Original Article

The conceptualization model of the visibility of medical knowledge and the increase of its application patterns in the metaverse space based on the Glazer database

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Abstract

Background: The lack of visibility of knowledge in the metaverse is the basis of instability challenges and is a prerequisite for new knowledge management and strategy for virtual organizations. This study was conducted in order to conceptualize the visibility of medical knowledge and increase its application patterns in the metaverse space.

Methods: The implementation of the current research is fundamental considering the main goal of the research, which is to conceptualize the visibility of medical knowledge in the metaverse. The statistical population is a collection of experts in the field of Metaverse. To interview the experts used the snowball sampling method, which is a part of non-probability and theoretical sampling. The tool for collecting information was a semi-structured interview checklist regarding the purpose of the study. And the data collection method was interview.

Results: The dimensions of the visible conceptualization of medical knowledge in the metaverse are the concrete effectiveness of the infrastructure elements of medical application patterns as a causal variable, the concrete effectiveness of the facilitator of medical education as a background variable, the concrete effectiveness of the content of medical knowledge as a background variable and the concrete effectiveness of learners' learning as an outcome variable were included in the conceptualization model of knowledge visibility.

Conclusion: The visibility of medical knowledge is a process with a collective approach resulting from the cooperation of all elements of educational spaces, which doesn't happen completely without the presence of one element of the process of visibility.

Keywords: Concept Formation; Database;Translational Science, Biomedical.

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Introduction

Today is the age of knowledge and technology to the extent that even the existence of different industries cannot guarantee success without them. Thus, tools, information, and knowledge are currently considered a kind of asset and their sharing improves people's performance. They are called organizational knowledge and sharing these data among people in an organization is called knowledge management (1, 2). Nowadays, intelligent agents play a vital role in all aspects of life ranging from social

networks to industry, medicine, defense, agriculture, education, monitoring, etc.

Internet of Things and making intelligent are among the most significant achievements in this area. They allow rapid and accurate inference by establishing a connection between huge data treasures and defined tasks (3). As a new phenomenon, the Metaverse has been considered by many information systems and policymakers in different fields. Metaverse can eliminate the fundamental limitations of web-based electronic education tools due to reality with virtualization and digitalization of e-learning (3). The reality of computer-based spaces is that humans are easily controlled in computer-based spaces. This makes users feel comfortable. It also paves the way for misuse of the unrelated data obtained from subsequent interception and analyses. Metaverse should be reliable for evolution and expansion.

Security violations are currently occurring and should be investigated immediately to build trust (4, 5). The concept of knowledge visibility to obtain insight into an act of knowledge sharing is vital to the Metaverse space. Non-visibility of knowledge in the Metaverse space is the basis for the instability, security, meaningfulness, the prerequisite of new knowledge management systems, and new knowledge strategies for virtual organizations. Thus, the significance of intelligent systems in education leads to the extensive growth of the number of intelligent systems courses and various types of services. Based on the review of the conducted studies, the present study for the first time develops the theoretical model of medical knowledge management in the metaverse space for knowledge sharing in educational institutions and its relationship with the identified variables to finally answer the question of the role of the metaverse space in sharing Investing knowledge in educational institutions has a suitable response.

Objectives and Aim of study

Qualitative data analysis:

Using Glazer's grounded theory method to extract new theories and patterns from qualitative data related to medical knowledge.

Visibility of medical knowledge:

Investigating how to increase the visibility of medical knowledge in the metaverse space, which can help facilitate access to medical information and training.

Development of application patterns:

Designing and developing application models that can be used in virtual environments and facilitate interactions between doctors, patients and students.

Analysis of social interactions:

Investigating how the metaverse space affects social and educational interactions in the field of medicine, especially in the fields of distance education and online counseling.

Creating new theories:

The final goal is to use the collected data to create new theories about the use of new technologies in medicine that can help improve the quality of medical services.

