of any studies examining Middle Eastern attitudes regarding humanoid robots.

People from the Middle East typically hold varied cultural and religious beliefs surrounding depictions of human-likeness. Islam traditionally espouses an anti-iconic doctrine, particularly with regard to three dimensional figures. The main reason for this is that when an artist forms an image of a living being, he or she is trying to adopt the role of creator, which is intended to be reserved for only God. This idea is even ingrained in Qur'anic Arabic; the word for "to fashion or form" (*sawwara*) is synonymous with the word "to create" (*bara'a*), and God is often referred to as a creator (*al-Bari'*) [15]. While we do not wish to delve into a deep analysis of Islamic doctrine and linguistic tendencies, we merely wish to mention this as a potentially strong influence on how people might view humanoid robots.

For other types of technology, some researchers have looked at how Arabic cultural attitudes might affect technology acceptance. Straub et. al noted that a lot of information technology to date has been developed with an ethnocentricity biased toward the cultural systems of the countries that built them. Such oversights can create many problems with technology acceptance [16]. Albirini found similar problems when studying how EFL teachers in Syria view information technology in the classroom. While most of the teachers viewed computers as being a very viable way to improve Syrian standard of living and education as well as being pertinent to Syrian schools and society, they felt the computers first needed to better suit Arabic identity and culture. The teachers felt there were many outstanding social issues to be addressed before using computers in education, and that computers were proliferating too quickly [2].

Thomas [19] and Rogers [14] stress how important it is to understand the social and cultural norms of a country in order to help ensure technology acceptance by its people. If a technological tool does not fit within the macro or micro-culture of a society, potential adopters may resist it [2].

Thus, we wanted to understand how Arabic people might view having humanoid robots in their daily lives, and developed a questionnaire to try to probe some of these ideas. While we considered administering the NARS or RAQ questionnaires developed by Nomura et al. [13], recent work by Syrdal et al. suggests that the internal consistency of NARS may be threatened in cross-cultural/cross-lingual studies [17]. Furthermore, we wanted an instrument that better captured important areas of Arabic life: community, domestic life, and education. Thus, we developed a new questionnaire which we've



Figure 1. A man gives Ibn Sina robot a traditional Emarati greeting.

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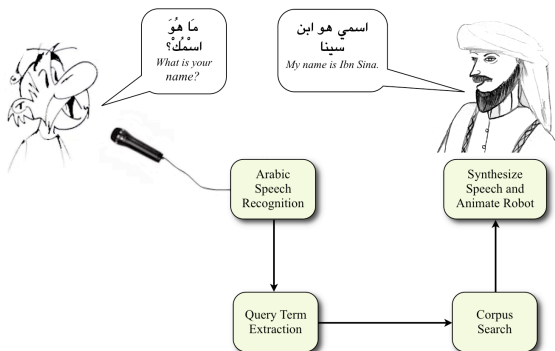


Figure 2. An overview of the system. First a person speaks in Arabic to the robot, next their speech is recognized, then appropriate query terms are extracted, next the corpus is queried, and finally the robot is animated to make facial expressions and speak.

called the Culture Education and Domestic Attitudes toward Robots (CEDAR) scale.

Rather than distribute the CEDAR scale without context, we thought it would be better to run a pilot study in a public setting where people could see and interact with a humanoid robot to get an idea about its capabilities. Thus, we brought our robot, Ibn Sina, to a local mall in the United Arab Emirates.

Overall, we wanted to know if peoples' attitudes were influenced by their region of origin, college educational level, gender, or age. Our major findings, presented in Section 4, are that people from the Gulf had more favorable views toward humanoid robots than people from Africa, and people with college degrees had less favorable views than those without one.

2 System Description

The robot used in our experiment was developed by Hanson Robotics made to resemble Ibn Sina, a well respected Islamic philosopher, doctor, and polymath who lived from 980-1037 A.D. The robot is a central part of the IbnSina Theatre, an augmented reality theater with intelligent robotic and virtual characters [9].

Ibn Sina robot has 19 degrees-of-freedom in its face, and each degree of freedom is intended to represent the human musculature. Its facial movements and expressions are very life-like and natural. The robot also has two degrees-of-freedom in its arms and is able to move them up and down. Figure 1 shows a person interacting with Ibn Sina.

