

Impact of Using Metaverse Technology in Enhancing Knowledge Sharing to Improve Academic Outcomes: An Applied Study on the Students of the College of Science at King Abdulaziz University

(A Literature Review)

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Abstract:

This study aims to review the scientific literature on Metaverse technologies and their application in university learning with a focus on their role in enhancing knowledge sharing and improving academic outcomes at King Abdulaziz University (KAU). The review examines Arabic and English literature published between 2020 and 2025. The study revealed that international studies use diverse experimental methodologies, while Arabic studies are largely limited to descriptive methods. This contrast highlights a research gap regarding the lack of applied institutional models. Consequently, this study proposes an institutional model for the College of Science at KAU to evaluate the impact of the Metaverse on students' academic performance.

Keywords: Metaverse, Virtual reality, Augmented reality, Knowledge sharing, Knowledge management, Academic outcomes, Quality education, King Abdulaziz University.

Introduction

Virtual reality and extended reality techniques are considered among the most important technologies that have gained increasing attention in the field of higher education. These techniques contribute to bringing about a radical change in teaching and learning methods by providing an interactive and immersive educational environment that simulates reality and increases academic interaction between students and teaching staff members, as many studies show the use of Metaverse as a tool to improve university education and enhance academic outcomes.

This paper aims to review the literature related to Metaverse techniques and their use in university education, specifying the impact of these techniques on knowledge sharing and enhancing students' academic performance. This paper seeks to shed light on the research gap in the Arabic

literature related to the application of Metaverse in Saudi universities, which is limited to general perspectives and challenges without providing clear applied institutional models.

The importance of this study lies in addressing this gap by suggesting an applied model for the College of Science at KAU. The study adopts a mixed methodology combining case studies, focus groups, and expert views.

The study will adopt a mixed methodology that combines a case study, focus groups, and experts' views for a better understanding of the impacts of the Metaverse on university education. Through this paper, literature in both Arabic and English will be reviewed, with an analysis of the differences between international and local trends, and finally presenting the proposed research, which seeks to apply Metaverse techniques in the college of science at KAU.

Frame and scope of reviewing the topic literature

- The time frame: The review of the literature covered studies published during the period from 2020 to 2025.
- The topic frame: The review of the topic literature focuses on issues related to knowledge sharing through the use of Metaverse, as they have a direct relationship with the study topic and its main thrusts.
- The form frame: The review includes books, dissertations, articles, and conference papers which constituting the main repositories of certified scientific knowledge.
- The language frame: The review includes intellectual production in both Arabic and English, aiming to cover as much relevant scientific literature as possible.

Terminologies

S\N	Main term	Main term (EN)	Synonyms	Synonyms (EN)	Research	Research (EN)
1	Metaverse	Metaverse	Augmented Reality	Virtual Reality	Universities	Higher Education
2	Knowledge Management	Knowledge Sharing	Knowledge Transfer	Knowledge Exchange	Technology Integration	Collaborative Learning
3	Academic Outcomes	Academic Performance	Learning Outcomes Academic Performance	Student Achievement Academic Performance Learning Outcomes	Higher Education Academic Achievement	Higher Education Academic Achievement
4	King Abdulaziz University	King Abdulaziz University	-	-	Saudi Arabia Universities	Saudi Arabia Universities

Section one: Metaverse and extended reality techniques in education:

Concept of Metaverse:

“A phrase composed of two words: (Meta), which means post, and (universe), which means the world. The combined term describes a virtual environment related to the real world” (Suwy’ed, 2024, p. 148).

Historical brief:

The first use of the word Metaverse was in the novel Snow Crash by Neil Stevenson in 1992, in which Metaverse was described as a three-dimensional virtual environment that contains images representing users (Suwy’ed, 2024).

Definition of Metaverse:

“The word Metaverse refers to an internet-based environment and a real space for users to interact socially and communicate with others, conduct business, and entertain themselves by using the real world as a metaphor” (Suwy’ed, 2024, p. 148).

Definition of Extended Reality (XR):

It is a term that includes the techniques of virtual reality (VR), augmented reality (AR), and mixed reality (MR). It is used to develop virtual, enhanced, or hybrid educational environments (Abdulateef, 2024).

