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Original Research

Using a Question Answering System to Enhance Knowledge and Improve the Exchange of Information among Physicians

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Abstract

Due to limited time, physicians often find it challenging to find the exact answers to their questions among search engine results; however, question and answer (Q&A) systems can facilitate more rapidly identify accurate solutions. This study aims to develop and evaluate a Q&A system for physicians at Tabriz University of Medical Sciences. Four clinical and informatics experts and the two health information managers agreed on 19 features and themes throughout two focus group meetings. Subsequently, a system was developed on a MySQL database using the PHP web development language and then uploaded to the web. Finally, the system was opened up to 40 users and, over three months, evaluated using a community evaluation questionnaire and the six-dimension Users' Experience Questionnaire. The focus group results in determining the features of the Q&A system consisted of 19 requirements. The average attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty were equal to 1.76, 1.625, 1.9, 1.425, 1.475, and 1.375, respectively. The Q&A system improved the tasks such as share of knowledge, transfer of information, social partnership, and cooperation among users. The physicians were able to obtain the information they required through contact with their co-practitioners over the system.

Keywords: Question Answering System, Medical Education, Knowledge Exchange, Information Exchange, information Technology, Questionnaires, UEQ, Physicians.

Introduction

Unlike automated search engines, question and answer (Q&A) systems were developed to use human knowledge to respond to users' information needs (Agichtein, Castillo, Donato, Gionis & Mishne, 2008; Lee et al., 2006; Pera & Ng, 2011). Due to the ease with which they

are used and their ability to assist during medical knowledge transfer, these systems have been found to produce accurate responses while expediting physicians' daily routines (Li, Li, King, Lyu & Yu, 2015). On these systems, user information is exchanged and semantically shared to answer users' questions (Carroll, 2015); this joint partnership allows for a kind of "collective wisdom" (Surowiecki & Silverman, 2007). Users ask each other questions, and one-to-one interactions are created, which results in a cooperative exchange of knowledge (Kim & Oh, 2009). With the recent development and increased popularity of the internet and information technology, the searching ability has become a superior skill to find expected results. (Zengin & Kaçar, 2015). Physicians use the Internet to search for health information because of its accessibility. People use the Internet to search for health information because it is easy to use and accessible anywhere. We can find powerful search engines like Google in the Internet world, which helps researchers find information and mining the web by applying advanced search methods. Google's search engine can be used as a source of evidence, which is free of charge scientific tool (Zengin & Kaçar, 2015; Zengin, 2009). Gaining information from the Internet can influence the way people decide on various matters (Maijala, Anttila, Koivunen, Pitkänen, Kuosmanen & Välimäki, 2015; Vinker, Weinfass, Kasinetz, Kitai & Kaiserman, 2007). Medicine continues to evolve as research advances, and physicians require up-to-date clinical evidence to prescribe the most appropriate treatments (Dunning, Prendergast & Mackway-Jones, 2003). Although accessible to physicians on the Internet, locating and interpreting this clinical evidence is generally time-consuming due to the extensive amounts of information available online and the high volume of physicians' ever-expanding records (Liu, Bian & Agichtein, 2008; Richardson, Wilson, Nishikawa & Hayward, 1995). Often, physicians do not even know where to begin looking for the information they need. Conversely, those who know where to find it often prefer to ask other competent persons to refer to databases with the knowledge they desire (Leonardi, 2017).

Rather than vague research summaries, (Dunning et al., 2003) found that physicians require specific accounts of supporting evidence to answer their questions sufficiently. Furthermore, Kahn et al. found that the use of information and communication technology and smartphone applications strengthens relationships between researchers, physicians, other healthcare providers, and patients by using caring methods and strategy explained unique methods which are needed for the rest of caring (Kahn, Yang & Kahn, 2010; Mirnia, Soltani, Rezaei, Heidarzadeh & Piri, 2014). Individual users may experience the same systems differently, thereby forming a range of conclusions about their usefulness; understanding the experiences and opinions of a diverse range of users is vital and imperative for developing value systems. (Cota, Thomaschewski, Schrepp & Gonçalves, 2014). Positive user experiences increase each system's chances of being used among competitors in the software market (Schrepp, Hinderks & Thomaschewski, 2014). The purpose of this study was to design, implement, and evaluate a Q&A system for physicians to exchange knowledge while providing accessible information as needed. To accomplish this, an Overall Forum Evaluation was designed to identify the effectiveness and extent of the system's use to evaluate the forum's content for the system's level of knowledge and content quality.