We built an end-to-end system that allowed people to talk to Ibn Sina in Arabic and have the robot generate an appropriate response. The system consisted of three main components: Speech Recognition, Corpus Searching, and Robot Expression Generation. (See Figure 2)

In addition to the system described in this paper, other cognitive engines are currently being developed and transferred to the robot from other embodiments. These include the FaceBots engine [10], which utilizes online social information for more effective dialogues, and the Grounded-situation-models engine [11], which enables situated language capabilities with reference to objects and events the robot is perceiving or imagining.

2.1 Speech Recognition

The speech recognition component of our system is based on the Acapela speech recognition engine [1]. To facilitate speech with the robot, we modeled a number of different sentences that are common to daily life. Figure 3 shows a subset of the Arabic sentences our system can recognize, as well as the corresponding phoneme realization of the Arabic speech. Phoneme realization was necessary because Acapela is based on phoneme based speech recognition technique. These phoneme realizations were generated by a fluent Arabic speaker using the Lexical Editor tool provided with Acapela system.

The Acapela engine utilizes both an acoustic model as well as a language model. The acoustic model contains statistical representations of the sounds that make up each acoustic unit, while the language model contains the probabilities of sequences of words.

Acapela provides options for two modes of recognition: isolated words and continuous speech. In our speech recognition system, we modeled the system to recognize continuous speech.

At the Language model layer, we developed an artificial grammar that restricts the recognition to a list of sentences that were modeled in grammar. Therefore, the effective speech recognition accuracy for our task was significantly improved, as compared to the accuracy that would have been obtained by having used a generic grammar.

2.2 Ibn Sina Corpus and Search

In order to help facilitate a meaningful dialogue, as well as to give Ibn Sina a bit of personality, we developed a corpus of phrases for Ibn Sina to say. All the phrases in the Ibn Sina Corpus (IBC) were written in the first person, and contained standard greetings (e.g., "Nice to meet you"), interesting anecdotes about Ibn Sina's life (e.g., "I developed the physics equations that Newton used when developing his laws of motion."), as well as a few humorous phrases (e.g., "I'm glad you learned something from me, I suggest you go read my book too.").

All items in the IBC were encoded as UTF-8 text files. Further, we added related keyword synonyms to each file in order to ensure an appropriate response would be generated by the robot when someone spoke to it. For example, if someone asked "What is your name?", we might have a file that contained keyword phrases such as "Name", "Who are you", etc.

In order to find phrases in the IBC, we used Google Desktop to index the directory containing all the text files, and wrote a C++ wrapper to send query terms and retrieve documents from it.

Each phrase in the IBC was also converted into an MP3 file that contained a text-to-speech reading of the phrase. We used the Acapela Arabic text-to-speech engine to do this.

2.3 Robot Expression Generation

Finally, after a user's speech had been recognized and an appropriate response was found in the IBC, we animated Ibn Sina to speak the phrase, move its lips in synchronization, and make appropriate facial expressions. For example, smiling while telling a joke, looking concerned when giving advice, etc. The robot's animations were done manually using Brookshire Software's Visual Show Automation [4].

3 Methodology

3.1 Sampling

We decided to run our study at the Al Ain Mall in Al Ain, United Arab Emirates. We chose this location for our study because it is

Phrase	Phoneme Realization
السلام عليكم ورحمة الله وبركاته	assalamualkumwarahmatuallahiwabarakatuh
ما هو اسمك	mahwaasmak
كيف حالك	kaifahaluk
متى ولدت	matawulidta

Figure 3. A subset of the Arabic phrases our system can recognize and their phonetic transliterations.

very egalitarian; frequented by people from a wide variety of cultures, races, income levels, and job classes.

Ibn Sina robot was set up at the entrance to the food court, a wide open space with many visitors. The robot was there for 12 hours, from 10:30AM to 10:30PM. Anyone who came to see the robot or talk to the experimenters were politely offered questionnaires to complete in the language of their choice (Arabic, English, or Urdu). Several people declined to complete the questionnaire for various reasons, such as a lack of time, concern that it was a test about robotics, etc. However, we believe we still had a good sample that well-represented the diverse population of the Emirates.

3.2 Interacting with Ibn Sina

At the mall, the robot was seated in a chair, and its position was stationary throughout the day. The experimenters asked people passing by if they wished to talk to the robot, and if they agreed they received a headset to wear and some simple instructions in Arabic or English to say hello and greet the robot. Also, people, children especially, were encouraged to shake the robot's hand (See Fig. 4).