Definition of Virtual Reality (VR):

It is a technique that uses special goggles or headsets to develop an immersive three-dimensional environment that enables students to interact with an environment that simulates reality or fiction (Abdulateef, 2024).

Definition of Augmented Reality (AR):

It is a technique that adds digital layers (images, video, and text) to the real environment through smart phones or smart goggles, with the aim of integrating digital content into reality (Abdulateef, 2024).

Definition of Mixed Reality (MR):

It combines elements of Virtual Reality and Augmented Reality to develop a new environment that enables interaction with both the real and virtual worlds simultaneously (Abdulateef, 2024).

- **Characteristics of Metaverse technology:**(Abdul Latif, 2024)
 - **Immersion:** Represents the extent to which the learner is able to fully concentrate and become deeply engaged in the educational experience.
 - **Interactivity:** Represents the learner’s ability to innovate within the educational environment, as well as to control and explore it.
 - **Realism:** Represents the degree to which the virtual or augmented reality environment matches real-life settings, and the learner’s ability to transfer educational experiences from it.
- **Advantages and disadvantages of adopting Metaverse technology in education:** (Maghaydah, Al-Emran, Maheshwari, & Al-Sharafi, 2024)

Advantages	Disadvantages
The perceived usefulness of Metaverse technology and its impact on improving performance and the overall learning process	Perceived risks and concerns related to privacy and security
Ease of use increases the learner’s willingness to adopt the technology	
Enjoyment and entertainment-driven motivation increase the learner’s desire to engage	
Satisfaction and the alignment of expectations with the experience enhance learner continuity	
Immersion and presence strengthen the learner’s sense of being in an interactive environment	
The availability of technical support and well-prepared infrastructure	System complexity, if difficult to understand, reduces learnability
Peer and supervisor support encourages the learner to use the technology	
Achieving positive and tangible outcomes in Metaverse through others’ experiences	
Learners’ tendency to explore and try modern technologies	

Section two: knowledge sharing and knowledge management

Definition of knowledge management:

“A set of activities and processes that help organizations generate, acquire, use, and disseminate knowledge, and work on transforming knowledge into products, as well as utilizing the outputs of knowledge management in decision-making and problem-solving.” (Nadia, 2022, p. 295)

Definition of knowledge sharing in universities:

“The educational process through which an organization is able to access its own knowledge and the knowledge of other organizations.” (Qazdar, 2023, p. 82)

Explicit knowledge: *“Knowledge that can be expressed in the form of words, drawings, symbols, or other means such as images, maps, diagrams, icons, or language. It is objective knowledge about a specific subject.”(Nadia, 2022, p. 293)*

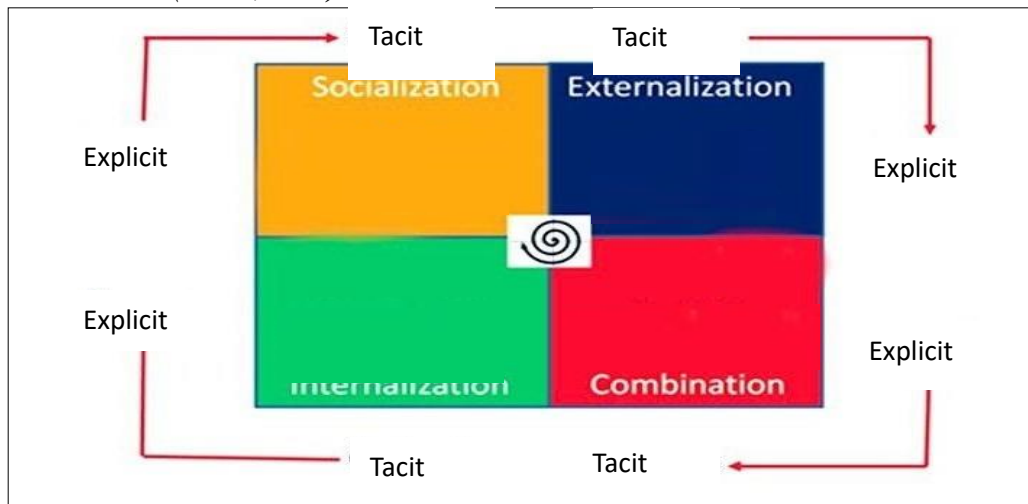
Tacit knowledge: *“Knowledge that is unwritten and difficult to express in any linguistic form, preserved in the human mind and memory—such as upbringing, experience, and expertise—and is difficult to extract or share.” (Nadia, 2022, p. 293)*

Characteristics of knowledge sharing in universities: (Qazdar, 2023)

- The university’s vision and mission support and enhance knowledge sharing.
- The university’s strategic objectives support and contribute to knowledge sharing.
- The university’s organizational structure facilitates and adopts knowledge sharing.
- The university’s technological and communication infrastructure supports knowledge-sharing activities.

