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Structural quality assesment of the villagemath instructional content platform

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Abstract

Background: The integration of culturally-based mathematics education is vital for making learning meaningful and relevant. The VillageMath platform was developed as a web-based ethnomathematics instructional content repository to address this need.
Aims: This study aims to evaluate the structural quality of the VillageMath educational intervention, focusing on its navigation, structure, and appearance.
Method: The study employed a developmental research design, involving 341 pre-service and in-service mathematics teachers in Benue State, Nigeria. The VillageMath platform was developed using WordPress Version 5.4, hosted online at https://VillageMath.net, on a Linux OS server with cPanel v80.p (Build 20), Apache Version 2.4.39, PHP Version 5.6.40, and MySQL Version 5.7.26. The Web-based Ethnomathematics Instructional Content Repository Assessment Questionnaire (WEICRAQ) was used as the research instrument. Data were analyzed using mean and standard deviation to answer three research questions regarding the quality assessment of the web tool.
Results: The analysis revealed that both pre-service and in-service mathematics teachers rated the VillageMath platform highly in terms of navigation, structure, and appearance.
Conclusion: The findings indicate that VillageMath is a structurally sound platform that can be utilized by mathematics teacher educators in higher education institutions. The platform serves as a reliable tool for promoting narratives in ethnomathematics and provides a forum for experts to share and develop innovative pedagogical strategies, particularly those highlighting African indigenous knowledge systems.

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INTRODUCTION

Digital technologies are significantly enhancing modern education by serving as a conduit for instructional content. Quantifiable successes in this domain include ICT-based instructional approaches, open and distance learning (ODL) implementations, online instructional repositories, and the distribution of open educational resources (OERs) (Iji & Abah, 2018). A prominent example in ODL is the Massive Open Online Courses (MOOCs), designed to accommodate a large number of participants. MOOCs can be accessed globally by anyone with an internet connection, require no entry qualifications, and provide a complete online course experience for free (Home & OpenupEd, 2015). Online instructional repositories and OER platforms facilitate conversation and collaboration within the mathematical community. In these online learning environments, tools such as email, bulletin boards, forums, chat groups, and conferencing bridge diverse interactions (Holzl in Iji & Abah, 2018). The advent of new technologies, such as virtual classrooms and social media, enables the replication of technology-based mathematical experiences both inside and outside the classroom (Hofmann, 2014), particularly through the design of web-based applications (WebApps).

Design is a creative activity where user requirements, business needs, and technical considerations converge to formulate a high-quality product or system. WebApp design results in products that integrate aesthetics, content, and technology. According to Pressman (2005), WebApp design involves six major steps driven by information gathered during analysis modeling, each contributing to the overall quality of the WebApp. The first step, interface design, details the

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structure and organization of the user interface, including screen layout representation, interaction mode definitions, and navigation mechanism descriptions (Li et al, 2020). Aesthetic design, also known as graphic design, determines the "look and feel" of the web-based tool, encompassing color schemes, geometric layout, text size, font, and placement, as well as the use of graphics and related aesthetic decisions (Gong & Fang, 2023). Content design establishes the layout, structure, and outline for all content presented in the WebApp, creating relationships between content objects. Navigation design represents the flow between content objects and WebApp functions. Architecture design identifies the overall hypermedia structure of the web-based tool. The final step, component design, develops the detailed processing logic needed to implement functional components within the WebApp. These activities adhere to key design goals, including simplicity, consistency, identity, robustness, navigability, visual appeal, and compatibility (Pressman, 2005).

Currently, numerous mathematical content repositories exist on the World Wide Web (WWW), but only a few are dedicated specifically to culture-based mathematics education. Conventional platforms such as Math.com, Mathplanet.com, BasicMathematics.com, Mathplayground.com, SOSmath.com, and Youcubed.org offer a broad range of content, including blog articles, mathematical games, videos, teacher guidelines, student workbooks, and mock tests. These sites also provide additional services like mathematics tutoring, specialized curricula, consultancy services, and marketing of educational products, targeting teachers and students across various educational levels. Some of these platforms require users to register as either students or teachers to access full functionality. In contrast, a culture-based mathematics education repository grounds mathematics instruction and student learning in the values, norms, knowledge, beliefs, practices, experiences, and language foundational to an indigenous culture. Ethnomathematics educational resources incorporate the five key elements of language, family and community, context, content, and data and accountability (Kanaiaupuni, 2007). Such tools use native or heritage languages and actively involve family and community in their development, daily learning, and leadership. They structure the presentation context in culturally appropriate ways, ensuring learning is meaningful and relevant through culturally grounded content and assessment. Additionally, these systems gather and maintain data to ensure progress in culturally responsible ways.