In terms of conversation content, the robot was limited to the phrases described in Section 2.2. Many people were fairly shy when interacting with the robot, so the experimenters would prompt them with phrases to say or questions to ask the robot. In the evening, when the mall was extremely crowded and noisy, we provided people talking to the robot a list of phrases and discussion topics to try. (See Fig. 5).



Figure 4. Children being encouraged by the experimenters to shake hands with Ibn Sina.



Figure 5. When the mall became very busy and noisy, people talking to Ibn Sina received a sheet of phrases the robot could recognize.

3.3 Instrument

3.3.1 Construction

Our primary instrument was an 11-item, 4-point attitudinal questionnaire that probed Arabic cultural attitudes toward humanoid robots called the CEDAR Scale. (See Appendix). We developed the questionnaire to capture three main ideas that are of high importance in Arabic society: domestic life, community, and education. The first four questions asked respondents to consider their personal feelings about humanoid robots in their daily lives (e.g., "I wouldn't mind if a human-like robot cleaned my house."). The next four questions asked respondents to consider the emotional feelings of others in their community (e.g., "Many people from my home country would feel comfortable if they saw Ibn Sina robot.") The final three questions probed ideas about using robotics for educational purposes (e.g., "Children would enjoy learning from a robot like Ibn Sina.>").

The scale was intentionally kept short because most Arabic people do not like to take the time to complete written surveys, particularly in public settings. By keeping the survey brief we helped ensure a high rate of completion and participation.

We prepared the CEDAR scale in three languages: Arabic, English, and Urdu, because these are the three most commonly spoken languages in UAE. The translation to Arabic was done iteratively by four bilingual Arabic/English speakers, and the translation to Urdu was done by two bilingual Urdu/English speakers.

All the questions were phrased to be positively biased to ensure that the questionnaire would make sense in the three languages, though two of the community questions contained negative attitudes ("People from my home country would feel [angry, afraid] if they

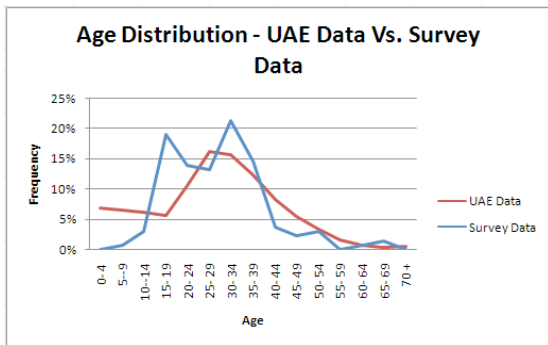


Figure 7. Distribution of ages of UAE nationals and distribution of survey respondents. Source: Cooperation Council for the Arab States of the Gulf.

saw Ibn Sina robot.”). The answers to these items were reversed for the factor analysis described in Section 3.3.2 and for all subsequent results analysis in Section 4.

3.3.2 Reliability and Factor Analysis

Cronbach’s α for the 11-item survey was .675, which gives us confidence in the reliability of using the score as a summed measure.

We also performed Principle Component Analysis (PCA) on the 11-items using an orthogonal rotation. The overall Kaiser-Meyer-Olkin (KMO) was 0.62, and all KMO values for all individual items were greater than 0.5 which is the acceptable limit. Bartlett’s test was $X^2(55) = 285.83, p < .001$, which indicated that inter-item correlation was sufficiently large for PCA. Three components with eigenvalues over Kaiser’s criterion of 1 explained 52.82% of the variance. See Figure 6 for the rotated factor loadings. The first component seems to represent the use of humanoid robots for education, the second the use of humanoid robots in domestic life, and the third community feelings toward humanoid robots⁴.

4 Results

4.1 Measures

Our dependent variable was the summed score on the questionnaire. Based on a Shapiro-Wilk normality test we found the score data to be normally distributed ($W=0.97, p\text{-value} = 0.006$). Thus, we used parametric statistics in our analysis of this data.

Two manipulations were made before the score was calculated. First, the two questions that asked “Many people from my home country would feel (angry / afraid) if they saw Ibn Sina Robot” were reversed to be positively biased. Second, questions that were not completed were assigned a score of 2.5 so as not bias the means. (Only a few questions were incomplete across the entire sample.)