Methodology

The study is applied and descriptive. In the development phase, the Q&A system was designed on a web architecture foundation. Two focus group discussions were convened to

identify features for inclusion in our system's design. These focus groups were designed to include between six and ten experts as recommended in the literature (Barbour, 2018). After dismissing the members who had missed meetings, the focus group meetings, each contained six members. Two health information managers and four clinical and informatics experts discussed and approved the system's features in these meetings, including categories, menus, and pages.

The system was developed with the approved features on a MySQL database platform and programmed using the PHP web design language in the next phase. Three months later, the system was uploaded and introduced to residents and professors. The inclusion criteria were users who had registered in the system and tracked the posts in three months. The sample consisted of nineteen students (both GP and specialized medical students) who had expressed interest in the system and four of their professors.

The User's Evaluation Questionnaire (UEQ) provides a brief assessment of the subject's experience with a system. Its template allows the user to easily express their feelings about a system while communicating its benefits and shortcomings. The UEQ consists of 26 items, which are divided into six dimensions: attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty (Diana & Saputra, 2015; Dunning et al., 2003; Heshmati, Moftian, Rezaei-Hachesu & Samad-Soltani, 2021; Santoso, Fadhilah, Nurrohmah & Goodridge, 2016).

Following this, for assessing the significance and impact of this website on end-users, they completed the UEQ. The UEQ results for our system were compared to benchmark results from 246 other studies that had evaluated similar systems. According to previous studies, UEQ has high reliability and validity to measure user experiences. This questionnaire shows sufficient consistency in their scales in other works of literature (Laugwitz, Held & Schrepp, 2008; Santosa, 2016).

Finally, to assess the level of knowledge promotion and quality of Q&A content, the overall forum evaluation form was used (Palombi, L., Olivarez, M., Bennett, L. & Hawthorne, 2019). This form was used to evaluate the knowledge extension between users and content quality on the online Q&A system (Laugwitz et al. 2008). Another indicator that was measured by overall forum evaluation is the improvement of crucial research activities between users (Sun, Lin, Wu, Zhou & Luo, 2018).

Overall, the forum evaluation questionnaire included six structured and unstructured questions presented in either a multiple-choice or descriptive format. Thirty users filled out questions online from Overall Forum Evaluation and the explanation part of the questionnaire remained blank.

The results of the two evaluations were reported as graphs and statistical tables. In total, 40 participants voluntarily completed both the Overall Forum Evaluation and the UEQ online.

Findings

The results of the focus group meetings and the agreed-upon features in these meetings are shown in Table 1 (including the 19 axes suggested during the expert meetings). The suggested and agreed-upon items included demographic information on participants' medical expertise, age, sex, academic degree attained, occupation, and experience background of six experts present at the meeting in Table 2.

Table 1
The focus group results in determining the features of the Q-A System

	Theme	Suggested	Agreed-upon
1	Easy access by smartphones application	6	6
2	Links of Papers & References	6	5
3	Sending Videos & Photos	6	5
4	Classification of Questions	6	5
5	Use of I'm-Agree Button	6	4
6	Use of Keywords	6	6
7	Getting Brief Answer Under Question	6	6
8	Free access to the system	6	5
9	Possibility of Q-A Slight Edit	6	6
10	Search Option	6	6
11	Feedbacks on a Question in Statistics	6	3
12	Feedbacks on an Answer in Statistics	6	4
13	User Percentage of Each Group in Statistics	6	3
14	Sending Questions & Answers Only by Physicians	6	4
15	Time Limit for Information Modifications	6	3
16	Choosing the Best Answer	6	6
17	Informants	6	4
18	Questions Classification considering Various Educational Groups	۶	۵
19	List of User's Former Questions on the Profile	6	5

