Research Article

Evaluation of the Rate of Data Transfer, Learning, and Ease of Access to Data via Data Visualization in Virtual Medical Courses from the Viewpoint of Teachers and Students in Shahid Beheshti University of Medical Sciences

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Abstract

Background: Data visualization refers to the methods of data presentation in visual formats using specific technologies, which can present data through a visual process with better understanding and recognition. The current study aimed at evaluating the rate of data transfer, learning, and ease of access to data through data visualization in virtual learning systems.

Methods: The current survey was conducted on 131 students and teachers of virtual medical courses at Shahid Beheshti University of Medical Sciences as the statistical population in the academic year 2015 - 2016. Of the study population, 79 subjects were selected using the simple random sampling method. Data collection tool was a 28-item researcher-made questionnaire, which its reliability was confirmed by the Cronbach's alpha 0.82.

Results: Based on the results of the current study, data visualization could significantly affect virtual learning in the students. In addition, data visualization improved productivity indices as well as rate of data transfer, learning, and ease of access to data among students and teachers.

Conclusions: Based on the results of the current study, it is recommended that data visualization be used in educational programs at all grades and courses in order to benefit from its advantages in improving productivity, rate of data transfer, learning, and ease of access to data among students and teachers of universities and institutes.

Keywords: Data Visualization, Learning Rate, Data Accessibility, Data Transfer Rate

1. Background

Application of pictograms and images to transfer concepts and thoughts has a very long history, which in addition to facilitating the communication, significantly helps to record and maintain human thoughts as pictographic and idiographic symbols. The ability of humans to receive information from the environment using the visual sense is not limited to signs and symptoms. By emphasizing the present-day human being in providing information, it is based on the study and recognition of these symbols and their ability to understand them.

The main objective of today's education is not to have access to more data. In fact, one of the main challenges of students is to mean the concepts they encounter, and absorb all the data purposefully. Hence, communication needs new approaches (1).

Visualization, in fact, is a new approach, which facilitates data-based decision-making more rapidly and accurately with less need for knowledge and education (in order to understand the data) and results in better data presentation, and consequently, effective data utilization. Based on this method, by the application of visual processes in data presentation, the users can have better understanding of the provided information, and may optimally recover their personal data. Data visualization skills are more important in recent years, and therefore, open a new chapter in visualization of data and computer-based data display (2). Data visualization systems benefit from human visual perception capabilities by the compression of a huge amount of textual data through controllable visualization. In this method, owing to high capacity of image-based data transfer, understanding and learning

abilities of the user are improved through the visualization of data. In addition, a huge amount of data is compressively changed into image formats with lower sizes and higher efficacy (3). Providing better conditions for the user to analyze data and thoughts are among the main objectives of using technologies and methods of visualization. Data visualization should not be mistaken with the presentation of simple images and pictures. By The visualization process transfers, data transferred to the user more effectively, which improves his/her understanding about the concepts (4).

The visualization can be applied in educational processes among which virtual education is a clear example. Since the basis of virtual education is the technological approaches, virtualization can be highly applicable. Virtualization, owing to its lexical meaning, is a type of illustration or picturing the data in order to be understandable and presumable for the audiences; although its concept is beyond the pictures. Many problems and challenges dealing with human in today's world can simply be administrated using virtualization; even in some cases, the virtualization is the only available solution (5).

Shahbeigi and Nazari in a study indicated that the purpose of education to recover knowledge is recently changed based on the particular conditions of each individual. Virtual education, as a relatively emerging method, seriously looks for this purpose. Although this type of education provides unique occasions for individuals via modern media such as internet, obstacles and problems are inevitable (6).

Kheyrandish indicated that the educational tools and methods are evolving in such a way that everyone can start learning in any specified time and place (7).

Doroudi and Soleimani Nejad indicated the significant role of visual communication in learning conceptual data, and stated that many conceptual data are transmissible through positive and effective interactions between the individuals. This useful method is now specifically available in digital environments using particular methods and technologies in order to help the users. In this method, basic skills such as data visualization, computer graphics, understanding the basics of arts, and particularly intellectual creativity are required to transfer data appropriately using data visualization processes. In fact, using this method, data visualization can be performed more rapidly and reliably; therefore, virtual environment is a suitable arena for the emergence of visualization applications (8).

