Indian Initiatives for Preserving and Protecting Ethnomathematics through Digital Means

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Abstract

Ethnomathematics refers to the mathematical practices, concepts, and problem-solving methods that are rooted in cultural traditions. In India, a rich history of indigenous mathematical knowledge has been passed down through oral traditions and community practices over generations. In recent years, several digital initiatives in India have sought to preserve and promote ethnomathematical knowledge by documenting indigenous mathematical concepts and making them more widely accessible through online platforms. In this note this study explores key digital initiatives and their challenges in India to preserve ethnomathematical knowledge through systematic documentation, raising awareness, capacity building efforts, and making indigenous mathematical concepts more accessible for contemporary use and integration with modern curriculum. For this study, a systematic literature review was followed to collect data by searching relevant scholarly documents based on the keywords, and a bibliometric analysis was conducted accordingly. The findings of this piece of study suggests that, though various organisations are working great with the help of technology in this regard, still Indian policy and civil society interventions needed to support knowledge preservation efforts, and further development of India's ethnomathematical heritage encompassing the ancient, indigenous knowledge traditions around mathematics in the diverse communities of the subcontinent by blending technology into the process.

Keywords: *Digital Means, Indian Initiatives, Preserving Ethnomathematics, Protecting Ethnomathematics,*

Introduction

Many people believe that we are living in the Digital Age, even if the phrase is debatable (Ginsburg, 2008). The ways that digital technology is changing are impacting Indigenous groups'

communication and traditional knowledge, posing new difficulties. It is important to think carefully about how to utilise these technologies in order to enhance their positive impacts and minimise their negative ones. Digital technology is assisting Native Indian tribes in documenting and disseminating their traditional knowledge to other Native Indian tribes, the global community, and forthcoming generations. These modern technologies give new methods to preserve traditional Aboriginal knowledge and traditions, even as they also pose new threats to Aboriginal cultural identity (Steeves, 2015).

Traditional knowledge, which is also known as Indigenous knowledge is highly related to a particular location and reflects how the indigenous group of people pursue themselves in relation to the environment (Semali, & Kincheloe, 1999). Basically, it is linked to the cultural heritage and integrated into cultural practices of an indigenous group of people.

Indigenous groups of people are very connected with their surroundings and their disciplinary knowledge also associates the natural environment locally as well as traditionally. Ethnomathematics is not only a mere subject but an important part of the Indigenous culture. It is both practical and as well as spiritual, not taught as a separate science but in combination with cultural engagement in the environment.

Ethnomathematics refers to the mathematical practices, concepts, and problem-solving methods rooted in cultural traditions. In India, there is a rich history of indigenous mathematical knowledge that has been passed down through oral traditions and community practices over generations. India has a rich and long tradition of contributions to mathematics over centuries, with many ideas and practices being developed regionally in various languages. This is referred to as the ethnomathematics heritage of the country. Indigenous knowledge is important because of its sustainability of the communities from which such knowledge originated as it is the root of daily living and hence it is needed to be preserved. But these days as community members gravitate to the urban civilization living their roots, it is becoming increasingly difficult to retain Indigenous knowledge even after several efforts made by different organizations to preserve intellectual property. Along with other mediums being taken for preserving and protecting indigenous knowledge a variety of digital technologies are being explored for preserving indigenous knowledge heritage.

Similarly with globalization, digitization, and declining emphasis on traditional knowledge systems, much of this ethnomathematical legacy risks being lost if not systematically preserved and, in this regard, Digital initiatives are playing an important role in documenting and preserving these ethnomathematical traditions before they disappear due to modernization and cultural homogenization.

In recent years, several digital initiatives in India have sought to preserve and promote ethnomathematical knowledge by documenting indigenous mathematical concepts and making them more widely accessible online ((Hunter, 2006). By harnessing digital tools for cultural preservation and interactive learning, these initiatives are underscoring the relevance of homegrown ethnomathematics for Indian education, science, and society - especially among marginalized groups like tribals, small farmers/fishermen, and traditional handicraft artisans in remote areas.

Objectives of the study

1. To find out the key ways to preserve and protect ethnomathematics through digital means.
2. To study the key digital initiatives in India that are preserving and protecting ethnomathematics.
3. To explore the opportunities and challenges faced by digital initiatives in sustainably safeguarding Indian ethnomathematics.