Methods

Research environment and population

The research method is fundamental regarding purpose as it designs and explains the conceptual model of the medical knowledge visibility in the Metaverse space with the studies of existing documents and interviewing experts. In other words, it conceptualizes knowledge visibility in Metaverse with the data grounded and interviews with experts using the Glazer approach. The fundamental theory, based on Glazer's approach, includes the epistemology of realism, in which the findings are revealed from the data. Based on Glazer's grounded data, the researcher can create a new theory (arbitrary modeling) based on the knowledge gained from a systematic review. Since the

conceptualization of knowledge visibility was first theorized, grounded theory was used based on Glazer's approach. Generally, the research method is philosophically interpretive and exploratory in terms of nature. This type of study is included in the class of qualitative research methods.

In this study, a major practical feature was using the analysis program MaxQDA 2007 for Windows to support the categorization of statements for concept development. Interview transcripts were uploaded to the program, and units of text were selected marked, and then allocated to self-generated categories. The software helps the researcher to survey the coding process and easily recover selected sequences of the texts. The program automatically generates a figure showing the category system in detail. Additionally, it offers a feature of generating memos on text passages, which helps to catch the researchers' impressions and highlights from the interviews. This mechanism visualizes structures, similarities, and differences between participants' contexts and perspectives and facilitates identifying connections and relations between categories.

Data collection method

The statistical population of this study included a set of experts in the field of medical knowledge in the Metaverse space. The snowball sampling method, which is a non-probabilistic and theoretical sampling, was used for interviews with experts in this study. Accordingly, the interview with experts was done to conceptualize the knowledge visibility in the Metaverse space to the stage where theoretical saturation was achieved based on to researcher, supervisor, and advisor. The theoretical saturation was achieved after interviewing 10 experts in this study. The experts were identified with symptoms of P1, P2, P3, P4, P5, P6, P7, P8, P9, and P10. The information collection tool in the present study included a semi-structural interview checklist on the purpose of the study.

In the quantitative section, several hospitals were used to evaluate the relationship between Metaverse space and its impact on improving therapeutic functions in some hospitals as the intervention group and some other hospitals as the case group. In the hospitals of the intervention group, the current programs of Metaverse in medicine were used. In the hospitals of the control group, usual medical programs were implemented.

Statistical analysis

Information analysis tool in this study was the researcher's analysis and MAXQDA, SPSS, and Excel software. The method of analysis to identify the dimensions of knowledge visibility in the Metaverse space was the DIMTEL technique. Then, the impact of the Metaverse program compared to the control group was examined in terms of improving patients' therapeutic performance based on the t-test.

Results

Investigating the demographic characteristics of the research experts

Table 1 shows that most of the research

Table 1. Investigating the demographic characteristics of experts in the Metaverse

Variable	Classes (years)	Frequency	Valid percentage
Age (year)	Under 30	1	10
	30-40	4	40
	Over 40	5	50
	Total	10	100
Employment history in the Metaverse field (Year)	under 10	2	20
	10-20	6	60
	Over 20	2	20
	Total	10	100
Gender	Female	3	30
	Man	7	70
	Total	10	100
Education	Bachelor	2	20
	Master	4	40
	PhD	4	40
	Total	10	100

Table 2. Open coding and extracting key points obtained from knowledge visibility interviews in Metaverse space