Keim attended a web-based distant education course and developed a questionnaire. He concluded that four factors of feedback and important related services could be explained through Korean culture. By understanding the Korean conservative cultural effect, teachers can seek a specific required layout based on feedbacks and service-related factors, and even can look for the texts regarding web-based distance learning systems; however, the strategy is successful (9).

Results of a study by Liao et al., showed that the virtual laboratories to teach scientific materials at school could promote the students following the employment of attractive learning environments by illustrating figures and images in 2D format. On the other hand, results of their study indicated that improving virtual laboratories from two points: (1) Virtual laboratory integration; (2) the introduction of 3D measurement tools for virtual laboratories can greatly increase the reality and attractiveness of the test. In addition to helping empirical assignments, the virtual lab helps students understand better the scientific processes and useful rules. It also teaches students how to turn knowledge into action (10).

Spencen believes that the virtualization is a new approach through which the process of decision-making performs more rapidly and accurately with less cognitive efforts (11).

Sadeghi stated that with the introduction of virtual reality, the importance of data visualization is highlighted. The main application of virtual reality is in medical practices as well as active education of anatomy and physiology for medical students. Using this system, the students can have effective and desirable learning in a stimulated 3D environment. By the application of virtual reality in surgery training systems, to enhance the skill level of medical student, a certain case can be practiced virtually for thousands of times. Using this system and stimulating surgery environments, thousands of surgical cases can be repeated consecutively in a long time. The basis of this technology is realized by data visualization (12).

Nikravesh and Jalali in an experimental study using virtual lessons, and the atlases prepared in this way were asked to use a 60-person class in anatomy of the head and neck to create virtualized lessons. While the same class was not given to such a license, the impact of virtual education as a kind of complementary and non-attendance in the target group at the end of the course and with the design of the same exam questions based on a single referenced evaluation. By comparing the scores of the two distinct groups that the virtual training group had significantly higher grades than the second group (13).

Naderifar et al. showed that electronic learning (e-learning), alongside its wide range of applications and benefits, has some challenges such as less employment by the teachers due to lack of knowledge about its efficacy, diminution of teacher's role, lack of expertise in using it, fear of using it, certain cultural beliefs, and inadequate references. Successful e-learning in medical education requires infrastructures and standards (14).

In a study by Hakimzadeh and Afandideh, the quality of

e-learning course was at a relatively favorable level according to MSc students and teachers of medical education department ([15]).

In recent years, e-learning technology and educational technology resources in the form of audiovisual materials assisted the traditional education in data transfer rate, learning, and ease of access. The contribution of these educational technologies to medical education disciplines was more than other disciplines. Introduction of information technology was associated with the evolution both in hardware (equipment) and software (programs and resources) structures, to such an extent that they were continuously applied in most of the applied fields.

Following the evolution in e-learning, virtual education was quickly overwhelmed at a wider level without spatial and temporal constraints. In virtual education technologies, in addition to hardware and software structures, the communication infrastructure plays a more significant role. By the application of this technology in education, in addition to hardware, software, and communication infrastructures, the educational resources were the next most important aspect. This important aspect, by the help of data visualization, was introduced as an important indicator of virtual education and provided a new approach of virtual education to academic environments, particularly medical fields and related disciplines. Since medical resources are mainly graphic-based, the need for picturizing resources such as designing logos, frames, tapes, menus, and other items seem necessary. To implement virtual education in medical resources, if data visualization is performed at higher levels and qualities, the data visualization methods and technologies can help the educational system to improve communication with the learners and let them have better understanding of provided data and information using such facilities.

Visualization, with the help of presentation methods and useful information for the audience, provides the right environment for interaction and exchange of information. Because the value of information depends on its beneficial use, using appropriate methods in data visualization, maintaining the value of information is a good ground for beneficial education and better learning in students. The above issues emphasize the need for the current study.

