A Pratibha Spandan's Journal

CONFLUENCE OF KNOWLEDGE
(A Multidisciplinary International Peer-Reviewed/Refereed Journal)
ISSN 2320–5237 | Volume 13, Issue 02, February 2026 (Special Issue)
http://cok.pratibha-spandan.org | © The Author(s) 2026

ENHANCING RESEARCH SUPPORT THROUGH VIRTUAL REFERENCE ECOSYSTEMS

DR. G. RENUKA
HEAD, DEPARTMENT OF MICROBIOLOGY, (PINGLE GOVERNMENT COLLEGE FOR WOMEN (A), WADDEPALLY, HANUMAKONDA)
K. VAISHNAVI
LECTURER, DEPARTMENT OF MICROBIOLOGY, (PINGLE GOVERNMENT COLLEGE FOR WOMEN (A), WADDEPALLY, HANUMAKONDA)

ABSTRACT
In the rapidly changing global setting of today, educational institutions must adapt to build a learning ecosystem that prioritizes skills essential for 21st-century learners. with a focus on Sustainable Development Goals (SDGs) integration, evidence-based education, global citizenship, translatory practice, active learning techniques, enhanced clinical placement experiences, and peer learning. A digital ecosystem has enormous pedagogical potential in research and innovation as well as in students' academic pursuits. However, a lack of knowledge about the essence, structure, and emergent qualities of the system complicates its production. A computer technique called virtual reality (VR) simulates an environment. It can produce a synthetic, computer-generated environment that people may interact with. In contrast to conventional user interfaces, virtual reality immerses the user in the experience. Users can engage with that thrilling 3D experience rather than only gazing at a screen in front of them. We will talk about this in this paper. Improving Research Assistance using Virtual Reference Networks

Keywords: *Research, Virtual Reference Ecosystems, Educational Institutions, Learning Ecosystem, Learning Organizations, Digital Age, Search Engines, Online Public Access Catalogues, Open Access, Emerging Technologies*

Introduction

Learning organizations are quickly changing the way they offer instruction and training. These adjustments are motivated by technology as well as pragmatic choices to quickly educate and teach a larger number of students. A deeper comprehension of best practices is required to assist decision makers more effectively.

A collection of web apps, tools, systems, and procedures that work together to support or improve any research activity both inside and outside of institutional borders is known as a virtual research environment (VRE). The creation and use of an information and data sharing concept where data sharing can be done by many media is the main concern of a VRE. Hardware and software components present additional technological issues and difficulties. Clear data ownership, a verified research project plan with data policies among the collaborators, distinct research aims and responsibilities, and a sufficient personnel resource for the IT management are all necessary for the successful usage of a VRE. The most crucial issue is that VREs should be viewed more as community-building initiatives than as technological ones. Scientific fields at all research levels benefit from VREs. Neither a "out-of-the-box-solution" nor a "one size fits all realizations" strategy can satisfy the requirements of every research endeavor. [1]

Using a VRE environment will speed up the release of research findings. Additionally, fresh lines of inquiry will be encouraged. VRE has a wide range of uses. Sustainability demands the same level of long-term dedication for long-term research as other project lifecycle infrastructure components. A collection of web apps, tools, systems, and procedures that work together to support or improve any research activity both inside and outside of institutional borders is known as a virtual research environment (VRE). The creation and use of an information and data sharing concept where data sharing can be done by many media is the main concern of a VRE. Hardware and software components present additional technological issues and difficulties. [2]

Clear data ownership, a verified research project plan with data policies among the collaborators, distinct research aims and responsibilities, and a sufficient personnel resource for the IT management are all necessary for the successful usage of a VRE. The most crucial issue is that VREs should be viewed more as community-building initiatives than as technological ones. Scientific fields at all research levels benefit from VREs. Neither a "out-of-the-box-solution" nor a "one size fits all realizations" strategy can satisfy the requirements of every research endeavor. Using a VRE environment will speed up the release of research findings. Additionally, fresh lines of inquiry will be encouraged. VRE has a wide range of uses. Sustainability demands the same level of long-term dedication for long-term research as other project lifecycle infrastructure components.