Using the principles of culture-based mathematics education, several research efforts have explored blended technologies for learning within a local cultural context. Vainio, Walsh, and Varsaluoma (2014) examined the impact of culturally sensitive issues in the design of a mobile mathematics learning service in a longitudinal study involving over thirty South African schools over three years. The platform, developed as part of Nokia Mobile Mathematics, utilized SMS-based applications, a mobile browser, and a mobile social network, MXit, to deliver learning content, including bookwork with content explanations, examples, exercises, homework questions, and competitions. Within this project, teachers could use the exercise bank and theory for in-class teaching and follow-up, analyzing and monitoring students' progress. Vainio et al. (2014) identified both subjective and objective culturally dependent issues related to the content, context, infrastructure, and technology of the platform, with localization enhancing user experience and supporting learning.

Similarly, Katmada et al. (2014) focused on the design, implementation, and evaluation of an online game for elementary and middle school mathematics, which redefined the flexibility, adaptability, and usability of web-based gaming tools. In a related study, Govaerts et al. (2015) reported on the development of the Go-Lab Tutoring Platform, which offers teachers an online peer assistance and knowledge-sharing environment. The results of the prototype demonstrated the platform's potential to support teachers in integrating online labs into the classroom. The study evaluated incentives to motivate teachers and tutors, suggesting a potential business model involving various stakeholders, including ministries of education, teacher professional development organizations, and the STEM teacher community. Other studies aimed at creating learning environments for indigenous students through culture-based mathematics modules have concluded that such implementations can motivate students' interest in learning mathematics and enhance their initiatives in the classroom (Yao, 2016; Ofoegbu et al., 2014; Garmpis, 2011; Kartam & Al-Rashaid, 2002; Jung et al., 2001).

Despite the prospects of culture-based instructional design and the enormous benefits accruable from optimal blends of culture and technology, there is a scarcity of research attempts on

the ethnomathematical approach from within Nigeria. Phenomenal works such as Abah (2017), Iluno and Taylor (2013), Kurumeh et al. (2012), and Yusuf et al. (2010), though robust in the ethnomathematical sense, fell short of extending culture-based solutions to the cyberspace. Considering the fact that present-day students are a new genre of students with learning needs vastly different from their predecessors (Thomas, 2011) and live in a culture of learning, leisure and social interaction (Iji et al., 2017), current research efforts need to explore the intricacies of using technology to give voice to indigenous knowledge systems in Mathematics education. Such research intervention in Mathematics education should basically prepare teachers to become innovative Mathematics instructors, professionally prepared to communicate Mathematics to learners at all levels (Iji et al., 2018), particularly in the context of the life and culture of the people of Benue State, Nigeria.

The late General Murtala Muhammed, the then Head of State of Nigeria, created Benue state on 3rd February, 1976 along with six other states, when he increased the number of states from 12 to 19. The creation of Benue State was the conclusion of decades of agitation by the people of the Benue Valley to carve for themselves an identity, separate from that of the people of the Plateau (Gbor, 2004). Some of the people that inhabited Benue state at its creation as a state migrated to the area and existed as the powerful Kwararofa Kingdom which lasted till about the 17th century when it collapsed following severe military campaigns from the emerging Borno Empire. Its fragmented groups disintegrated from the economic and political cohesion of the Jukun leadership and migrated in different directions. The Idoma, Igala and Etulo to mention a few, are a product of this scenario (Gbor, 2004).