The Virtual Medical School of Shahid Behshti University of Medical Sciences already admits students at Master's degree owing to a hypothesis that formatting and picturizing software items and medical resources data can provide suitable conditions for better learning and understanding in virtual education. The current study aimed at evaluating the effect of data visualization on virtual education of medical sciences in order to determine to what extent the visualization of data can increase productivity, rate of data

transfer, learning, and ease of access to data among students and teachers of Virtual Medical School of the affiliated university.

2. Methods

The current study used descriptive-analytical method and was naturally a survey based on the employed data collection method. However, the educational resources of the medical courses in the past were provided with the visualization structure and can be very influential in the process of virtual training in terms of type, content and structure. In this study, we seek to evaluate the impact on increasing the speed of data transfer, increasing the speed of learning, ease of access to information, increasing the level of efficiency in the quality of knowledge and evaluation of information.

The statistical population of the current study included all students and teachers of Virtual Medical School (n = 131), Shahid Beheshti University of Medical Sciences in academic year 2015 - 2016. Of the total population, 79 subjects were selected by the simple random sampling method. Data collection tool was a 28-item researcher-made questionnaire including nine items in productivity improvement (items 1 - 9), six items in data transfer rate (items 10 - 15), seven items in learning rate (items 16 - 22), and six items in the ease of access (items 23 - 28). The items were scored based on a five-point Likert scale from very high to very low ranged 1 to 5 (3 as mean score). The validity of the questionnaire was confirmed by the experts and its reliability was confirmed by Cronbach's alpha of 0.82. To evaluate the normality of data in order to employ parametric or non-parametric tests, the Kolmogorov-Smirnov test was used. Since the variable scores had normal distribution, the parametric tests were used to analyze the data. Data were analyzed with SPSS version 22 (SPSS Inc., Chicago, IL) using *t*-test.

3. Results

Results of data analysis on the students and teachers viewpoints toward the effect of data visualization on virtual education (increased productivity, rate of data transfer, learning, and ease of access) using *t*-test to assess the study hypotheses in Shahid Beheshti University of Medical Sciences are shown in Table 1.

The mean score of the students and teachers viewpoints toward the effect of data visualization on virtual education was compared with the desired score (> 3), using *t*-test. Based on the measured mean (3.35) and (P = 0.01), the null hypothesis of the study was rejected; it means that the mean score of students and teachers was significantly

Table 1. The Analysis of Study Hypotheses Regarding Data Visualization in Virtual Medical Education from the Viewpoints of Teachers and Students of Shahid Behehti University of Medical Sciences, Using *t*-Test

Study Hypotheses and Questions	Mean $\pm$ SD	Mean Difference	Degree of Freedom	*t* Score	P Value
Effect of data visualization on virtual education for continuing education at the university	3.3582 ± 0.665	0.490	78	10.567	0.010
Effect of visualization on increased productivity in the students of virtual medical course	3.610 ± 0.596	0.610	78	9.100	0.020
Effect of data visualization on increased rate of data transfer	3.729 ± 0.608	0.729	78	10.660	< 0.001
Effect of data visualization on increased rate of learning	3.490 ± 0.589	0.490	78	7.378	< 0.001
Effect of data visualization on increased ease of access to data	3.503 ± 0.665	0.503	78	6.720	0.023

higher than 3 and consequently, visualization could significantly affect virtual education.

First hypothesis: It seems that visualization significantly affected productivity of students in Virtual Medical School of Shahid Beheshti University of Medical Sciences.

The mean score of students and teachers viewpoints towards the effect of data visualization on the students productivity was compared with the optimal score (> 3), using *t*-test. Based on the measured mean score (3.16), and since the calculated P value in the current study was lower than the considered level (P = 0.01), the null hypothesis was rejected. It means that the mean score of students and teachers viewpoints was significantly higher than 3; in other words, visualization could significantly affect the students' productivity.

Second hypothesis: It seems that data visualization can significantly affect the rate of data transfer in the students of Virtual Medical School at Shahid Beheshti University of Medical Sciences.