- o The university adopts digital transformation practices.

SECI Model: (Nadia, 2022)



(SECI Model for Knowledge Sharing)

A dynamic model that outlines how knowledge is generated among individuals and then shared within groups, beginning with tacit knowledge, moving to explicit knowledge, and then returning back to tacit knowledge through multiple phases and patterns.

Operationalizing the SECI Model in the Metaverse

The proposed institutional model operationalizes the SECI phases as follows:

- **Socialization (Tacit to Tacit):** Avatars in 3D environments allow for observation and imitation, facilitating the transfer of experiential knowledge.
- **Externalization (Tacit to Explicit):** Collaborative virtual tools allow students to articulate complex concepts into 3D models.
- **Combination (Explicit to Explicit):** The Metaverse integrates diverse digital repositories, allowing students to synthesize information into new insights.
- **Internalization (Explicit to Tacit):** "Learning by doing" in simulated environments helps students turn academic content into personal mastery

Patterns of the SECI model (Nadia, 2022)

Pattern	Type of knowledge	Stage
First	From implicit knowledge to implicit knowledge	Socialization
Second	From implicit knowledge to explicit knowledge	Knowledge Externalization and Expression
Third	From explicit knowledge to explicit knowledge	Gathering and Integrating Knowledge

Forth	From explicit knowledge to implicit knowledge	Incorporating or Incorporating or Assimilating Knowledge
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Section three: Academic Outcomes and Quality of Education:

An overview of the use of Metaverse Technology in Light of Academic Outcomes and Quality of Education:

Metaverse is one of the most advanced educational innovations and aims to change the concept of students’ learning by providing interactive and immersive learning environments. Students can interact with educational content, exchange ideas with their peers, and experience interactive learning activities in simulated real-life environments. This type of learning increases student engagement with course materials and motivates them to participate more, leading to improved academic outcomes (Amin, 2025).

Definition of Metaverse technology in light of academic outcomes and quality in education:

Metaverse is a digital learning environment that integrates virtual reality and augmented reality technologies to create an immersive learning experience. Through Metaverse, students can interact with academic content within three-dimensional virtual environments, giving them the opportunity to engage with the digital world as if they were in a real-life environment. This allows them to interact with advanced educational content that simulates reality, which facilitates the understanding of complex subjects, enhances the quality of education, and leads to better academic achievement (Ali, 2025).

Characteristics of Metaverse technology in light of academic outcomes and quality in education:

Immersion is one of the most prominent characteristics of Metaverse, as it provides immersive learning environments in which students feel as though they are inside the educational setting. This immersive experience helps capture students’ attention and increase their motivation, thereby enhancing the effectiveness of learning and contributing to improved academic outcomes (Figueroa, 2024).

The Impact of Metaverse Technology on Academic Outcomes and Quality of Education:

Numerous studies have shown that the use of Metaverse in education has positive effects on students’ academic performance in simulated environments such as virtual laboratories or interactive classrooms. In addition, students who participated in educational activities through Metaverse demonstrated an increase in their academic achievement compared with those who studied using traditional methods (Youssef, 2025).

Advantages and disadvantages of Metaverse technology on academic outcomes and quality in education (Ali, 2025)

Advantages	Disadvantages
Student motivation	technical challenges such as infrastructure and internet connectivity
Interactive learning	Health issues due to prolonged use
Collaborative or group learning	High cost

Analysis of Literature and Research Gap

The review covered studies from 2020 to 2025 across Arabic and English databases.