Information access, sharing, and consumption have all undergone significant change as a result of the digital era. Libraries have changed to accommodate users' demands for quick and easy access to a multitude of digital materials. Digitized

CONFLUENCE OF KNOWLEDGE
(A Multidisciplinary International Peer-Reviewed/Refereed Journal)
ISSN 2320–5237 | Volume 13, Issue 02, February 2026 (Special Issue)
http://cok.pratibha-spandan.org | © The Author(s) 2026

collections, online chat assistance, and virtual reference services are now standard. However, the incorporation of robots marks a significant advancement in the development of reference services, providing both quick access to information and the possibility of dynamic, customized interactions. According to Talaviya et al. (2020), robots are mechanical devices that use artificial intelligence (AI) techniques to automate jobs under direct human supervision or under a predetermined program and set of general principles. The incorporation of robots into reference services also signifies a revolutionary change in the way libraries interact with their patrons and offer information access. Librarians are investigating cutting-edge strategies to satisfy the varied and ever-changing demands of their clients as the digital landscape continues to change. Robots have emerged as prospective instruments to alter the role of reference services due to their automation, artificial intelligence, and human-like interaction capabilities. [3–4]

Evolution of Reference Services in the Digital Age

The way that libraries and information centers give access to information and help users navigate an increasingly complicated information ecosystem has changed dramatically as a result of the digital age. The major turning points and advancements in the development of reference services in the context of the digital age are examined in this section.

- *Proliferation of Electronic Resources:*Electronic resources, such as databases, scholarly publications, and digitized books, proliferated quickly with the onset of the digital age. By subscribing to these electronic resources, libraries were able to adapt and give patrons remote access to a multitude of information. Due to this change, reference services had to be extended online, where librarians helped patrons navigate these digital collections.
- *Online Catalogues and Search Engines:*Search engines and online catalogues, like Google and OPACs (Online Public Access Catalogues), have become indispensable resources for finding information. Digital interfaces, which allowed users to search for materials by keywords, subjects, and other metadata, replaced conventional card catalogues. Reference librarians took on the role of instructors, assisting users with efficient search tactics and assessing search outcomes.
- *The Development of Virtual Reference Services:* As the internet grew in popularity, libraries started providing virtual reference services via chat, email, and other online communication channels.
- *Initiatives for Digital and Information Literacy:* Libraries and information centers incorporated information literacy programs into their offerings after realizing the significance of digital literacy in the digital age.
- *Open Access and Open Educational Resources (OER):* The availability of open educational resources and the growth of open access publishing both occurred in the digital age.
- *The Problem of Information Overload:* Users encountered the problem of information overload as digital information was more widely available.
- *Integration of Emerging Technologies:* Artificial intelligence and chatbots are examples of emerging technologies that have been included into reference services in the digital age. [5]

Review of Literature

The basic understanding of how humans learn has not changed over the past few decades, despite the fact that technology has become a more significant part of the learning process. Learning is messy for humans; teaching and learning cannot occur in a sterile environment; learning is individualistic, sometimes spontaneous, but frequently very effortful, slow, and gradual, and it moves forward in fits and starts (Hattie, 2009). Learning organizations must be established to support the needs of the stakeholders, ensure that the right resources are allocated, and gain support from all stakeholders.It is crucial that teachers, instructional designers, and educational decision makers comprehend the best learning techniques and apply them to the best of their abilities and resources. [6]

As a crucial link between patrons and the extensive collection of information resources at their disposal, reference services have long been a mainstay of libraries and information centers. Robotic technologies are used by academic libraries in many different ways, such as chatbots, telepresence, autonomous shelfreading robots, and humanoid robots for reference services and circulation data maintenance (Tella, 2020). The function of reference librarians has changed in the digital age to include a variety of digital resources, online databases, and virtual help in addition to traditional print materials.Libraries are using cutting-edge technologies to address the changing requirements of their patrons in this dynamic environment, and robots are emerging as a promising tool to transform reference services. Robots are capable of responding to reference requests, particularly simple ones. These robots could include online chatbots (Blut et al., 2021). [7]

As the world entered the digital age, the conventional reference consulting service, which is the main activity of contemporary libraries, logically followed suit and evolved into the virtual reference consulting service (VRS) at the turn of

CONFLUENCE OF KNOWLEDGE
(A Multidisciplinary International Peer-Reviewed/Refereed Journal)
ISSN 2320–5237 | Volume 13, Issue 02, February 2026 (Special Issue)
http://cok.pratibha-spandan.org | © The Author(s) 2026

the century. In recent years, library users have been able to provide a thorough expert consultation for library retrieval, issue processing and distribution, issue process tracking, literature delivery, verifying evidence and citation, scientific and technological research, fixed-question services, such as online information service, via the network whiteboard, video conferencing, network call centers, voice over the Internet, email consulting, form consulting, etc. [8]

Objectives

- To Study the Enhancing Research Support Through Virtual Reference Ecosystems
- To Design structure of the library virtual reference service system
- To Services for a Virtual Research Environment (VRE)
- To Explain Virtual reality simulation based on virtual ecosystem model

Research Methodology

The study is exploratory in nature. The data used for preparing this paper are secondary in nature which is collected from the various published resources. The data derived for preparing this research paper has been extracted from various elite journals and relevant websites.