Interviewers	Key points of the interview text	Initial code
P1, P3, P7, P9	The learning rate of the learners is effective in the visibility of Metaverse knowledge.	Rate of learning
P10, P7 ,P9, P1	The level of satisfaction of the learners from the course is effective in the visibility of Metaverse knowledge.	The level of satisfaction of learners
P9, P8, P1, P2	The level of importance of learners in doing homework is effective in the visibility of Metaverse knowledge.	Responsibility in doing tasks
P1, P2, P7, P9, P10	The degree of importance that learners consider for class attendance in the Metaverse space	Commitment to attend class
P3, P5, P4, P10	The use of images, photos, animation, and other multimedia methods to present facts and learn concepts by educators is effective in the visibility of Metaverse knowledge.	The appropriateness of technology in holding a class on Metaverse
P1, P9, P8	The role of educators as facilitators in the Metaverse	The facilitating role of educators in the Metaverse space
P1, P7, P3, P10	Establishing cooperative and sustainable education between students and learners	The level of active participation between learners and facilitators
P2, P4, P9, P7	Learners' interest in participating in discussions in the Metaverse space	Active motivation of learners in learning interactions
P1, P3, P9, P6, P7	Observability of education feedback among learners	Evaluability of the learners in the Metaverse space
P2, P3, P10, P7	Appropriate and adequate technology, reliable human resources, and feedback mechanisms ensure continuous improvement.	The quality and type of technology used in education in the Metaverse space
P1, P8, P9	The extent of sharing scientific ideas of learners in the Metaverse space	Comprehensive activeness in group learning
P2, P5, P10	The amount of content of scientific information provided in Metaverse should be appropriate to the time.	Evaluability of the content of knowledge information provided in the Metaverse space

experts to conceptualize knowledge visibility in the Metaverse space were aged over 40 years (50 %), had master's and PhD degrees (80 %), had an employment history of 10-20 years (60 %), and were male (70%).

Results based on research steps

Table 2 shows the open coding of the information from the interviews.

Axial coding

This is axial since coding is done around an axis or category. At this stage, the categories, characteristics, and dimensions of open coding are formulated to create increasing knowledge of relationships. At this stage, the researcher selects a category of open coding stage and puts it in the center of the process that is being investigated as a central phenomenon, and then relates other categories to it. These three stages include drawing a chart called the coding pattern, as shown in Table 3.

Table 4 shows the categorization of concepts extracted from interviews with experts regarding the conceptualization of knowledge visibility in the Metaverse space.

Table 3. Axial coding and extracting important categories of knowledge visibility interview

Interviewers	Initial code	Axial code
P1, P3, P7, P9	Rate of learning	Transparency of the rate of learning achieved
P10, P7, P9, P1	The level of satisfaction of learners	Transparency of the level of satisfaction achieved
P1, P8, P9	Responsibility in doing tasks	The transparency of the pervasive interaction in the space
P2,P4,P9,P7	Commitment to attend class	Clarity of students' motivation
P9, P8, P1, P2	The appropriateness of technology in holding a class on Metaverse	Transparency of learners' responsibility for learning exercises
P1, P2, P7, P9, P10	The facilitating role of educators in the Metaverse space	Responsibility for class attendance
P3, P5, P4, P10	The level of active participation between learners and facilitators	Capability of infrastructure technology
P2, P3, P10, P7	Active motivation of learners in learning interactions	the capability of infrastructure elements
P1, P9, P8	Evaluability of the learners in the Metaverse space	Transparency of the active role of educators
P1, P7, P3, P10	The quality and type of technology used in education in the Metaverse space	Facilitator's active interaction
P1, P3, P9, P6, P7	Comprehensive activeness in group learning	Evaluability of the content of scientific information provided in the Metaverse space
P2, P5, P10	Evaluability of the content of knowledge information provided in the Metaverse space	Appropriateness of the scientific information provided in the Metaverse space

Table 4. Coding and extracting important categories from knowledge visibility interview

Core category	Knowledge visibility categories in Metaverse space	Axial coding
Knowledge visibility in the Metaverse space	The tangible effectiveness of learners' learning	Transparency of the rate of learning achieved among learners
		Transparency of the level of satisfaction achieved among learners
		Transparency of the level of comprehensive interaction in the space among learners
		Transparency of the level of learning motivation among learners
		Transparency of learners' responsibility for learning exercises
		Responsibility for class attendance
	The tangible effectiveness of infrastructure elements in the Metaverse space	Capability of infrastructure technology
		Capability of infrastructure elements
	The tangible effectiveness of the educational facilitator in the Metaverse space	Transparency of the active role of educators
		Facilitator's active interaction
	The tangible effectiveness of knowledge content in the Metaverse space	Evaluability of the content of scientific information provided in the Metaverse space
		Evaluability of the content of scientific information provided in the Metaverse space