4.2 Demographics

136 people completed our survey, though 5 people were removed from the sample because they clearly did not read the questions (picked all “1”s). The following demographics and subsequent analysis refer to the remaining 131 respondents.

94 respondents were male, 34 were female, and 3 did not identify their gender. 109 respondents completed the survey in Arabic, 19 in English, and 3 in Urdu. 76 respondents had a college degree, 49 did not, 6 did not answer.

Respondents’ ages ranged from 8-68 years old, the mean age of respondents was 29.15 years old ($s.d = 11.02$). This age distribution corresponded quite well with the overall age distribution in UAE. (See Figure 7). Four people did not report their age.

116 respondents were Muslim (89%); the remaining respondents wrote they were Orthodox: 1, Catholic: 3, Christian: 2, Hindu: 2, and 5 did not identify their religion.

Respondents came from a wide range of countries around the Middle East and Southeast Asia: UAE: 43, Egypt: 21, Oman: 12, Syria: 8, India: 5, Jordan: 5, Pakistan: 4, Palestine: 4, Philippines: 4, Iraq: 3, Saudi Arabia: 3, Sudan: 3, Iran: 2, Morocco: 2, Tunisia: 2, Bangladesh: 1, Lebanon: 1, Libya: 1, Qatar: 1, and Yemen: 1. Also, one person was a UK national, one was from Moldova, and three did not answer.

The questionnaire also asked “Did you talk one-on-one with Ibn Sina robot today? Y/N”; 63 respondents replied “Yes”, 56 replied “No”, and 12 did not answer.

4.3 Quantitative Results

Overall scores on the summed questionnaire ranged from 19 - 42, out of a possible 44. The mean score was 32.4, $s.d.= 4.6$.

4.3.1 Regional Analysis

Given the diverse nationalities of our respondents, we decided to group them by geographic region. The regions we selected were: African (Egypt, Morocco, Tunisia, Libiya, and Sudan; $n = 29$), Southeast Asian (Bangladesh, India, Pakistan, and Phillipines; $n = 14$), The Gulf (Iran, Iraq, Oman, Qatar, Saudi Arabia, United Arab Emirates, and Yemen; $n = 65$), and Shaam (Jordan, Lebanon, Palestine, and Syria; $n = 18$). Figure 8 depicts the score distributions by region.

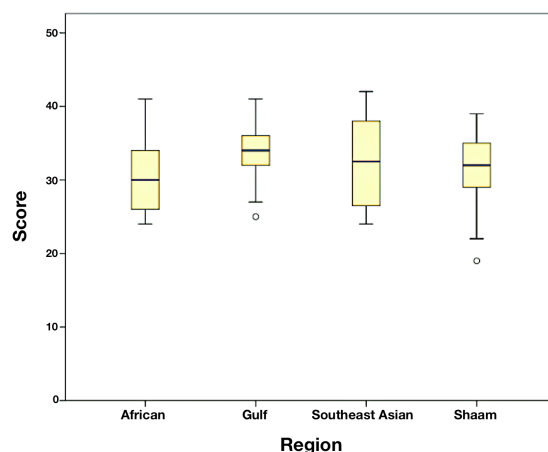


Figure 8. Score distributions on the CEDAR questionnaire by the four regions: African, Gulf, Southeast Asian, and Shaam.

⁴ Factor analysis reporting paraphrased from Field [5])

Item	Rotated Factor Loadings		
	Education	Domestic Life	Community
I wouldn't mind if a human-like robot treated me at the hospital	0.24	0.71	-0.13
I wouldn't mind if a human-like robot cleaned my house	0.04	0.74	0.02
I wouldn't mind if a human-like robot was in my workplace	-0.05	0.68	0.10
I wouldn't mind if my child was instructed by a human-like robot	0.28	0.31	-0.40
Many people from my home country would feel happy if they saw Ibn Sina Robot	0.75	0.22	0.20
Many people from my home country would feel comfortable if they saw Ibn Sina Robot	0.64	0.13	0.42
Many people from my home country would feel angry if they saw Ibn Sina Robot	0.14	-0.04	0.80
Many people from my home country would feel afraid if they saw Ibn Sina Robot	0.04	0.10	0.80
Elderly people would learn a lot from robots like Ibn Sina	0.41	0.51	-0.06
It would be easier to learn about history from a robot like Ibn Sina than from a textbook	0.61	0.05	-0.32
Children would enjoy learning from a robot like Ibn Sina	0.66	0.01	0.02
Eigenvalues	2.10	1.94	1.78
Percentage of Variance	19.05	17.63	16.13

Figure 6. The rotated factor loadings for all 11 items on the questionnaire. Factor loadings above .40 are in bold.