Result and Discussion

One of the college library's main businesses and a significant readers' service project is its virtual reference consulting service, which uses the reference information source through the network method to find, analyze, evaluate, and reorganize the information and provide knowledge service for college teachers and students. The library's information management and information services are determined by user demand. Figure 1 illustrates the connection between user demand and the library's virtual reference consultation service. [9]

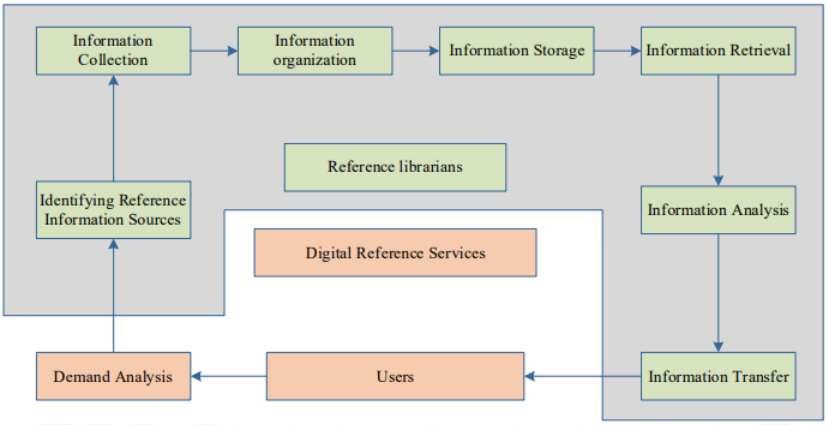

Figure 1. The relationship between user demand and library virtual reference service

College student readers' information demand patterns and service expectations have significantly changed as a result of the quick development of networked and digital information technology. Therefore, in order for college libraries to provide virtual reference consulting services and to better understand how to organize information resources as well as the issues and aspects that need to be improved in the service, they must first analyze and comprehend the actual needs of their patrons.

Figure 2 depicts the library virtual reference service system's general architectural structure.

1) Create a good extensible system and lower the coupling degree between each function to have a clear system structure. The design scheme used in the text consultation module and consultation desk administration is based on J2EE architecture and MVC design.

2) An electronic whiteboard. Make use of the repeated sharing approach, which entails giving a whiteboard client program to every client. The whiteboard client's activities are packaged and sent to the server in accordance with the developed whiteboard interaction information format protocol by the Applet, which is used on the client side to communicate with the whiteboard server on the server side. In order to ensure user consistency, the server parses the information package after receiving it and alerts other whiteboard clients to replicate the operation.

3) A method for synchronized browsing. Similar to the whiteboard, the system client uses the applet to communicate with the proxy server for synchronized browsing.

4) Retrieving Distributed Knowledge Bases. Distributed querying of the consultation desk's knowledge base is done in order to facilitate user queries and disseminate knowledge base records across businesses. [10–11]

CONFLUENCE OF KNOWLEDGE
(A Multidisciplinary International Peer-Reviewed/Refereed Journal)
ISSN 2320–5237 | Volume 13, Issue 02, February 2026 (Special Issue)
http://cok.pratibha-spandan.org | © The Author(s) 2026