The Research Gap:

- **Methodological Disparity:** International studies utilize field experiments and meta-analyses, whereas Arabic literature relies heavily on descriptive analysis and questionnaires.
- **Institutional Implementation:** There is a scarcity of applied institutional models within the Saudi context despite global advancements.
- **Disciplinary Focus:** Most local studies focus on general education challenges, leaving a gap in empirical evidence for specific scientific disciplines like the College of Science.

Section Four: Research methodologies:

Case study method:

Definition:

It is a method used to examine complex phenomena in their real-world contexts. This method allows researchers to answer the questions (how and why) and is considered a powerful tool for gaining a deep and detailed understanding of human or organizational processes, behaviors, and activities (Annamalah, 2024).

Uses:

Widely used in the social sciences such as sociology, anthropology, education, and industrial relations, as well as in the fields of business, management, and health. It is considered a particularly useful tool for studying organizational practices, understanding human behavior, and exploring complex interventions or phenomena that are difficult to measure using traditional quantitative methods. (Annamalah, 2024)

- **Characteristics: (Annamalah, 2024)**
- **Flexibility for modification**, as questions and research tools can be adjusted during the study.
- **The possibility of employing multiple sources** to collect data, such as interviews, observations, documents, and questionnaires.
- **Focusing on the context or phenomenon** under study.
- **Providing a comprehensive and detailed description of the case.**
- **Understanding the meanings and processes**, not just the numbers, through their interpretation.

- **Advantages and disadvantages:(Annamalah, 2024)**

Advantages	Disadvantages
Provides realistic and detailed data on phenomena	Results cannot be generalized; they only apply to the case under study
Possibility of building or developing theories	Potential for researcher bias due to reliance on interpretation
Supporting practical application and decision-making	Data collection and analysis require considerable time and effort
Suitable for studying new or rare phenomena	The study becomes descriptive if it lacks a clear theoretical framework
Credibility achieved through the use of more than one data collection tool	Difficulty in maintaining neutrality during fieldwork

Focus group method

- **Definition:**

A method that involves organizing a group discussion session, supervised by a facilitator, in which a small group of individuals, usually 6 to 12 participants, engage in dialogue on a specific topic to explore attitudes, opinions, perceptions, and motivations in an interactive environment (Bachtiar & Arif, 2024).

Uses (Bachtiar & Arif, 2024):

- Understanding employee behavior, motivation, and decision-making in the management and organizational research fields.
 - Evaluating health campaigns and understanding individual behavior towards medical services in the healthcare field.
 - Testing reactions to policies or public decisions in the field of public policy.
 - Identifying student experiences or evaluating curricula in the field of education.
- **Characteristics of the focus group method (Bachtiar & Arif, 2024):**
 - Encourages dialogue among participants and the generation of new ideas through interaction.
 - The facilitator leads and ensures the discussion proceeds without imposing opinions.
 - Encourages flexibility in modifying questions according to the flow of the dialogue.
 - Allows documentation through audio or video recording for subsequent data analysis.
 - Involves a limited number of participants, usually 6 to 12.

Advantages and disadvantages:(Bachtiar & Arif, 2024)

Advantages	Disadvantages
The result of group interaction provides diverse data	Some individuals' dominance of the discussion may reduce the opportunity for others' opinions to be heard
Understanding the underlying motivations behind attitudes and opinions	Potential for participants to be influenced by others
More efficient than individual interviews for collecting multiple data points	Difficulty in generalizing results as they reflect a limited group only
Generating new ideas thanks to group dialogue	Challenges such as coordination, recording, and participant selection

Expert opinion methodology:

Definition:

A method used to reach a reliable consensus among a group of experts with the aim of obtaining the most accurate collective belief by compiling the opinions of specialists in a specific field, especially when sufficient quantitative data are lacking (Schifano & Niederberger, 2025).

- **Uses of the expert opinion methodology (Schifano & Niederberger, 2025):**
 - Guiding clinical practice in health sciences.
 - Building institutional frameworks and structures in health policy.
 - Dealing with complex issues that require consensus among experts.
- **Characteristics of the expert opinion methodology (Schifano & Niederberger, 2025):**
 - Engages experts from multiple disciplines.
 - Uses both closed and open-ended questions.
 - Conducted through repeated rounds to reach a consensus.