Table 2
Experts' Identification Information in decision Delphi techniques

Expert	Age	Sex	Academic Degree	Occupation	Work Experience
Health Information Management	52	Male	PhD	Faculty	15 < years
Health Information Management	40	Male	PhD	Faculty	7 < years
Medical Informatics	35	Male	PhD	Faculty	7 < years
specialist	46	Female	PhD	Faculty	10 < years
specialist	-	Male	PhD	Faculty	30 < years
GP	65	Male	Professional Doctorate	Faculty	25 < years

The designed system was uploaded to the domain medprsyar.ir and made available to students and professors. An image of the main page (including menus and sliders) is displayed in Figure 1. From the homepage, access was provided to user registration, questions–answers collection, ask questions module, the latest posts, and the search menu. Access was also given to the most recent searches and submitted questions. Additionally, a menu was included beside

the help for entrance to the management profile. The help button contained information designed to help users to navigate the system. The system's internal page is shown in Figure II. This was a question-answer page, which included responses to users' questions. The most recently answered question was posted at the top of the page. For each question, the time of submission and the number of users who had voted in its favor were visible on this page alongside its answer. A quick-access system search tool and a keyword-based search were also included on this page.

Figure 1. Main Page

Figure 2. Question answering page

Over three months (April 9–July 11, 2017), 15 questions and 34 answers were registered on the system. Of these, 13 questions were registered in the clinical sciences category: one under the physical medicine and rehabilitation subcategory, four under cardiovascular diseases, two under neuroscience, one under radiology and radiotherapy, two under pediatric medicine,

two under internal organ medicine, and one under psychiatry. Two questions were registered in pharmacy: one each under the pharmacology and clinical pharmacy subcategories. At the end of the study period, the 23 system users were evaluated; the results are presented in Table 3. The mean UEQ results were measured relative to the six dimensions outlined above, namely attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty. Negative numbers represent negative user feedback, while positive numbers represent positive feedback. Values between −0.8 and +0.8 were considered as nervous assessments. A comparison between the mean results and the UEQ benchmark values is shown in Figure 3.

Table 3
Average Six Scale of UEQ

Scale UEQ	Average (+3 to -3)
Attractiveness	1.76
Perspicuity	1.625
Efficiency	1.9
Dependability	1.425
Stimulation	1.475
Novelty	1.375