The Bassa-Komo and Bassa-Nge, like their kith and Kin, the Nupe, may have probably fled from the turbulence caused by the invading Fulani Jihadists, crossed the Benue to settle where they live today. The Tiv, a people of the Semi-Bantu stock who are believed to have migrated from the Congo Basin to the west of Cameroon between 1750 and 1800 finally arrived in the Benue valley by 1800 (Gbor, 2004). Since the communities that made up the Apa Kingdom were in a state of turmoil, it was easy for the arriving Tiv to fight their way into the land until they reached the banks of the Benue. By 1800 all the people who inhabited what later became Benue State had settled down and learnt to co-exist with one another, establishing unique ways of life (Gbor, 2004). The people of Benue State are known for their rich cultural practices, in arts, agriculture, language, dance, music, festivals and games (Abah, 2018b). Mathematics educators in Benue State have been leveraging on this rich cultural milieu to humanize the teaching and learning of mathematics across various educational levels. Diverse cultural artefacts and practices in everyday life of Benue people constitute valuable resources, illustration, adoption and adaptation within the mathematics classroom.

In terms of systematic research into the ethnomathematics of the people of Benue State, The Mathematical Heritage of the Tiv (Adaaku, 1982) and A Comparative Study of Mathematics Concepts and Skills Possessed by Tiv and Idoma Unschooled Children in Benue State, Nigeria (Tarbo, 1987) are the earliest reported works in available literature. Both works are unpublished project works from the Ahmadu Bello University, Zaria, Nigeria. Like other theses in their class (Kurumeh, 2004), the full texts of these pioneering works are not available in public open access archives, resulting in the eventual loss of their original content in contemporary ethnomathematics research. However, much more recent works have continued to showcase the beauty of Mathematics of the Benue people.

A study carried out in education Zone B of Benue State, for instance, deployed a form of ethnomathematics teaching approach by taking the students out of class to practically undertake some culturally loaded activities like house roofing and planning farm layout (Achor et al, 2009). Specifically, students were made to roof houses, layout some farms and in the process take measurements to be further used in calculation, focusing on locus, straight line, circle, ellipse, trajectories and parabolic shapes. The outcomes of the study revealed that students exposed to the culture-based approach were superior in achievement and retention than those taught with conventional approach (Achor et al, 2009). Similar outcomes were reported by Kurumeh et al. (2012) when students were taken out to practically undertake some traditional ways of data collection using counting sticks, stones and other materials from school playground and home environment.

From the perspective of language, another unique study from Benue State deployed Tiv language in the presentation of mathematics lessons to 230 students of Tiv origin from six secondary schools in Zone B of Benue State (Anyagh et al., 2016). The findings of the study showed that the

students taught using Tiv language only performed better than those taught using English language only, with even those in the urban schools performing better than those in the rural areas (Anyagh et al., 2016). This striking outcome highlights the benefits that accrue to children who are exposed to very rich oral language backgrounds in their mother tongue, in learning a second language and in studying Mathematics and other subjects (Dankaro & Agoom, 2015).

Another recent study adopts a simple survey research design to explore the extent of storytelling usage by mathematics teachers at the Basic education level in Benue State, Nigeria (Abah et al., 2018). The investigation was conducted on the premise that traditional folktales are heading down the path to extinction and are steadily being blown away in the wind of change being fanned by increasing technology penetration in the country. Thematic analysis of stories described by mathematics teachers drawn from Benue State showed that stories were used to illustrate learning points and motivate learners to action within the instructional context. Abah et al. (2018) reported specific patterns of stories that are far from local folktales and oral traditions, with a propensity among Benue mathematics teachers to use storytelling in their future teaching practice.

Evidently, ethnomathematics researches are coming to the front burner within the mathematics education community in Benue State. The imperative to revisit culture-based educational approaches is higher now than ever considering that folklore is disappearing fast with the incursion of modernity, to the extent that many Nigerian youths have lost touch with their ethnic folklore and culture (Ezeigbo, 2013). The use of ethnomathematical artefacts from within students' culture and previous knowledge contributes greatly to students' learning process, help them better understand the study material, raise their motivation and ultimately, improve their achievement in Mathematics (Fouze & Amit, 2018).