Advantages and disadvantages: (Schifano & Niederberger, 2025)

Advantages	Disadvantages
Achieving structured consensus among experts	Variability in study quality and differences in methodology
Provides support for informed decision-making	Absence of consensus and systematic analysis mechanisms
Suitable for complex or novel issues lacking quantitative data	Results may be influenced by individual biases or the study design

Literature in Arabic

	Title	Author	Year	Source classification	Methodology used	Database
1	Challenges of Using the Metaverse in University Education	Soeiad Elqarany	2024	Scientific paper	Mixed methodology	MFES
2	The Metaverse: A Gateway to Anticipating Future University Jobs	Hussien Mohamed	2024	Scientific paper	Analytical descriptive	EKB
3	Augmented reality in social studies education	Ebtisam Elzahrany	2021	Scientific paper	Descriptive analysis	IJEPS
4	Designing an Augmented Reality Book to Develop Digital Image Production Skills	Mohamed Ali	2023	Scientific paper	Quasi-experimental	MFES
5	The Effectiveness of a 3D Virtual Learning Environment in Developing Practical Performance in Augmented Reality Project Production Skills	Teba et al	2023	Scientific paper	Quasi-experimental	EKB
6	The effectiveness of using virtual reality in training and assessing skills for people with disabilities: A systematic review and meta-analysis	Manal Baamer	2024	Scientific paper	Systematic review	KAU
7	Knowledge Production Challenges in Saudi Universities in Light of Contemporary Global Variables	Hessa Elbazeay	2022	Scientific paper	Analytical descriptive (questionnaire)	EKB
8	Knowledge Production Challenges in Saudi Universities in Light of Contemporary Global Variables	Mohamed Alzahrany	2023	Scientific paper	Content analysis	KAU
9	A Future Vision for Developing Knowledge Sharing Among Educational	Maram Al-Sherif	2022	Scientific paper	Conceptual / analytical	IJoHSS

	Title	Author	Year	Source classification	Methodology used	Database
	Leaders at King Abdulaziz University Based on Artificial Intelligence Applications					
10	Proceedings of the International Virtual Conference on the Future of Digital Education in the Arab World – Part One	Editor: Ethraa El Marefa	2020	Conference Proceedings	Conference Proceedings	Shamaa
11	Proceedings of the International Virtual Conference on the Future of Digital Education in the Arab World – Part Two	Editor: Ethraa El Marefa	2020	Conference proceedings	Conference proceedings	Shamaa
12	A Proposed Vision for Digital Transformation in Saudi Universities in Light of Global Best Practices	Hayaa Alfarawy	2022	Scientific paper	Descriptive analysis	JALHSS