The results of Tables 2, 3, and 4 (open and axial coding) show that the conceptual dimensions of knowledge visibility in the Metaverse space system are:

1-Tangible effectiveness of learners' learning

The analysis of the researcher shows that based on the interviewed experts, knowledge visibility in the Metaverse space system can be evaluated by measuring the level of satisfaction of the learners from holding such classes and tools that show the learning of the learners after the course. In other words, measuring the level of comprehensive involvement of learners in the Metaverse space and measuring the level of motivation and interest of learners to attend the Metaverse class, evaluating the level of responsibility of the learners to attend the Metaverse class, and their commitment regarding completing the assignments provided by the facilitator in the Metaverse classroom cause knowledge visibility. Accordingly, the more tangible the rate of learning of the learners is through the evaluation of the relevant issues, the more visible the knowledge is in the Metaverse space.

2-Tangible effectiveness of infrastructure

The capability of technologies and infrastructure elements in the Metaverse space is crucial in knowledge visibility. In other words, the more appropriate the quality, type, and multiplicity of technologies in providing knowledge content in the Metaverse space, the higher the learning learner's learning system. Thus, the capabilities of the infrastructure are effective in the effectiveness of learners' learning. In other words, the tangible effectiveness of the infrastructure will be the causal variable in the conceptual model of knowledge visibility.

3-The tangible effectiveness of the educational facilitator in the Metaverse Space System

Based on interviews, another dimension of knowledge visibility in the Metaverse space is the tangible effectiveness of the educational facilitator. In this dimension, the educators' active role in presenting the textbooks in the Metaverse space system tangibly and the establishment of active discussions in the Metaverse space between the learner and the learner is effective in determining the tangible effectiveness of the facilitator in the Metaverse space. This dimension is one of the contextual factors affected by the tangible effectiveness of technology infrastructure, etc. in the Metaverse space, and ultimately causes the tangible effectiveness among the learners.

4-The tangible effectiveness of knowledge content in the Metaverse space

Based on the interviews, the more effective the information provided by the facilitator in the Metaverse knowledge space, the more effective the content provided in the Metaverse space. Based on the researcher, the tangible effectiveness of knowledge content in the Metaverse space as the contextual variable is affected by the infrastructure and it affects the tangible learning effectiveness of learners.

The DIMTEL technique is used to determine the relationships between variables:

For this purpose, in this section, the self-interaction matrix first is created. This matrix is completed based on the opinions of 10 expert experts. Table 5 the relationships between the identified dimensions of knowledge visibility in the Metaverse space system.

In the next step, the initial reachability matrix is determined in a way that the symbols used in the self-interaction matrix are converted to numbers 0 and 1.

After determining the strategies at Level 1 (the tangible effectiveness of the educational facilitator in the Metaverse space system and the tangible effectiveness of knowledge content in the Metaverse

Table 5. Self-interaction Matrix

Variables (i/j)	C1	C2	C3	C4
C1: The tangible effectiveness of learners' learning		X	X	A
C2: The tangible effectiveness of the infrastructure elements			X	A
C3: The tangible effectiveness of the educational facilitator in the Metaverse space system				A
C4: The tangible effectiveness of knowledge content in the Metaverse space				

space), they are re-leveled to determine Level 2 for the remaining variables (the tangible effectiveness of learners' learning and the tangible effectiveness of the infrastructure). After determining the level of each of the factors and the final reachability matrix, the initial interpretive structure model is drawn.

Variables such as the tangible effectiveness of learners' learning and the tangible effectiveness of infrastructure as cause-and-effect variables that are at high levels of the hierarchy have less impact on the knowledge visibility in the Metaverse space system. Also, variables such as the tangible effectiveness of the educational facilitator in the Metaverse space and the tangible effectiveness of knowledge content in the Metaverse space as the contextual variables have more effectiveness Figure 1.