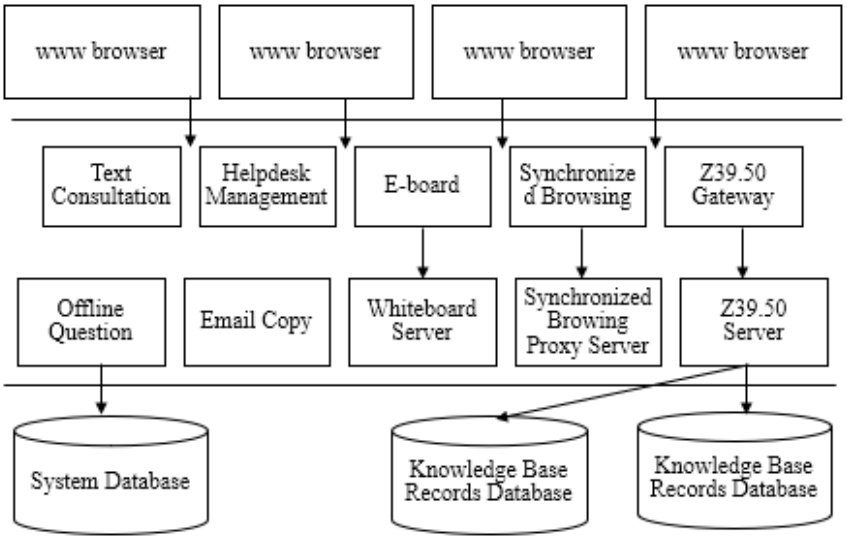

Figure 2. The overall design structure of the library virtual reference service system

VRE services

Several services are offered in a VRE environment, depending on the project objectives. A VRE's exterior view ought to be a distinct monolithic system with quick access. However, neither a complete self-development of a VRE nor a software tool that satisfies all the requirements for such a VRE is known (due to time, knowledge, and resource conflicts).

Table 1 provides a summary of some of the services included in a VRE. There is a lot of hidden labor between defining services and choosing apps. It takes years to test and assess every software component, several extensions, various versions, and the entire VRE system, including the web server software and hardware. [12]

Table 1. Services for a Virtual Research Environment (VRE)

VRE service	Characteristic
Access management	Single sign in for different applications
Communication	Web 2.0 elements like messaging, chat, forum, wiki
Data analysis	Data analysis tool, statistical methods
Data visualization	Visualization of information and datasets
Data warehousing	Complex data storage and data analysis
Decision support	Aggregated data for decision makers
E-learning	Platform for students with E-learning procedures
Event calendar	Internal and external community events
Group management	Groups-and rights management, organization for teams
Map and spatial data	Map-server, case area maps
Metadata management	Information about data
Mobile access	Optimized layout of webpages, augmented reality, access control
Monitoring	Real time monitoring of sensor data etc.
Project management	Project organization tools like tasks, milestones, workflow, reports
Project website	Flexible content management system (CMS)
Repository	Data repository and data storage, comprehension, indexing
Search engine	Global and local comfortable search engines
Social web	Facebook, Twitter integration, etc.
Search engine optimization	(SEO) ranking in top search engines like Google

System Architecture

Based on the virtual ecosystem model for environmental science education, Figure 3 depicts the system architecture of an immersive virtual reality simulation that includes simulation data, a simulation server, a virtual environment, and a data instrument. Model-based simulation and physical simulation are the two categories into which Winn et al. divided the

simulations used in science education. While physical simulations replicate the look of real-world phenomena exactly, model-based simulations simplify and abstract phenomena as much as possible to help students understand important ideas. Scientific visualization, for instance, is based on physical simulations that replicate real phenomena; in contrast, this study used a simplified model-based simulation set up for environmental education so that the students could comprehend the phenomena as easily as possible; these features do not align with the expected laws of physics but are new aspects of the virtual world that the students accept.

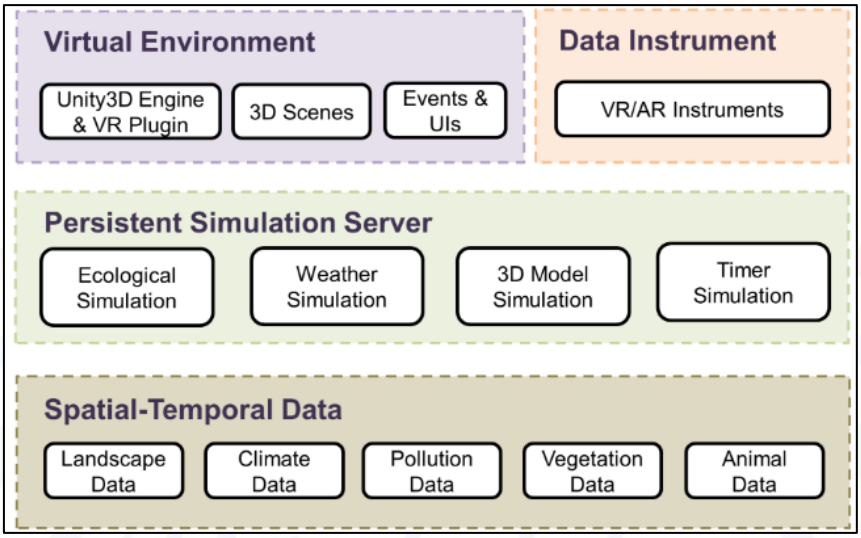

Figure 3. System architecture of virtual reality simulation based on virtual ecosystem model.