In light of the promise of individualized learning available through a widely connected educational cloud, there is a need for a custom-made, web-based product for mathematics education practitioners in Benue State, Nigeria. Such a product must be designed with respect to the cultural foundations of mathematics, particularly referencing the indigenous people of Benue State. Although future enhancements may extend to Nigeria, Africa, and globally by incorporating multicultural and diverse components, these specific needs form the basis of this study on developing a web-based ethnomathematics instructional content repository. This tool aims to be a comprehensive reservoir of online resources tailored to the peculiarities of mathematics education in Benue State, Nigeria. The repository is intended to collect digital content rooted in the culture of the various ethnic groups living in Benue State. Specifically, the digital contents of this repository will include instructional articles, crowd-sourced blog articles, culture-based teaching approaches and lesson plans, instructional procedures for incorporating local artifacts into mathematics instruction, adaptations of local mathematical games, community-based forums, social media, and links to other mathematics instructional platforms. The development of the online repository aims to showcase the beauty of the mathematics surrounding students and to draw the attention of in-service and pre-service mathematics teachers to pedagogies that effectively integrate everyday mathematics into classroom practice. The repository targets making mathematics more realistic, particularly within the cultural context of Benue State, North Central Nigeria.

With such a powerful tool in place, there is the concern of quality assessment. Quality in web-based tools, relates to customer satisfaction and also with the level of accomplishment of user expectation when interfacing a website. In this regard, quality captures perceptual aspects likely to be involved in human-website interaction. These aspects focus on the affective and cognitive royalty of a site and are subjectively assessed by the user community. Such focus on quality maps to user satisfaction assessment and contributes to the emergence of website quality as an aggregate composite that brings together formal metrics and perceptual user traits (Moustakis et al., 2004). By collecting various web analytics metrics, such as number of visits and visitors, and visit duration, one can develop Key Performance Indicators (KPIs) – a versatile analytic model that measures several metrics against each other to define visitor trends (Booth & Jansen, 2010). KPIs use these dynamic numbers to get an in-depth picture of visitor behaviour on a site, allowing web-based educational platforms to align their websites' goals with their intentions for the purpose of identifying areas of improvements, promoting popular parts of the site, testing new site functionality and ultimately making the desired impact.

Web quality is a complex concept, thus its measurement is expected to be multi-dimensional in nature (Aladwani & Palvia, 2002). The scientific literature identifies several aspects or criteria of quality, often categorized into navigation, design and structure, and appearance and multimedia (Moustakis et al., 2004). Content reflects the quality, completeness, degree of specialization or generalization, and reliability of the information included on the website. Navigation reflects the support provided to the user when moving around the site, while structure and design incorporate aspects that affect the order of presentation, speed, and browser compatibility (Moustakis et al., 2004). Appearance and multimedia capture aspects related to the site's "look and feel," with special emphasis on state-of-the-art graphics and multimedia artifacts (Lavie & Tractinsky, 2004; Moustakis et al., 2004). However, there are no specific studies assessing these web quality aspects within the context of culture-based mathematics instructional design, a gap that this present study intends to fill.

It is against this background that this study embarks on the design, implementation and assessment of a web-based ethnomathematics instructional content repository for pre-service and in-service Mathematics teachers in Benue State, Nigeria. While seeking to draw attention of key stakeholders in the Mathematics education sub-sector to the Mathematics embedded in the culture, traditions and daily practices of the people of the Benue valley, this work reports the conception, development and growth of a web-based resource for all categories of practitioners in Mathematics teaching and learning. This effort entails inquiry into the perception of pre-service mathematics teachers and in-service mathematics teachers on the quality of the web-based ethnomathematics instructional content repository in terms of the five website quality assessment criteria of contents, navigation, structure and design, appearance and multimedia, and uniqueness.

RESEARCH OBJECTIVES

The core objective of this study was to develop and assess a web-based ethnomathematics instructional content repository for pre-service and in-service Mathematics teachers in Benue State, Nigeria. Specifically, the study seeks to:

1. Find out the extent to which pre-service and in-service Mathematics teachers in Benue State rate the quality of the web-based ethnomathematics instructional content repository in terms of navigation.
2. ascertain out the extent to which pre-service and in-service Mathematics teachers in Benue State rate the quality of the web based ethnomathematics instructional content repository in terms of structure.
3. determine the extent to which pre-service and in-service Mathematics teachers in Benue State rate the quality of the web-based ethnomathematics instructional content repository in terms of appearance.

RESEARCH QUESTIONS

The following questions guide this study.