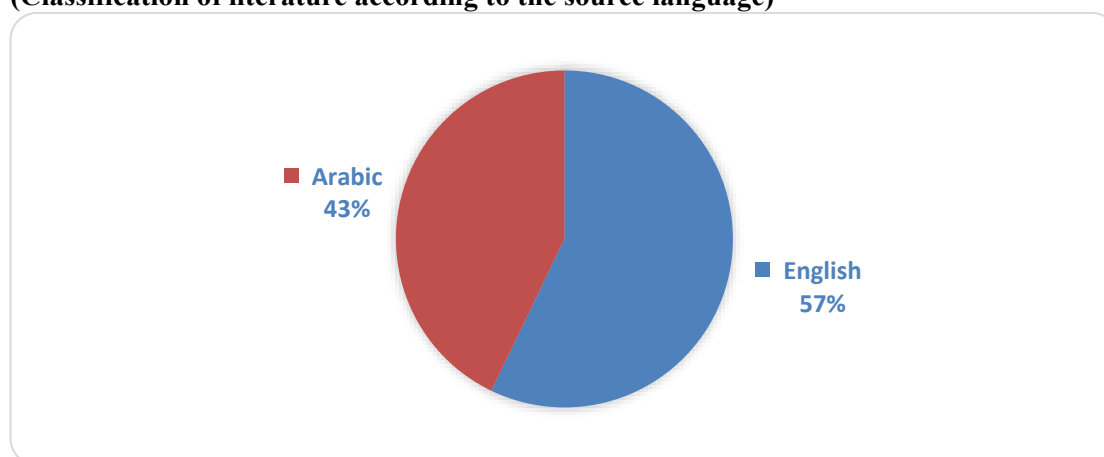
Literature in English

	Title	Author	Year	Source classification	Methodology used	Database
1	The Metaverse in Education: Definition, Framework, and Approach	Zhang et al.	2022	Paper	Conceptual / framework	Frontiers
2	A Systematic Review of Metaverse-Based Blended English Learning	Li et al.	2023	Systematic Review	Systematic review (bibliometric + content)	Frontiers
3	The Impact of Virtual Reality on Student Engagement in the Classroom: A Review	Lin et al.	2024	Review	Systematic review	Frontiers
4	Exploring the Impact of Virtual Reality on Presence: Findings from Higher Education Students	Uribe et al.	2024	Empirical Study	Field experiment (classes in 4 Metaverse platforms)	Frontiers
5	Exploring the impact of virtual reality on presence: findings from higher education students	Austermann et al.	2025	Empirical Study	Quantitative comparison (VR vs iPad)	Frontiers
6	Flow-mediated effects of VR on post-pandemic emotional resilience among university students	Guerra-Tamez et al.	2025	Empirical Study	Quantitative mediation analysis	Frontiers
7	Developing and evaluating the fidelity of a VR-AI environment for academic poster sessions	Tan et al.	2025	Empirical Study	Design-based research / evaluation	Frontiers
8	Augmented Reality in Higher Education: A Systematic Review	Li et al.	2025	Systematic Review	Systematic review + meta-analysis	MDPI

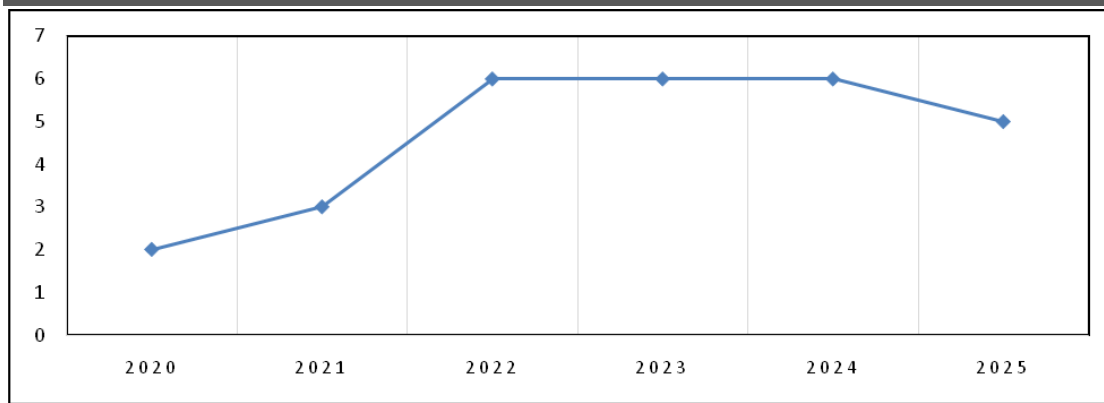
	Title	Author	Year	Source classification	Methodology used	Database
9	Investigating continuous intention to use Metaverse in higher education	Ali et al.	2025	Empirical Study	Survey / structural modeling	Springer Open
10	A Systematic Overview of Reviews of the Use of Immersive Virtual Reality in Education	Craig et al	2023	Systematic Overview of Reviews	Overview of 10 reviews (integrated synthesis)	ERIC
11	Use of Augmented and Virtual Reality in Remote Higher Education	Nesenbergs et al.	2021	Systematic Review	Systematic review	Applied
12	Using virtual reality learning environments to motivate and increase perceived sociability	Çoban et al.	2022	Empirical Study	Experimental comparison (3D VR vs web-based)	Education
13	A decade of research on the effectiveness of augmented reality for special needs in higher education	Jdaitawi	2022	Systematic Review	Systematic review (36 studies)	International
14	The use of virtual reality for student training on bias and microaggressions	Hamed et al.	2024	Empirical Study	Mixed-methods	Journal
15	A systematic review of research on online learner collaboration (2012 – 2021)	Oyarzun & Martin	2023	Systematic Review	Systematic review	Online
16	The effect of computer-supported collaborative learning (CSCL) on academic achievement	Talan et al.	2021	Meta-analysis	Meta-analysis (40 studies)	Education