Simulation Data

The topography (i.e., 3D map models), climate and weather (temperature and humidity), pollution (CO2, N, P, O2, O3, and NaCl), vegetation (population of different plants), and animals (population of different animals) are all included in the virtual ecosystem simulation data. In order to allow the user to experience diverse spatial data according to time, this simulation data is based on temporal coordinates and matching geographical coordinates of various eras.

Simulation Server

The server in the virtual ecosystem simulation model has a database of environment configuration data and offers functions for data measurement, causality, spatiotemporal data linkage, and persistent world.

Virtual Environment

The server provides the virtual ecosystem data, which are subsequently set up and shown in the three-dimensional virtual environment to depict the virtual ecosystem. The landscape is displayed in this virtual environment by the derivation of 3D modeling parameters based on various environmental conditions within the virtual ecosystem.

Data Instrument

"The process of continuously observing and regularly measuring environmental parameters of a specific area in order to understand a phenomenon" is the definition of environmental monitoring. Environmental monitoring is crucial for data analysis related to nature and the environment in virtual or augmented reality. [13]

Conclusion

In order to determine the service objectives, design the library virtual reference service system operation objectives, construct the virtual reference service's overall structure, update the online consulting function module's design, and evaluate the impact of this virtual reference consulting service using the quality evaluation index, this paper integrates the user's demand for virtual reference services.

References

Anne G. Lipow: „ Serving the remote user: reference service in the digital environment". Keynote address at the Ninth Australasian Information Online & On Disc Conference and Exhibition. Sydney Convention and Exhibition Centre, Sydney Australia, 19– 21 January 1999.

Abdul Rahman, MohdHishamuddin, NoraffandyYahaya, and Noor Dayana Abd Halim. 2014. Virtual World for Collaborative Learning: A Review. Paper Presented at International Conference on Teaching and Learning in Computing and Engineering, Kuching, Malaysia, April 1–13.

Bailey, R. C., R. H. Norris, and T. B. Reynoldson. 2004. Bioassessment of freshwater ecosystems using the reference condition approach: Comparing predicted and actual benthic invertebrate communities in Yukon streams. Freshwater Biology 39:765-774.

ISSN 2320–5237 | Volume 13, Issue 02, February 2026 (Special Issue)
http://cok.pratibha-spandan.org | © The Author(s) 2026

Diane Nestor Kresh: „ Libraries Meet the World Wide Web: The Collaborative Digital Reference Service". ARL Bimonthly Report 219, December 2001.

Barbara Quint: „ QuestionPoint Marks New Era in Virtual Reference". Information Today, June 10, 2002.

Hattie J. (2009). Visible learning: A synthesis of over 800 meta-analyses relating to achievement. New York, NY; Routledge.

Blut, M.; Wang, C.; Wu¨nderlich, N.V. & Brock, C. (2021). Understanding anthropomorphism in service provision: a meta-analysis of physical robots, chat bots, and other AI. Journal of the Academy of Marketing Science, 49 (4) 632-658.

Qomariyah, A. N., & Kusuma, R. C. D. (2018). Analysis of e-mail transactions in virtual reference services. Record and Library Journal, 1(2), 105.

Biasutti, M.; Frate, S. A validity and reliability study of the Attitudes toward Sustainable Development scale. Environ. Educ. Res. 2017, 23, 214–230.

Rieckmann, M. Education for Sustainable Development Competencies for Educators. In Proceedings of the The Global Sustainable Technology & Innovation Conference (G-STIC), Brussels, Belgium, 20–22 November 2019.

Winn, W.; Stahr, F.; Sarason, C.; Fruland, R.; Oppenheimer, P.; Lee, Y.-L. Learning Oceanography from a Computer Simulation Compared with Direct Experience at Sea. J. Res. Sci. Teach. 2006, 43, 25–42.

Efrati, Valentina, Carla Limongelli, and Filippo Sciarrone. 2014. A Data Mining Approach to the Analysis of Students' Learning Styles in an e-Learning Community: A Case Study. Paper Presented at International Conference on Universal Access in Human-Computer Interaction, Heraklion, Greece, June 22–27.

Labrake, M. (2019). Getting your faqs straight: how to make your knowledgebase power virtual reference. Computers in Libraries, 39(8).