1. To what extent do pre-service and in-service Mathematics teachers rate the quality of the web-based ethnomathematics instructional content repository in terms of navigation?
2. To what extent do pre-service and in-service Mathematics teachers rate the quality of the web-based ethnomathematics instructional content repository in terms of structure?
3. To what extent do pre-service and in-service Mathematics teachers rate the quality of the web-based ethnomathematics instructional content repository in terms of appearance?

METHOD

Research Design

The study utilized a developmental research design, a process that combines design and scientific methods to allow researchers to generate useful products and effective theories for solving individual and collective educational problems (Easterday et al., 2014). This approach is particularly suitable for design-based research, including studies of instructional design and development

(Diedrich et al., 2023), specifically for the development and assessment of instructional interventions such as VillageMath. The specific development model adopted for the study is the Cleanroom Software Engineering Model (Mills et al., 1987). This model integrates conventional software engineering modeling, program verification (correctness proofs), and statistical software quality assurance (SQA) into a technique that can produce extremely high-quality software products. The Cleanroom Software Engineering Model emphasizes building correctness into software during its development, differing from the classic cycle of analysis, design, coding, testing, and debugging (Linger, 1994).

Participants

The study was conducted in Benue State, Nigeria, involving a population of 2,981 pre-service mathematics teachers (mathematics education students) from universities and colleges of education in Benue State, as well as in-service mathematics teachers at the Basic and Secondary Education levels across the state (Benue State Ministry of Education, Science and Technology, 2019, and Examination Office Records, 2019). A sample of 341 pre-service and in-service mathematics teachers was selected using purposive sampling of registered users of the VillageMath platform. The sample size was determined using the Krejcie and Morgan (1970) table for sample determination.

Instrument

The instrument for data collection was the Web-based Ethnomathematics Instructional Content Repository Assessment Questionnaire (WEICRAQ). The WEICRAQ is a 4-point scale (benchmark = 2.50) user experience questionnaire adapted from several existing measures of website user experience, including the Measure of Perceived Visual Aesthetics of Websites (Lavie & Tractinsky, 2004), WebQual Measure of Website Quality (Loiacono et al., 2002), Multi-dimensional Scale for Measuring User-perceived Web Quality (Aladwani & Palvia, 2002), Measure of User's Perceived Portal Service Quality (Kuo et al., 2005), Standardized User Experience Percentile Rank Questionnaire (SUPR-Q) (Sauro, 2015), and Scale to Measure the Interactivity of Websites (Liu, 2003). The instrument's validation involved two experts in mathematics education, two experts in measurement and evaluation, two pre-service mathematics teachers, two in-service mathematics teachers, two computer science experts, one ICT expert, and a digital technology critic. Reliability analysis of the WEICRAQ from trial testing yielded a Cronbach's alpha coefficient of 0.98.

Analysis Plan

The WEICRAQ was administered online using JotForm. Data collected were analyzed using descriptive statistics. Research questions one to three were answered by analyzing the WEICRAQ responses using mean and standard deviation.

RESULTS AND DISCUSSION

The presentation of data analysis and interpretation of results for this study was done according to the research questions.

Research Question One

To what extent do pre-service and in-service Mathematics teachers rate the quality of the web-based ethnomathematics instructional content repository in terms of navigation?

Table 1: Navigation Mean Scores of Pre-Service and In-Service Mathematics Teachers

		Pre-Service (N = 241)			In-Service (N = 100)		
S/No.	**Item**	**Mean**	**SD**	**Remark**	**Mean**	**SD**	**Remark**
1*	Accessing information on *VillageMath*.net is difficult.	3.34	0.74	High	3.02	0.95	High
2	Hyperlinks on the website are valid.	3.18	0.81	High	3.57	0.49	High
3	Information category on the website is simple and straightforward.	3.53	0.62	High	3.47	0.74	High
4	Learning to operate the website is easy.	3.71	0.45	High	3.53	0.50	High
5	Links on the *VillageMath*.net platform lead to instantaneous information.	3.28	0.66	High	3.34	0.69	High