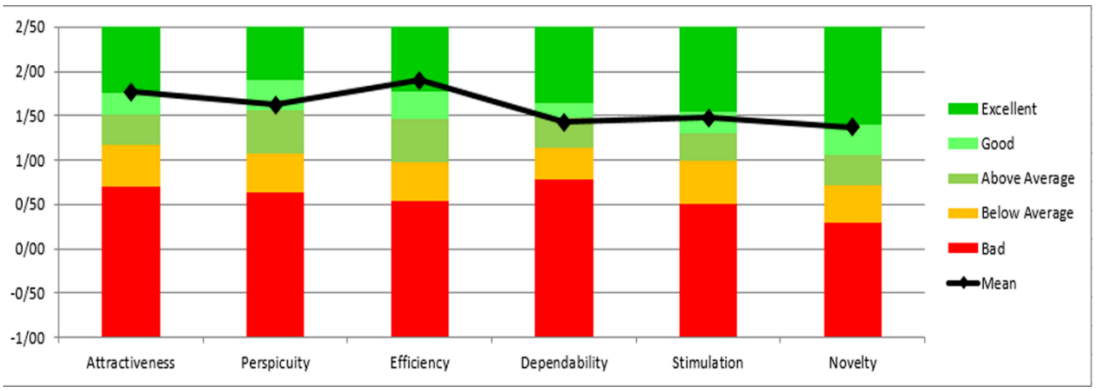

Figure 3. Benchmark Comparison Result

The UEQ scale results are presented in Figure 4. The scale ranges between −3 and +3. The lowest value, −3, indicates the most negative response, while the highest value, +3, represents the most positive response. Additionally, the 0 value represents a neutral response. When analyzing the data, we considered scales above +1 to indicate a positive impact on the user and scales below −1 to represent a negative experience. Given the well-documented tendency of respondents to avoid extreme values (Cota et al., 2014), it was not surprising that the observed scales generally fell in the range of −2 to +2. Values outside of this range occurred rarely; therefore, values close to +2 were considered favorable and positive responses.

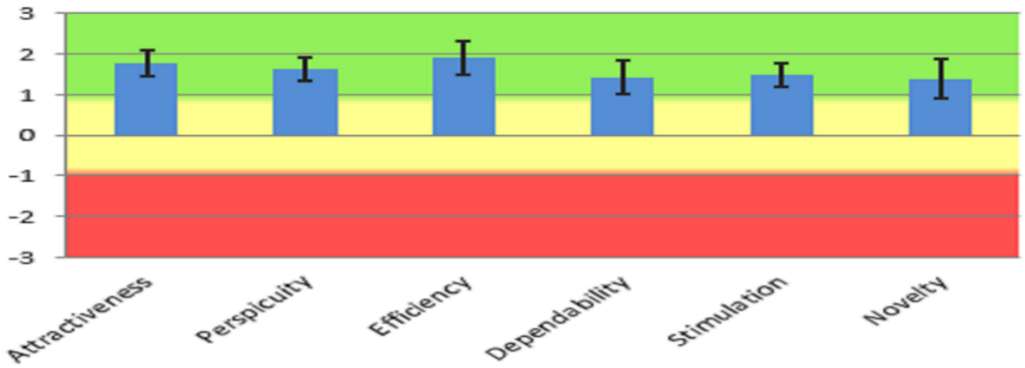

Figure 4. UEQ Scale Result

The results of the Overall Forum Evaluation are also presented below. The questionnaire's eight assessment axes are shown in Table 4. Results are presented along with the questionnaire's content in Table 5, which includes the overall mean percentage for each unit. The degree to which respondents agreed to questions 1–8 has been reported as percentages in Figure 5, which is presented according to the axes of the forum evaluation questionnaire. The results displayed in Table 5 and Figure 5 show that respondents agreed most with the first and third axes, namely "informative and useful" and "addressed important issues", respectfully.

In contrast, they agreed least with the fifth and sixth axes, namely, changes in professional development of work and respectfully tracking the ideas among colleagues. "Follow up on idea" and "changing my work and professional development" received the most disagreement by respondents. However, in an extensive picture overview, the system achieved a positive attitude by users.

Table 4
Axis of Evaluation

Axis	
1	The forum was informative and useful.
2	The forum met my expectations.
3	The forum addressed important issues in my work or studies.
4	The forum provided me with opportunities to network with other professionals.
5	Based on this forum, I will make changes in my work, professional development, and/or studies.
6	I plan to contact people I met today after the forum to follow up on our discussed ideas.
7	I plan to collaborate in some way with people I met today.
8	I hope that SF state hosts a similarly themed forum next year.

Table 5
Result Axis of Evaluation

	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Average of total percentage
Strongly Agree	0.4	0.4	0.133	0.433	0.133	0.3	0.266	0.2	0.283
Agree	0.6	0.3	0.666	0.4	0.4	0.23	0.533	0.366	0.437
neither disagree nor agree	0	0.3	0.2	0.1	0.33	0.33	0.03	0.4	0.212
Disagree	0	0	0	0.066	0.133	0.133	0.033	0.033	0.05
Strongly Disagree	0	0	0	0	0	0	0	0	0