Literature statistics

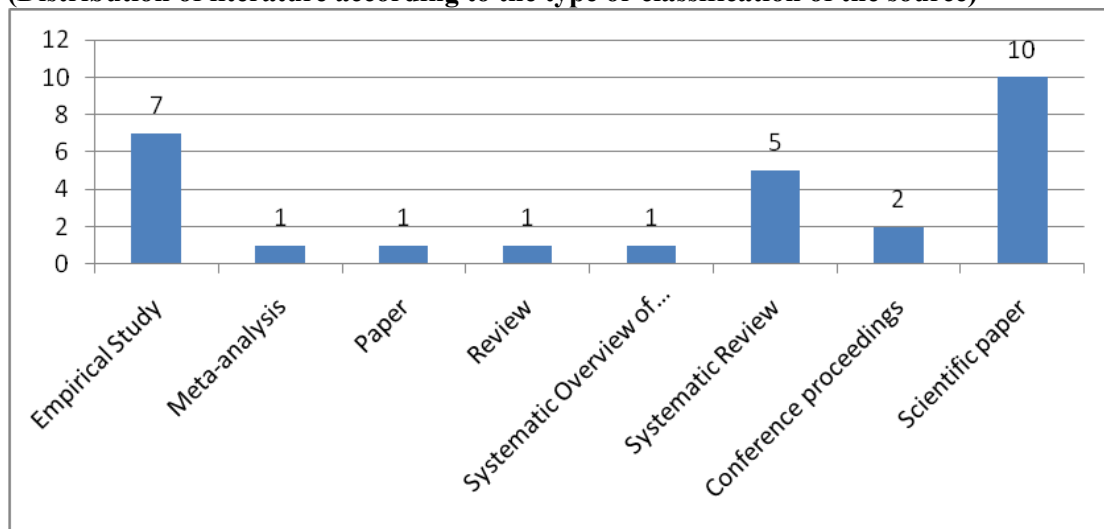
Distribution of literature by language:
(Classification of literature according to the source language)



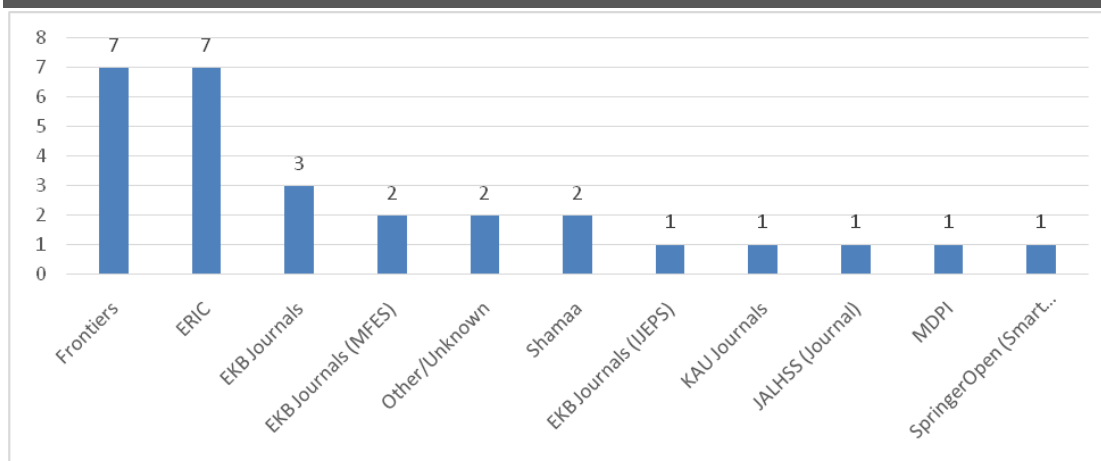
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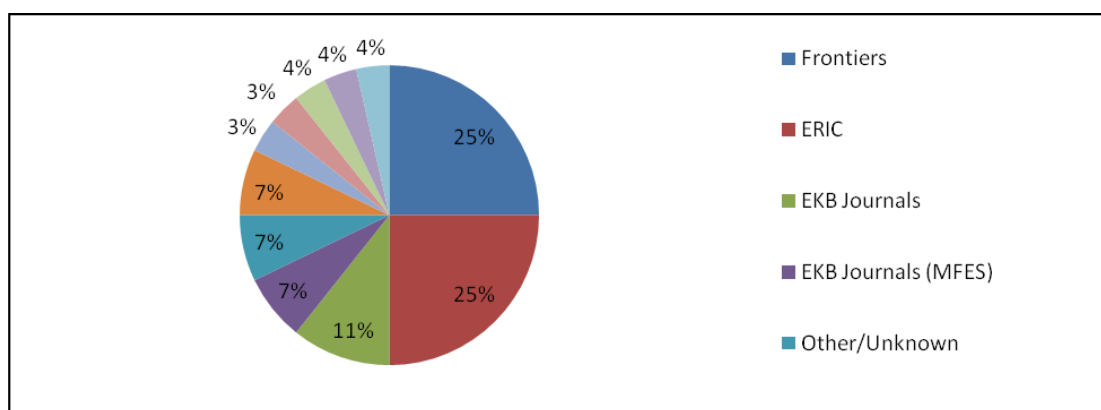
Distribution of literature by source classification:
(Distribution of literature according to the type or classification of the source)