S/No.	Item	Pre-Service (N = 241) Mean	SD	Remark	In-Service (N = 100) Mean	SD	Remark
6	Mathematics teachers are able to find what they need quickly on this website.	3.32	0.67	High	3.29	0.69	High
7	Mathematics teachers visiting the *VillageMath*.net website are able to obtain the information they want without any delay.	3.15	0.68	High	3.41	0.77	High
8*	The layout available on *VillageMath*.net makes it difficult to navigate the platform.	2.90	0.77	High	3.18	0.55	High
9	The site exhibits easy orientation for different devices and browsers.	3.38	0.69	High	3.24	0.69	High
10	The *VillageMath*.net website has adequate search facilities.	3.32	0.71	High	3.37	0.79	High
11	The website has many interactive service features such as comments, contact, and forum that can be easily accessed.	3.23	0.78	High	3.51	0.64	High
12*	The website *VillageMath*.net is not available all the time.	3.29	0.88	High	2.95	1.12	High
13	Web pages on *VillageMath*.net load fast.	3.35	0.78	High	3.58	0.69	High
	Cluster Mean	**3.31**	**-**	**High**	**3.34**	**-**	**High**

*Scoring for negative items are reverse-coded

The results in Table 1 indicate that pre-service and in-service mathematics teachers rate *VillageMath* high in terms of navigation, considering the high cluster mean of 3.31 and 3.34 for Pre-Service Teachers and In-Service Teachers respectively. Both means are above the benchmark of 2.50.

Research Question Two

To what extent do pre-service and in-service Mathematics teachers rate the quality of the web-based ethnomathematics instructional content repository in terms of structure?

Table 2: Structure Mean Scores of Pre-Service and In-Service Mathematics Teachers

S/No.	Item	Pre-Service (N = 241) Mean	SD	Remark	In-Service (N = 100) Mean	SD	Remark
1	Information structure on *VillageMath*.net reflects order and togetherness of information.	3.34	0.68	High	3.29	0.71	High
2	Links to share topics from *VillageMath*.net to different social media platforms (such as twitter and facebook) makes the site desirable.	3.39	0.67	High	3.34	0.62	High
3	Services on *VillageMath*.net is easy to locate.	3.30	0.72	High	3.32	0.69	High
4	The availability of discussion forums on *VillageMath*.net makes the platform professional for mathematics teachers.	3.42	0.60	High	3.65	0.47	High
5	The site has a simple background schemes.	3.41	0.64	High	3.31	0.61	High
6*	The site is not adaptable to all devices and screens.	2.75	0.95	High	2.40	1.03	Low
7	The structure of the website shows originality in design.	3.57	0.49	High	3.62	0.48	High
8	The user authentication feature of *VillageMath*.net provides additional security for mathematics teachers on the platform.	3.26	0.62	High	3.52	0.71	High
9	The *VillageMath*.net site is responsive in providing information in real time conditions.	3.32	0.71	High	3.54	0.64	High
10	The *VillageMath*.net website has a functional sitemap.	3.27	0.57	High	3.28	0.55	High
11	The website has a fast loading speed.	3.46	0.52	High	3.60	0.58	High
12	The website is compatible with different web browsers.	3.47	0.64	High	3.62	0.48	High
13	Visiting the site does not require any specialized software.	3.47	0.62	High	3.34	0.57	High
	Cluster Mean	**3.34**	**-**	**High**	**3.37**	**-**	**High**

*Scoring for negative items are reverse-coded

The results shown in Table 2 indicate cluster means of 3.34 (Pre-Service Teachers) and 3.37 (In-Service Teachers) which are higher than the benchmark of 2.50. This implies that pre-service and in-service mathematics teachers rate *VillageMath* high in terms of structure.

Research Question Three

To what extent do pre-service and in-service Mathematics teachers rate the quality of the web-based ethnomathematics instructional content repository in terms of appearance?