Investigating the relationship between Metaverse application in medicine and its impact on improving patients' performances

In this section, an independent T-test was used to compare two groups of hospitals with a Metaverse and without a Metaverse program to improve patient recovery. Patient improvement performance was investigated by examining the two variables of patient hospitalization period and patient clinical status (1-5, very highly: 1, low: 2, average: 3, high: 4, and high: 5). Table 11 shows a significant difference between the intervention and control groups regarding the patient's hospitalization period and the clinical status of the patient. Thus, with 99 % confidence, the hospitals used by Metaverse in the care system of patients were less in hospital for about 4 days. Also, regarding the health staff, with 99 % confidence, the clinical status of hospitals that used Metaverse in the care system of patients was evaluated as very good (1.32±4.65) compared to non-Metaverse program groups.

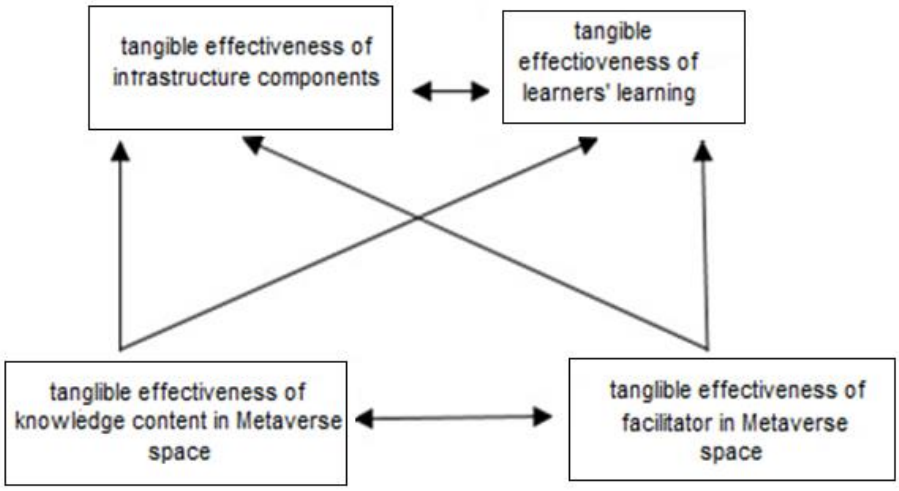

Figure 1. Determining the relationships between the dimensions of knowledge visibility in the Metaverse space

Table 6. Application of Metaverse in medicine and its impact on improving patients' performance

Patient's improvement performance variables	Classes	SD±Mean	t-value	sig
The patient's hospitalization period	Control	0.32 ± 6.5	31.24	0.0001
	intervention	0.84 ± 4.42		
Evaluation of the patient's clinical status	Control	1.20 ± 3.54	19.43	0.0001
	intervention	1.32 ± 4.65		

Discussion

An effort to improve the skills, knowledge, and expertise, or change the attitudes and behavior of learners to achieve a higher status and ultimately to enhance the performance or overall productivity of learners in any situation is called training and education. Both individual goals and organizational goals should be considered when designing educational programs (6). Accordingly, the effectiveness of education can be visible through changes in the behavior and attitudes of learners. Thus, there is a direct relationship between the two categories of knowledge visibility in the Metaverse space and the tangible learning effectiveness and change in learners' behavior (7). Training and education are vital components of lifelong learning that empower individuals to achieve their goals. By investing in these processes, learners can elevate their status, improve performance, and contribute positively to their organizations and communities. Embracing both training and education can lead to a fulfilling journey of growth and development (25).

However, researchers believe that the effectiveness of this concept of dimensions and educational components is used as a means of evaluation of knowledge visibility in general and Metaverse space in particular. Thus, since the components of educational spaces include learners, facilitators (educators), knowledge content, and educational tools and equipment, the results of Glazer's approach to the conceptualization of knowledge visibility in the Metaverse space showed that the dimensions of knowledge visibility in the Metaverse space were possible through the following concepts (26). In summary, Glazer's approach highlights that knowledge visibility in the Metaverse is achievable through a combination of immersive experiences, global connectivity, and effective educator-student interactions. As this field evolves, further exploration into its dimensions will be crucial for maximizing its educational potential.