Methodology of the Study

The aim of the present study is to analyze the Indian initiatives regarding digital practices for preserving and protecting Ethnomathematics and the involved opportunities and challenges during the practices. This study is a type of literature review article which includes articles from 1999 onwards. The keywords for searching the research articles were: Ethnomathematics, Digital Initiatives, Preservation of Ethnomathematics, Challenges and Opportunities. The search engines used for literature review purpose are Research Gate and Google Scholar.

Result and Discussion

Objective 1: To find out the key ways to preserve and protect ethnomathematics through digital means

Digital documentation and archiving is one of the basic ways to protect and preserve ethnomathematics. Ethnomathematics Digital Library, which is an initiative by the University of Delhi, has created digital databases and repositories to store and organize ethnomathematical knowledge, artifacts etc. These repositories preserve a wide range of digital resources like images, videos, texts, and audio recordings that are linked to traditional mathematical games, practices, patterns, etc. For digitalizing rare manuscripts, historical texts, and documents containing important information related to traditional mathematical knowledge systems, several efforts have been made (Chahine & Naresh, 2021). This initiative is not only for preserving fragile resources but also to be easily accessible to the stakeholders.

Multimedia Documentation, multimedia technologies have been instrumental in documenting oral traditions and living practices related to ethnomathematics. There are few projects in India, as for example, Honey Bee Network, have utilised photography, audio, video to capture contextual information and cultural contexts surrounding Ethnomathematical Knowledge (Gupta, 2006). So, to not just the preservation of knowledge but also the cultural contexts in which it is embedded. As there exist few challenges, such as privacy concerns, obtaining informed consent from communities and addressing intellectual property rights (Lipka et al., 2021), so ethical guidelines and protocols should be followed for doing culturally sensitive documentation practices.

Online platforms and portals are dedicated to disseminating and sharing ethnomathematical resources. And also initiate collaboration for knowledge sharing among the researchers, educators and other academic communities to preserve and promote ethnomathematical knowledge. Initiatives like the Indian Ethnomathematics Digital Library, and Ethnomathematics India Portal provide access to digital collections, research materials, and other educational materials related to ethnomathematics (D'Ambrosio & Rosa, 2016).

Integrating Digital technologies in the creation of educational resources and integrating

ethnomathematics into formal and informal educational fields is quite mainstream. Homi Bhabha Centre for Science Education and community mathematics Centres have developed a few initiatives to not only preserve traditional mathematical knowledge but also to foster cultural appreciation and understanding among students by integrating it into the educational curricula. As for example, interactive lesson modules, digital lesson plans, simulations based on ethnomathematical practices (Gerdes, 2014).

Local communities and Indigenous knowledge holders play a great role to preserve and protect ethnomathematics. Digital technologies have facilitated this approach where the stakeholders involve in documenting and disseminating their mathematical knowledge and practices (Sharma, L. et al., 2021). This ensures cultural sensitivity, appropriate representation, and overall empowerment of the communities to preserve their heritage. But for the marginalised communities digital divide remains as a challenge. To address this challenges and disparities, training and support are utmost important for inclusive and equitable preservation of ethnomathematics (Chahine, 2016). 6The proper preservation and protection of ethnomathematics through digital means requires proper ethical considerations and intellectual property rights issues. The stakeholders must respect the ethical guidelines and protocols to document and disseminate the resources and also in addressing the cultural appropriation and misinterpretation for promoting ethical practices (Chahine, 2021).

Even after the fact that digital technologies offer various tools for preserving ethnomathematics but ensuring collection, long term preservation and sustainability is indeed a challenge. To prevent data loss and ensure uninterrupted access strategies for digital curation, migration and preservation are essential (Gerdes, 2021). Institutional support and funding models play a crucial role here.

Objective 2: To study the key digital initiatives in India that are preserving and protecting ethnomathematics

Here are some key digital initiatives in India that are aimed to preserve and protect ethnomathematics through their various projects.

One of the key digital initiatives that India has focused on Ethnomathematics is development of digital archives and repositories. The Ethnomathematics digital library (EDL) is such an effort taken by Delhi University in this regard. Since 2010, EDL aims to create a comprehensive digital repository of ethnomathematical knowledge, practices, and artifacts from different regions across India (Gerdes, 2014). This includes various texts, audios, images, videos etc related to traditional mathematical practices, games, patterns, and architectural designs.