Two of the respondents from Europe (Moldova and UK) were excluded from this analysis because of their small sample size, and the three people who did not identify their region were also excluded.

We performed a one-way ANOVA on the scores from the four regions, and there was a significant effect between them, $F(3, 122) = 3.192, p < .05, \omega^2 = .05$. Based on Kirk [8], this indicates a medium effect size between the four groups. A Hochberg posthoc analysis test revealed a significant difference in scores between people from the Gulf and African regions ($2.87, p < .05$), however, the differences in scores between the other regions was not significant.

4.3.2 Age

After distributing our data into age groups as suggested by the brackets in Figure 7, a one-way ANOVA did not find a significant effect of age on score. The four people who did not identify their age were excluded from this analysis.

4.3.3 Gender

We did not find a significant effect between male and female respondents' scores. Three respondents who did not identify their gender were excluded from this analysis.

4.3.4 College Education

Next, we analyzed if having a college education influenced respondents' scores. We found that having a college degree resulted in a significantly lower score ($M = 31.7, s.d. = 6.0$) than not having one ($M = 33.8, SE = 6.1$), $t(117) = 2.73, p < .05, r = .06$. However, because our effect size was small this does not represent a substantive finding. The six respondents who did not specify their educational status were excluded from this analysis.

4.3.5 Conversation with Ibn Sina

Speaking to Ibn Sina before completing the questionnaire did not have a significant effect on respondents' scores. The 12 respondents who did not specify if they spoke to Ibn Sina were excluded from this analysis.

4.4 Qualitative Results

In addition to the quantitative data, we also received some qualitative data from the "Comments" section of the questionnaire as well as from verbal comments made by respondents. (English translations of Arabic comments are italicized.)

Some respondents said that they liked the idea of Ibn Sina robot and wanted to help improve it to be even more human-like:

« زيادة كمية المعلومات في الرجل الآلي، و تنمية قدرته على التعامل مع البشر »

"Add more variety to the types of things Ibn Sina can talk about and improve its ability to interact with humans."

On the other hand, a few people opined that they would rather prefer interacting with real humans than with robots. One person wrote:

« أعتقد أن الإنسان البشري أفضل بكثير من الإنسان الآلي وذلك إذا كان الإنسان متعلماً ناضجاً لأن الأحساس والمشاعر أفضل بكثير من أي شيء مع التعليم أيضاً والخبرة »

"I believe humans are better than robots. Humans are educated, mature, have feelings and emotions, and have experiences. Robots don't have this."

Other positive views were that some people expect that robots in the next generation will be more acceptable and popular in Emirates society. Many young people, especially young children and teenagers, love the idea of robots, and are willing to learn more about them and deal with them more often in their daily lives. For example, one person wrote:

« فكرة جيدة وجديدة وربما تلقى قبولا أكثر في الأجيال القادمة »

"This is a good and new idea. Perhaps it will be acceptable among future generations."

A few people expressed views on the human-like form of the robot. Most of them were positive, but a few were negative. One negative comment was:

« الآلات هي وسيلة مساعدة ولا يجب أن تكون مستخدمة في حياتنا اليومية عوضاً عن خدمات الإنسان لأنه لا يوجد أعظم وأحسن صورة من خلق الله عز وجل »

"The main job of machines is to help humans, not replace them. No matter how human-like you make a robot, it will never be as good as one of God's creations." However, a number of people expressed positive comments with regards to robot appearance, such as:

« الهيكل فهو ممتاز »
"The body of the robot is excellent", and "It's nice. It's like a real human."

5 Discussion

Our pilot study found that Arabic attitudes toward humanoid robots are fairly positive overall. Respondents from the Gulf region (Iran, Iraq, Oman, Qatar, Saudi Arabia, United Arab Emirates, and Yemen)

had significantly more favorable views toward humanoid robots than respondents from African regions (Egypt, Morocco, Tunisia, Libiya, and Sudan) with a medium effect size. We also found that having a college degree was significantly associated with less favorable views toward humanoid robots, though with a small effect size.