The mean score of students and teachers viewpoints towards the effect of data visualization on the rate of data transfer was compared with the optimal score (> 3), using *t*-test. Based on the measured mean score (3.73), and since the calculated P value in the current study was lower than the considered level (P < 0.001), the null hypothesis was rejected. In other words, the mean score of teachers and students viewpoints was significantly higher than 3. Hence, it can be concluded that the visualization of data could significantly affect the rate of data transfer.

Third hypothesis: It seems that visualization can significantly affect the rate of learning in the students of Virtual Medical School at Shahid Beheshti University of Medical Sciences.

Using *t*-test, the mean score of students and teachers viewpoints towards the effect of data visualization on the rate of learning was compared with the optimal score (> 3). Since the measured mean score was 3.49 and the calculated P value was lower than the considered level (P < 0.001), the null hypothesis was rejected. In other words, the mean score of teachers and students viewpoints was significantly higher than three; hence, it can be concluded that the data visualization could affect the rate of learning.

Fourth hypothesis: It seems that data visualization can significantly affect the ease of access to data in the students of Virtual Medical School at Shahid Beheshti University of Medical Sciences.

The mean score of students and teachers viewpoints towards the effect of data visualization on the ease of access to data was compared with the optimal score (> 3), using *t*-test. Since the measured mean score was 3.50 and the calculated P value was lower than the considered level (P = 0.023), the null hypothesis was rejected. In other words, the mean score of students and teachers viewpoints was significantly higher than 3; hence, it can be concluded that data visualization could significantly affect the ease of access to data.

4. Discussion

Based on the results of students and teachers viewpoints, data visualization had significant and positive effects on virtual medical education; therefore, data visualization with benefitting from technological facilities and different methods helps the students and teachers to benefit from visual strategies in line with fundamental expansion and development of knowledge. Different useful methods of data visualization can play a significant role in the education system in order to improve the process of teaching.

Therefore, it can be said that visualization, particularly its new and effective techniques and technologies, can play a significant role in visual education. Due to lack of physical relationship, actual classes, etc. the students may not understand the provided contents and concepts, properly. If virtual education benefits from visualization methods properly in such a way that students and users can have access to their required resources in the educational websites, such courses sound fruitful and meeting the shortfalls seems rational. Results of the current study were in agreement with those of Doroudi on the application of data visualization techniques and visual literacy in educational activities in order to develop effective techniques of data visualization and support students educational processes. In addition, data visualization preserves technical

data and lets the students express the contents of images, symbols, graphs, and other available data resources, and benefit from effective tools in educational purposes (3).

Students and teachers in the current study showed that all the objectives and aspects of virtual education cannot be met without visualization of data; the better the technical structure of visualization, the higher the rate of data transfer, ease of access to data, learning, and productivity. Although the obtained mean score was at medium upward level regarding virtual education effectiveness, it is hoped that by the improvement and promotion of data visualization techniques, the ascending trend of this development is continued. Moreover, Nikravesh and Jalali in a study concluded that following the electronically compilation of virtual textbooks and anatomy atlases, and putting the provided data at disposal of students via the virtual education system of Deputy Dean (Education) of Mashhad University of Medical Sciences, the access of students to new and applicable references was provided in such a way that significantly increased their ability in scientific competitions (13). The findings were consistent with those of the current study.

The current study results indicated that data visualization could significantly improve the productivity of students of Virtual Medical School at Shahid Beheshti University of Medical Sciences. Of the advantages of virtual education, the increased ability of data storage in the learners seems noteworthy; in this regard, different factors such as vocal and video data, as well as short-interval exams and interaction with the learner and some other factors to re-emphasize purposive learning are also applicable (1, 5). Picturizing reduces the need for education (to explain the data) and causes better presentation of data and consequently, better benefitting from data. By the application of data presentation method, visual processes help the users to have better understanding of the provided data and recover data more desirably (2).

Visualization and use of its new techniques in virtual courses let the students and other users understand data perfectly via benefitting from the websites and other facilities of virtual universities; this trend significantly increases the students' productivity. Kheyrandish in his study indicated that following the advances in information technology and increased penetration of telecommunications into the society, the educational tools and methods are evolved. Evolution in such tools and methods increased the utilization to such an extent that everyone at any specified time and place can start learning (7). Hakimzadeh and Afandideh in a study on 118 M.Sc. student of medical education as well as 11 teachers of the Department of medical education in Tehran University of Medical Sciences. It is revealed that the quality of e-learning course in this department was at a relatively favorable level (15).