Another notable initiative in India is Indian National Ethnographic Museum's digital collection. This digital collection, dedicated to provide access of the ethnomathematical artifacts and practices such as various mathematical tools, architectural designs, measurement systems from different cultural groups across India.

There are several projects in India that includes digital documentation of various ethnomathematical practices involving the oral traditions related to their cultural and traditional mathematical knowledge. The Honey Bee Network which is a collaborative initiative by the National Innovation Foundation (NIF) and the Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI), has considered the grassroots innovations including

traditional mathematical practices through audio, photography, video etc (Gupta, 2006).

The People's Resources Mapping and Documentation Centre (PRMDC) has also undertaken multimedia documentation projects, involving Mathematical practices related to different Indigenous communities' traditional crafts, architecture and measurement systems.

To facilitate the access of ethnomathematical resources, India has developed various online platforms and portals. An initiative by University of Delhi, named, The Ethnomathematics India Portal serves as a pivotal repository for digital resources like academic materials, research publications related to ethnomathematics (Rosa et al., 2016).

The Indian ethnomathematics Digital Library, developed by National Institute of Technology Rourkela is another online platform that disseminates and shares digital resources related to ethnomathematics (Chahine, 2021).

The Homi Bhaba Centre for Science Education (HBCSE) has been actively involved teacher training programs and in creating educational resources for the educational stakeholders (Gerdes & Travis, 2021).

To promote the integration of ethnomathematics into mathematics education, Community Mathematics Centre (CMC) has also developed digital resources and provides professional development programs with the aim to promote the integration of ethnomathematics into Mathematics education (Sharma, 2021).

Academic research projects and scholarly collaborations have played a vital role in analysing, documenting, and promoting ethnomathematical practices in India. Indian Statistical Institute, Indian Institute of Technology, Gandhinagar have undertaken research projects focused on ethnomathematics. They have taken such initiatives collaboratively with the local communities and Indigenous Knowledge holders (Chahine, 2016).

These research initiatives have contributed to a better understanding of the mathematical practices and knowledge systems practiced by different cultural groups of India and the procedure for preserving and protecting them.

Objective 3: To explore the opportunities and challenges faced by digital initiatives in sustainably safeguarding Indian ethnomathematics

Here are some of the key opportunities and challenges faced by digitization projects in sustainably safeguarding Indian ethnomathematics:

Opportunities
- Comprehensive digital documentation and archiving of ethnomathematical knowledge and practices through the creation of various online databases, repositories, platforms, and multimedia resources (Gerdes, 2010).
- Wide access and widespread dissemination of ethnomathematical resources have made researchers and other stakeholders to access and explore India's rich mathematical heritage (Rosa, 2016; Chahine, 2016).
- Digital technologies have enabled the development of educational resources related to ethnomathematics and the integration of ethnomathematics into the education system. In this way, ethnomathematical practices are incorporated into lesson plans, interactive modules, and teacher training programs (Gerdes, 2010; Sharma, 2021).

- Through digital platforms, various collaborative efforts have been made to facilitate collaboration and sharing resources among researchers (Chahine, et al., 2016).

Challenges

- The choice of technology regarding its safety, security and privacy is very vital to protect the right of the ethnomathematics of the indigenous group (Hunter, 2006). Ethical considerations related to intellectual property rights for disseminating sensitive information is essential for responsible and respectful digital preservation efforts (Chahine, 2016).

- Despite having various opportunities, digital technologies, and unequal access to technologies, into digital divide remains as significant barrier for remote and marginalised societies. For the sustainable preservation and protection of ethnomathematics ensuring equitable and inclusive access are very crucial.

- Long-term preservation and sustainability of digital resources which can be done through digital curation, migration, and preservation as well as robust funding models and institutional support are needed to prevent data loss and provide continued access to the ethnomathematical resources over time (Gerdes & Travis, 2021).

- To preserve ethnomathematics there is a need for active involvement, contribution, and participation of the local indigenous community and other stakeholders. By adopting participatory approaches and fostering community engagement through digital initiatives, cultural sensitivity, community empowerment preserving their traditional practices and heritage are ensured (Sharma., 2021).