Table 3: Appearance Mean Scores of Pre-Service and In-Service Mathematics Teachers

		Pre-Service (N = 241)			In-Service (N = 100)		
S/No.	**Item**	**Mean**	**SD**	**Remark**	**Mean**	**SD**	**Remark**
1	The appearance is gratifying with each visit to *VillageMath*.net	3.11	0.65	High	3.02	0.82	High
2	The combination of image, voice and video on the site are appropriate.	3.24	0.64	High	3.48	0.50	High
3*	The display pages within the website are not easy to read.	3.10	0.93	High	2.93	0.77	High
4	The placement of graphics within articles on *VillageMath*.net makes the articles more attractive for reading	3.43	0.64	High	3.67	0.61	High
5	The *VillageMath*.net website looks organized.	3.34	0.62	High	3.44	0.63	High
6	The *VillageMath*.net website uses multimedia features properly.	2.98	0.71	High	3.05	0.93	High
7	The website has a clean and simple presentation.	3.20	0.57	High	3.62	0.63	High
8	The website labels are easy to understand.	3.05	0.78	High	3.49	0.64	High
9*	The website looks unattractive.	3.32	0.78	High	3.14	1.02	High
10	The website uses colours properly.	3.07	0.59	High	3.12	0.71	High
11	The website *VillageMath*.net uses fonts properly.	2.97	0.77	High	3.05	0.81	High
12	Web pages on *VillageMath*.net are visually attractive	3.34	0.61	High	3.47	0.59	High
	Cluster Mean	**3.18**	**-**	**High**	**3.29**	**-**	**High**

*Scoring for negative items are reverse-coded

In Table 3, the result shows that pre-service and in-service mathematics teachers rate *VillageMath* high in terms of appearance, considering the high cluster means of 3.18 and 3.29 which are above the benchmark of 2.50.

DISCUSSION

The outcome of this study in Table 1 indicates that pre-service and in-service mathematics teachers rate *VillageMath* high in terms of navigation. Navigation entails the support provided to users when moving in and around a web platform (Moustakis *et al.*, 2004). High quality of navigation translates to fast loading web pages, responsive links, adaptability to different devices and browsers, adequate search facilities, and interactive layout. Unlike the challenges reported by Arroyo, Hornos and Montes (2007), the high rating given the *VillageMath* instructional content platform points to a generational leap in the capability of modern technologies used in the design of this repository. Also the *VillageMath* design deploys underlying technologies similar to those reported by Charles and Babatunde (2014), but without specific focus on course delivery, and real-time synchronous class activities. In contrast, *VillageMath* is basically a resource hub and not a certification environment. Instructional activities for users, particularly pre-service and in-service mathematics teachers, are designed to be consumed in an asynchronous mode with all necessary provision for feedback and user support as attested to in Table 1. While on the platform, teachers are able to reflect upon their ideas before sharing them as threaded discussions, leading to more reflective responses and in-depth learning.

Findings in Table 2 indicate a cluster means of 3.34 and 3.37 which are higher than the benchmark of 2.50, implying that pre-service and in-service mathematics teachers rated *VillageMath* high in terms of structure. Moustakis *et al.*, (2004) defines the structure of a web platform as aspects that affect speed, order of presentation, and browser compatibility. Pre-service and in-service mathematics teachers agreed that the information structure of *VillageMath* reflects order and togetherness of information. Again, this design feature was made possible through WordPress' utilization of themes. The use of WordPress themes clearly distinguishes the designed instructional platform from those reported by Jung, Jun and Gruenwald (2001), Kartam and Al-Reshaid (2002) and Garmpis (2011). The availability of discussion forums on *VillageMath* makes the platform structurally professional for mathematics teachers and educators. This professionalism is further

aided by links for sharing topics from the platform to social media platforms such as WhatsApp, Telegram, Facebook, Twitter, and LinkedIn, since teachers and educators can extend their professional points of views to other stakeholders within the mathematics education sub-sector (Abah, Age & Okoronkwo, 2018).

Results in Table 2 delivers serious positive implications for the platform's visibility on the Internet. A vital aspect of Search Engine Optimization (SEO) strategy is site structure. The structure of the web platform shows search engines which pages of the site are most important. This implies that the site structure influences which articles will rank the highest in related search results on search engines. The result on structural quality of *VillageMath* is in line with Van de Rakt (2018) assertion that site structure implies how the websites content is organized. The *VillageMath* Repository consists of content of related topics, presented on posts and pages. The unique structure of the platforms handles how the content is grouped, linked and presented to the site's visitor. In this structure, users find their way more easily and search engines can index the platform's URLs. In addition, taxonomies like categories and tags, internal links and navigation toggles available on the platform all redirect traffic to https://*VillageMath*.net.