Results of the current study indicated that data visualization can significantly affect the increased rate of data transfer in the students of visual medical school at Shahid Beheshti University of Medical Sciences. The use of visualization has had an impact on increasing the speed of the transfer of information to students and users, and as the use of visualization techniques is done correctly, the speed of data transfer to users also increases; this finding was in agreement with that of Liao et al. (10); they established a virtual physics laboratory for school students and reported that using figures, graphs, and formulas with different themes and colors to teach sciences provided an attractive educational environment for the young students associated with quick data transfer (10).

Based on the results of the current study, data visualization could significantly improve the rate of learning in the students of Virtual Medical School at Shahid Beheshti University of Medical Sciences. The current study findings indicated that, owing to the scores of variables, the rate of communication between the image and concept of data, easy and rapid understanding of data, creativity in stimulation of information, the ability to subjective schematization of data, hypothecation based on the visualized data were among the influencing factors. Therefore, it can be explained that the visualization significantly affects and increases the rate of learning in students. When the students receive information in pamphlets as textual files, they may only retain the contents, but if something is presented pictorially or in a particular manner, it is more quickly understood by the student, and consequently, the learning rate increases (3). Results of the current study were in agreement with those of Doroudi and Soleiman Nejad that reported a correlation between rapid understanding of data and data visualization (8).

Finally, results of the current study showed that data visualization can significantly increase ease of access to data in the students of Virtual Medical School at Shahid Beheshti University of Medical Sciences. Data visualization techniques can provide better methods to understand and have access to extensive data spaces (3). An individual engaged in information search system has one or more objective in mind and benefits from the search system as a tool to achieve his/her goals. Therefore, if the virtual education courses employ appropriate and optimal data presentation methods, the student can achieve his/her goals easily with the independence of action; it significantly affects and improves the ease of access to data. These findings were in agreement with those of Keim (9). They concluded that the teachers can acquire their targets by finding a required, particular layout based on the feedbacks and factors associated with services, and also by finding contents for high-performance web-based learning systems.

Based on the results of the current study, it can be said

that the application of visualization techniques plays a significant role in the virtual education. Data visualization results in valuable decision-making, better and faster understanding of environmental changes, discovering emerging opportunities, increasing the power of future prediction, operational budgeting, desirable data interpretation, creating awesome reports, general data observation, saving time, and increasing the productivity. Clarification of data, independence in information seeking, direct and tangible relationship with data, classification of data, and visual understanding of data are among the factors significantly affecting the rate of data transfer. Effective communication, creativity, and hypothesizing are among the important factors affecting the rate of learning. Information-seeking skills, relationship between information sets, ease of access to data in order to improve recognition and data assessment quality are of the advantage of virtual medical course at Shahid Beheshti University of Medical Sciences.

Resources and interactive educational software in virtual education, and the process of presentation help the users to attempt acquiring required data using data visualization software, based on their perceptual abilities. Augmented and virtual reality technologies in medical sciences significantly increased the importance and application of data visualization. Virtual reality is one of the extensive research fields in medical engineering. Not in a distant future, medical education without the application of virtual reality and data visualization is impossible, although there are still some challenges such as lack of technological infrastructures and even lack of enough information in students and teachers about the electronic resources in visualization of data (14).

The related research and practical suggestions are provided as follows:

Owing to the effect of visualization on virtual education, it is recommended that designers and officials be familiarized with modern technologies and employ them in designing scientific-educational resources.

Students and other users involved in virtual education should inform the authorities regarding the information problems and shortcomings in order to prevent the reduction of productivity and performance, and improve utilization.

Designers and compilers of virtual education tools and resources should benefit from the students and teachers' comments and suggestions in order to improve their products.

Visual and media literacy training as well as data visualization educations should be included in the curriculum and educational programs of audiences, learners, and officials of virtual education courses.

Supplementary Material

Acknowledgments

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