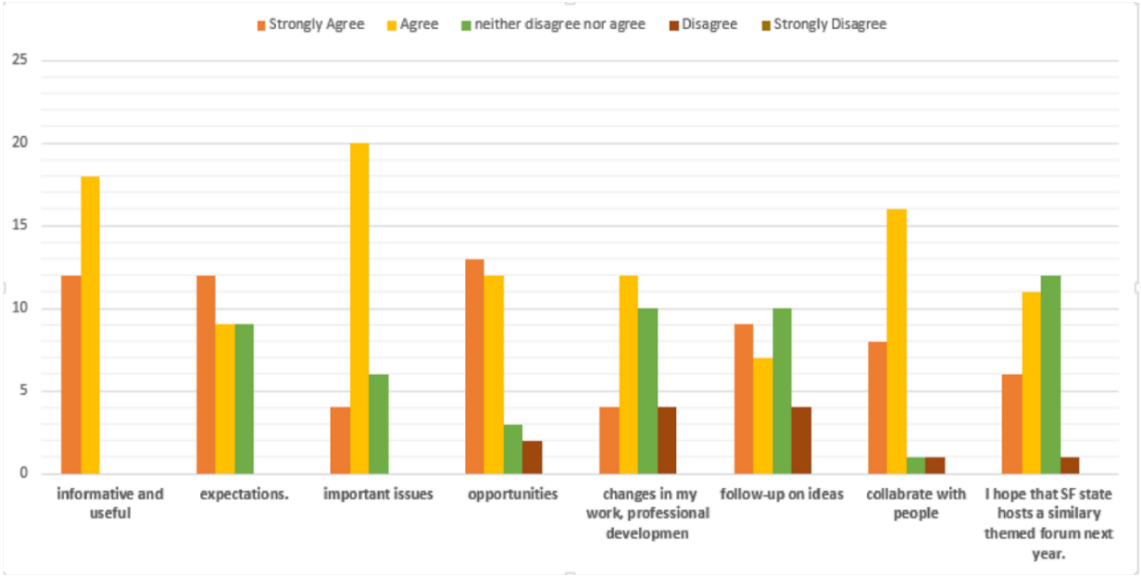

Figure 5. Bar Diagram of the Extent of Agreement on Questions 1-8 (n=30)

Discussion

In this study, a Q&A system was designed to provide physicians with a source of knowledge in their specialty fields. We found that using this system streamlined physicians' ability to find the appropriate answers to their questions. Similarly, (Ely, Osheroff, Chambliss, Ebell & Rosenbaum, 2005) stated that their Q&A system played an essential role in increasing the speed of information sharing in a scientific society, thereby allowing for timely and relevant answers to users' questions regardless of time and location limitations. Rauschenberger, Schrepp, Cota Olschner, & Thomaschewski (2013) noted that online information sharing was possible on a Q&A system within the shortest time. Therefore, we designed and implemented our Q&A system to help physicians save time while performing clinical tasks and improve medical services through an exchange of knowledge unaffected by practitioners' geographical constraints.

The results of the focus group that determined our Q&A system's features indicated that

the most highly valued features were the search option, the use of keywords, access via a smartphone application, and the inclusion of summarized answers below each question, the ability to edit questions and answers slightly, and the opportunity to provide feedback regarding the best answer. The finding corresponds to Carroll (2015), who outlined a smartphone applications' positive effect on improving access to information and document users' preference for keywords when searching for solutions. Specifically, Carroll found that access to a Q&A system over a smartphone application provided users with a way to locate answers instantaneously from anywhere worldwide. Additionally, to locate the best answer to a clinical question, previous studies (Dunning et al., 2003; Kim & Oh, 2009) have found users to require help from peers to sort through the extensive amount of material available on a system.

To successfully maintain a system over the long term, the user experience (broadly defined as the relationship between a machine and its user) must satisfy all user groups associated with the product (Rauschenberger et al., 2013). Different users and user groups often form divergent opinions of a system due to their varying needs and abilities (Cota et al., 2014). Through user experience evaluation, it is possible to generate a large amount of user feedback with minimal effort.