The outcome in Table 3 shows that pre-service and in-service mathematics teachers rated *VillageMath* high in terms of appearance. Appearance and multimedia captures aspects that relate to the platform's "look and feel" with special emphasis on state of the art graphics and multimedia artefacts (Lavie & Tractinsky, 2004; Moustakis *et al.*, 2004). The core users of the instructional platform seek interactive multimedia elements that are used to represent culture-based concepts, abstractions, actions or simulations, metaphors and modifiers. Users intend to integrate these learning objects available on the platform into complex arguments, in a creative and innovative fashion, as demanded by their specific learning aims outlined in the mathematics curriculum or being canvassed by the culture-based mathematics paradigm (Mondi, Woods & Rafi, 2007). Apart from this cognitive uses and gratification expectancy, pre-service and in-service mathematics teachers also seek affective uses and gratification expectancy in their quest for media experiences that evoke pleasure and emotional engagement and enhance their self-efficacy perception. Additionally, the results in Table 3 alluded to high entertainment uses and gratification expectancy. The appearance quality of *VillageMath* adequately meets users' tendency to seek e-learning resources that are fun and exciting. The unique intrinsic properties of the resources available on this indigenous knowledge platform appeal to users' imaginations and arouse their emotions, matching the users' idiosyncratic appraisal of these properties (Mondi, Woods & Rafi, 2007). The appearance value of the platform lies in the tendency of visitors to use multimedia to escape through attention, engagement, aesthetic enjoyment and tension release. This also meets users' expectation that *VillageMath* afford the entertainment, compelling and engaging lesson contents and tasks in form of visual models, multimedia presentations, simulations and indigenous games.

The development of *VillageMath* gave special attention to site appearance because of its impact on user engagement. The Kontrast theme that controlled much of this appearance was selected after trying several others within the framework of the Cleanroom Software Engineering Model (Mills, Dyer & Linger, 1987). The theme creatively optimized the site's appearance as can be gleaned from the outcomes reported in Table 3 and the high average page per visitor arrived at for the system. The strategies resulting in these positive outcomes are evidence-based, building on recommendations such as that of Dahal (2011) which underscore that it takes a very short time for users to form an opinion about a website that determines whether they will stay or leave. It was, thus, essential to make the web design of *VillageMath* simple and familiar. Users have expectations of what a rich and entertaining educational website should look like. Diverting from those is a risk, no matter how imaginative or striking the design (Laja, 2019).

CONCLUSION

Analysis of results obtained from the web performance assessment tools indicated that the Web-based Ethnomathematics Instructional Content Repository appeals to a wide range of highly engaged users. The user experience data obtained in this study showed that pre-service and in-service mathematics teachers rated *VillageMath* high in terms of navigation, structure, and appearance. Both categories of mathematics teachers unanimously rated the platform high in terms

of navigation, structure, and appearance. These findings indicated that the designed innovation has the potential to aid teachers in providing the necessary guided-re-invention of the mathematics classroom along the culture-based continuum. The study has established that culture can indeed become an integral part of instructional design, making it important to consider social and cultural peculiarities in planning and delivering mathematics instruction.

RECOMMENDATIONS

The following recommendations are made based on the findings of this study:

i. African educational policy makers should ride on the popularity of VillageMath to spur the inclusion of relevant cultural artefacts and indigenous games in the development of the Mathematics curriculum for Basic and Secondary Education, restructuring curricula, and re-training activities around indigenous knowledge systems.

ii. Considering the affirmed structural quality of *VillageMath*, Mathematics teacher educators in institutions of higher learning should use the platform as a dependable tool for voicing narratives across the field of ethnomathematics. The forum available on the platform can be used by these experts of Mathematics Education to communicate their development of state-of-the-art pedagogies for the field.

iii. Given the dependable navigational, structural, and appearance quality of *VillageMath*, educational organizations and agencies in the cultural sectors should make use of *VillageMath* to drive their initiatives in grassroots development. The intervention is open to all for curating and sending socio-cultural messages to the dedicated followership on the Network.

iv. In-service and pre-service mathematics teachers should customize the numerous adaptable templates available on *VillageMath* for classroom activities that can boost serious conversations on ethnomathematics.

With the attested structural quality, Mathematics Education students should use *VillageMath* to enrich their learning experience by interacting with indigenous knowledge content of the platform.

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