1-Tangible effectiveness of infrastructure in the Metaverse space as a causal variable: The reason for selecting this category as a variable is that it has been indirectly adapted from interviews with experts in all scientific studies. This category alone affects all mentioned categories including educators, facilities, and even effective educational content.

2-The tangible effectiveness of the educational facilitator in the Metaverse space as the contextual variable

3-The tangible effectiveness of knowledge content in the Metaverse space as the contextual variable: The reason for selecting this category as a contextual variable is that it has been indirectly adapted from interviews with experts in all scientific studies. This category as an intermediary between the process of infrastructure variables affects the variable of learners' learning effectiveness.

4-The tangible effectiveness of learners' learning as an outcome variable: This category is the outcome of the cooperation of the education components including educators, learners, space, and educational installations. In the case of non-tangible

learning, knowledge visibility will not be achieved (8).

The results revealed that knowledge visibility is achieved with the cooperation of all the components of educational spaces. It does not happen in the absence of one of the components of knowledge visibility. Knowledge visibility refers to the ability to access, share, and utilize knowledge effectively within educational environments. The findings you mentioned highlight the importance of collaboration among various components of educational spaces to achieve this visibility. Let's delve deeper into this concept. To foster an environment where knowledge visibility thrives, it's essential to ensure that all components are functioning harmoniously. This holistic approach not only enhances learning outcomes but also prepares students for collaborative work in their future endeavors. By recognizing the importance of each element, educational institutions can create spaces where knowledge is not only visible but also valued and utilized effectively (27).

Accordingly, the components of knowledge visibility in the Metaverse space are as follows:

1-The tangible effectiveness of infrastructure in the Metaverse space as a causal variable

2-The tangible effectiveness of the educational facilitator in the Metaverse space as a contextual variable

3-The tangible effectiveness of knowledge content in the Metaverse space as the contextual variable

4- The tangible effectiveness of learners' learning as an outcome variable

A study by the Erlicashion Research Team expanded the virtual reality of Cardiac arrest resuscitation. This program allows four learners to be in a "virtual room" and work together to care for a patient with cardiac arrest. Under these conditions, they experience the pressure caused by the high volume of work in these environments (9-15). Medical education tailored to modern technologies has also been developed. We need to know how we can best use these unique features of Metaverse in the design of medical education and treatment (16-20). Metaverse can be used to simulate real-world scenarios, interactive feedback, and personalized learning based on the needs and preferences of individual learners. This tool can also be used to simulate real environments such as hospitals, surgery rooms, or natural environments that can help medical students develop their skills and knowledge in a safe and controlled environment (21- 24).

Conclusion

Metaverse is a strange technology that is expected to get a large share of health care and medical progress in the future. In other words, all the events we experience in the real world can also be implemented in the Metaverse world. This revolutionary technology is one of the most important applications in the medical and health sector.

Limitation

The conceptualization model of the visibility of medical knowledge and its application patterns in the metaverse, particularly based on the Glazer database, faces several limitations that can impact its effectiveness and implementation. Here are the key points regarding these limitations:

1. Data Integration Challenges

2. User Experience and Accessibility

3. Ethical and Privacy Concerns

4. Technological Limitations

Authors' contribution

Hamid Alaghehband and Zahra Alipour Darvishi developed the study concept and design. Mohammad Feizi Zangir and Ali Hijiha acquired the data. Hamid Alaghehband and Zahra Alipour Darvishi analyzed and interpreted the data, and wrote

the first draft of the manuscript. All authors contributed to the intellectual content, manuscript editing and read and approved the final manuscript.

Informed consent

Questionnaires were filled with the participants' satisfaction and written consent was obtained from the participants in this study.

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Conflict of interest

The authors declare that they have no conflict of interests.

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