Distribution of literature by database:
(Literature distribution according to information rules)



(Literature distribution according to information rules)



Comparison between the literatures:

Criterion	Arabic language literature	English language literature
Academic fields studied	Focuses on university education and modern technologies, such as Metaverse and Virtual Reality.	Covers broad fields such as university education, information technology, and social sciences.
Diversity of sources	Most sources are Arabic or related to the Arab region, such as EKB and KAU.	Greater diversity in global sources, including prestigious international academic journals.
Chronological coverage	The studies cover the period from 2020 to 2025.	The studies cover the period from 2020 to 2025.
Quality and credibility	Includes local Arabic journals, which may limit diversity and affect quality.	International peer-reviewed journals with high credibility and diverse research from prestigious institutions.
Research trends	Focuses on the development of educational technologies in the Arab region, such as augmented reality and Metaverse.	Diverse topics, including knowledge sharing, collaborative learning, and technological innovation.

○ **Strengths and weaknesses in Arabic-language literature**

Criterion	Strengths	Weaknesses
Academic Fields Studied	Focus on local education	Focus on limited fields
Diversity of Sources	Validation of local culture	Less diversity in sources
Chronological Coverage	Modern coverage	Lack of coverage for older research
Quality and Credibility	Local journals	May have lower impact
Research Trends	Focus on local issues	Limited diversity of topics

Strengths and weaknesses in English literature

Criterion	Strengths	Weaknesses
Academic fields studied	Diversity of topics	Focus is not on local issues
Diversity of sources	Diversity of sources	May be related to the non-local context
Chronological coverage	Comprehensive coverage	Lack of chronological coverage for older research
Quality and credibility	Reliable research	May be related to non-local contexts
Research trends	Multiple research trends	Some local topics are missing

Researcher's opinion

The search process was conducted within databases using a specific set of terms and a particular context, as outlined in the search criteria. All studies that met the research requirements were included, without excluding any results. A review of the literature shows a scarcity of applied institutional models that address knowledge sharing via Metaverse in the Saudi context, despite the existence of strong global studies as well as local descriptive studies. This research proposal aims to fill this gap by developing an institutional model specific to King Abdulaziz University and employing a mixed-methods approach to measure the impact of knowledge sharing on academic outcomes.

Recommendations

- **Infrastructure Investment:** Develop well-prepared infrastructure and technical support for Metaverse applications.
- **Institutional Modeling:** Adopt the proposed model in the College of Science to evaluate long-term impacts on academic achievement.
- **Strategic Alignment:** Ensure university vision and strategic objectives support digital transformation and knowledge-sharing activities.
- **Risk Mitigation:** Address concerns related to privacy, security, and health issues arising from prolonged use.

6. Conclusion

The Metaverse represents a radical shift in higher education by providing immersive environments that enhance student engagement and motivation. While global literature has established a strong empirical foundation, this study fills a critical local gap by providing an applied institutional model for King Abdulaziz University. By integrating the SECI model of knowledge management with immersive technologies, the university can significantly improve student academic outcomes and lead digital innovation in the region.

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