- Rapid technological advancements like artificial intelligence, virtual reality, and augmented reality are becoming challenges for integrating them into ethnomathematics, even after there exists various technological tools for preservation. The use of digital technologies may also challenge traditional thoughts on ownership of knowledge, and this can result in a loss of stewardship by indigenous communities who are publishing content on the Internet (Ginsburg, 2008).

Thus, while digital technologies open up promising possibilities, conscientious design choices are vital for nurturing inclusive, participative, and ethically aligned digitization initiatives to sustain India's rich ethnomathematical legacies.

Major Findings of this Study

- This research study reveals that, Digital documentation and digital archiving, multimedia documentation, Online portals and Online platforms, Curriculum integration and other educational resources, Local community engagement and their participatory approaches, Addressing various disparities, following ethical considerations and intellectual property rights, strategies for long term preservation and sustainability are several key ways to preserve and protect ethnomathematics through digital means.

- This study finds that, the Ethnomathematics Digital library and the Ethnomathematics India Portal initiative by the University of Delhi, Indian National Ethnographic Museum's digital collections, a few projects like, The Honey Bee network, which is a collaborative initiative by the National Innovation Foundation (NIF) and the Society for Research and Initiatives

for Sustainable Technologies and Institutions (SRISTI), initiatives by The People's Resource Mapping and Documentation Centre (PRMDC), the Indian Ethnomathematics Digital Library under NIT Rourkela, Homi Bhaba Centre for Science Education (HBCSE), The community Mathematics Centre, etc. are a few key digital initiatives in India that are preserving and protecting ethnomathematics.

- The result of this piece of research shows that a few opportunities for digital initiatives are comprehensive documentation and archiving of ethnomathematical knowledge, increased accessibility and dissemination in online platforms and portals, development of educational resources and the integration of ethnomathematics into informal and formal educational sector, increased collaboration and knowledge sharing among academic community and stakeholders etc. A few challenges also identified, those are access barriers because of digital divide, maintaining ethical considerations and intellectual property rights for ensuring culturally sensitive representations, adopting techniques for maintaining ethnomathematical practices and safeguarding are quite tedious task.

Suggestions and Recommendations

Based on the findings, the researchers have recommended a few suggestions to the Stakeholders for ensuring the sustainable safeguarding of Indian ethnomathematical practices through digital initiatives, are as follows:

- *Community participation:* Actively engage indigenous communities in documenting their ancestral mathematical ideas rather than extraneous digitization. Build local capacities for self-documentation. This enhances contextual accuracy and ownership.

- *Culturally responsive technologies:* Choose digital formats and platforms aligning with traditional knowledge transmission modes. Oral narratives are better captured through digital video than textual documents for instance.

- *Linguistic localization:* Support multilingual interfaces with local dialect options for digitization projects to reach ethnic groups conversant mainly in vernacular languages.

- *Sustainable funding models:* Petition public funding by framing heritage preservation outcomes. But also showcase contemporary relevance of digitized ethnomathematics content to attract private investors eyeing future commercial applications.

- *Intellectual property sensitivity:* Mandate collective community consent before digitizing and disseminating traditional knowledge for balancing open access with preventing exploitative appropriations, misrepresentations, or patenting.

- *Iterative digitization:* Chart out iterative digitization schedules spanning decades rather than one-time efforts. This allows responding to regular technology shifts via format migrations and feature enhancements.

- *Intergenerational knowledge transfer:* Digitization should complement not isolate traditional interpersonal apprenticeship of mathematical ideas. Blend digitally archived concepts with in-person learning.

- *All-round accessibility:* Broaden access to digitized collections via text translations, audio descriptions, and multi-modal embodying for usage by differently abled as well.

Adopting these supportive, people-centric, and culturally integrated guidelines in digitization initiatives can help sustainably uphold both the technological preservation as well as

living essence of India's rich ethnomathematical legacy for posterity.

Conclusion

It is undeniable that digital initiatives have opened up several opportunities to collect, preserve and safeguard Indian ethnomathematics. Various efforts are being made and practiced in India, however these initiatives also have several opportunities and also face various challenges. For future generations, In this regard, digital initiatives can play a vital role in sustainably safeguarding India's ethnomathematical heritage by addressing those challenges and maximizing the opportunities through integrating emerging technologies.

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