The UEQ, which is designed to be quickly completed online, allows users to immediately express their feelings, impressions, and attitudes about a system (Cota et al., 2014; Laugwitz et al., 2008; Rauschenberger et al., 2013). Compared to benchmark results taken from similar studies, our system was evaluated positively by users concerning the attractiveness and efficiency dimensions of the UEQ; however, the stimulation, novelty, and perspicuity dimensions required improvement. Furthermore, the dependability score for our system was only 25% of similar systems' best results. This low dependability may be rooted in the fact that the item does not play a significant role in learning when it comes to users' experience or is the result of a misinterpretation of this item (Santoso, Schrepp, Isal, Utomo & Priyogi, 2016). To enhance the dependability of our system, we could reinforce its security, consistency, and navigation. The tools employed to do so must be stimulating and innovative to drive users to interact and self-observe. Furthermore, users' motivation to use our system could be enhanced by further enhancing and developing its user interface based on achieved results. The system's perspicuity could be improved by increasing its usability factors and organization (Santosa, 2016; Santoso, Fadhilah, Isal, Utomo & Priyogi, 2016).

Knowledge sharing among our system's users was associated with the higher applied impact on user collaboration and information management. Using the forum evaluation questionnaire, we demonstrated that knowledge sharing and the strength of the virtual community contributed to the success of the system application and reinforced knowledge management tasks. Based on sharing information to improve knowledge management in organizations, our approach was an effective instrument for transferring information between users. Information was shared directly from one user to another and transferred electronically across the entire virtual community. As in (Lai & Chen, 2014), this study focused on a virtual professional community (PVC) in which relevant knowledge and best practices were exchanged for specific learning goals. In our system, medical knowledge was divided among specific subgroups of medical specialties such as pediatrics, radiology, neurology, into which all shared information was classified.

While sharing information through our Q&A system, several physicians commented on its usefulness; specifically, they pointed to how it helped navigate essential issues relevant to their

work and, ultimately, fostered effective collaboration with other users. This is consistent with several previous studies (Koh & Kim, 2004; Kwahk & Park, 2016; Lin, Hung & Chen, 2009), which also showed that sharing knowledge in a virtual community setting promotes social partnership: Those actively engaged in a virtual community can obtain the information they require by interacting with colleagues in their field. Users of our system expressed positive opinions about the information exchange and tracking of other user's activities, such as questions and answers that had been active in this system. They further stated that their activity on the system had played an influential role in improving their professional skills through their ability to exchange information, including ideas and opinions, with colleagues. This may be related to (Lai & Chen, 2014) observation that a special relationship exists between pleasure and the intention to share knowledge. Koh & Kim (2004) found that the exchange of information and cooperation between users indicate that the managers of a virtual community can apply simple activities, such as transmitting knowledge or observing activities, as an appropriate substitute for evaluating the real motivation of Q&A systems. The way information is shared in the virtual world has dramatically changed our lives. Today, users can directly share knowledge by publishing information electronically, and those active in virtual communities can use these systems to answer questions. In this vein, our system uses user engagement to provide solutions, support the spread of knowledge, and promote best practices across the medical community.

Within communities, the Q&A system has improved the quality and quantity of information sharing and activity among users. The amount of knowledge sharing and even the observation of knowledge has considerably bolstered society's positive appreciation of social partnership and social promotion. In this study, many physicians reported a positive experience when using our system to access the information they required. However, the system's novelty, the limited amount of information, participants' habit of using traditional methods caused the physicians to use our designed system less frequently.

Conclusion

One of the most impressive findings of this study was the ease with which physicians could consult with their colleagues worldwide; indeed, several users even reported their intention to visit and collaborate with other physicians that they had met on the system.

Finally, this research was faced with limitations such as the lack of cooperation of all physicians, the pervasive introduction of the website, and the low presence of physician professors and residents in online activities. Other limitations included website security assurance, network failure, and limited intranet to external users. We recommend the upgrading of health forums with evidence-based supporting tools. According to take the pervasive accessibility of such Q&A systems to health staff, it will be possible to promote medical students' knowledge, attitude, and practice skills.

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