In terms of sampling, we believe our study was representative of the Emirates population in terms of age, ethnic, religious, and cultural background. However, a main limitation of this study is that our sample was probably biased toward people who felt more positive and interested in robots in general, simply because people who were uninterested or felt strongly negative were less likely to stop by to see the robot and complete the questionnaire. On the other hand, the diverse range of regional backgrounds of respondents helped to provide good external validity. In the future we hope to replicate this study in other equally diverse regions and compare our results.

The questionnaire did not directly probe respondents' religious attitudes for two reasons. First, this kind of query is extremely difficult to do properly, and at this stage we merely wished to perform an exploratory study. Secondly, like other Asian cultures, Arabic culture is high-context, meaning people are less verbally direct, and communicate concepts in more subtle ways, using non-verbal behavior, indirect speech, and paralinguistic communication [6, 21]. Thus, asking people directly about their religious views on robots seemed unsuitable at this time. However, this is a topic we wish to delve deeper into in future work.

The qualitative data were interesting in that some of the respondents' views echoed the types of views expressed by subjects in other studies and other countries. For example, people preferred robots not to take the place of humans, but rather to serve as a means of helping improve their lives. This echoes findings by Takayama et al. [18] and Weiss et al. [20], and warrants further investigation.

We have recently collected a second sample of several hundred questionnaires from people who interacted with Ibn Sina at a trade show in Dubai and will analyze this data in the coming months. Using this data, we plan to refine the CEDAR questionnaire by further testing its validity, consistency, and test-retest reliability. We also plan to perform more in-depth data analysis, such as exploring the instrument's subscales across different participant groups.

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6 Appendix

	Strongly Disagree	Slightly Disagree	Slightly Agree	Strongly Agree
I wouldn't mind if a human-like robot treated me at the hospital	1	2	3	4
I wouldn't mind if a human-like robot cleaned my house	1	2	3	4
I wouldn't mind if a human-like robot was in my workplace	1	2	3	4
I wouldn't mind if my child was instructed by a human-like robot	1	2	3	4
Many people from my home country would feel happy if they saw Ibn Sina robot.	1	2	3	4
Many people from my home country would feel comfortable if they saw Ibn Sina robot.	1	2	3	4
Many people from my home country would feel angry if they saw Ibn Sina robot.	1	2	3	4
Many people from my home country would feel afraid if they saw Ibn Sina robot.	1	2	3	4
Elderly people would learn a lot from robots like Ibn Sina.	1	2	3	4
It would be easier to learn about history from a robot like Ibn Sina than from a textbook.	1	2	3	4
Children would enjoy learning from a robot like Ibn Sina.	1	2	3	4

موافق بشدة	موافق	غير موافق	شعب موافق بشدة	
4	3	2	1	أنا لا أمانع ان يقوم إنسان آلي بالإحتناء بي في المستشفى
4	3	2	1	أنا لا أمانع ان يقوم إنسان آلي بتنظيف منزلي
4	3	2	1	أنا لا أمانع إذا تواجد إنسان آلي في مكان عملي
4	3	2	1	أنا لا أمانع إذا تلقى ابني تعليمه من إنسان آلي
4	3	2	1	معظم الناس في بلدي سوف يتعرفون بالسعادة إذا راوا رجل آلي " كايين سينا "
4	3	2	1	كثير من الناس في بلدي سوف يتعرفون بالراحة إذا راوا رجل آلي " كايين سينا "
4	3	2	1	كثير من الناس في بلدي سوف يتعرفون بالغضب إذا راوا رجل آلي " كايين سينا "
4	3	2	1	كثير من الناس في بلدي سوف يتعرفون بالخوف إذا راوا رجل آلي " كايين سينا "
4	3	2	1	كبار السن قد يتعلمون الكثير من رجل آلي " ابن سينا "
4	3	2	1	سيكون تعلم التاريخ من خلال الرجل آلي " ابن سينا " أسهل من تعلمه عن طريق الكتب
4	3	2	1	سيستمتع الأطفال من التعلم من رجل آلي مثل ابن سينا

Figure 9. The English and Arabic versions of the Culture, Education, and Domestic Attitudes Toward Robots Scale (CEDAR).