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DEVELOPMENT AND EVALUATION OF REMOTE OFFLINE LEARNING MANAGEMENT SYSTEM WITH NETWORK FILE SYSTEM USING INTRANET NETWORKS

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Abstract— The lack of internet access in underdeveloped nations, particularly the Philippines, exacerbates the digital divide and restricts universal access to ICT. This research developed an alternative standalone offline open educational resources access methods for distant learning and teaching-based eLearning called Remote Offline Learning Management System with Network Files system (ROLMS-NFS) utilizing intranet networks and a Network File System, particularly for far-flung and hinterland schools. The proposed system combines a standard computer unit, a robust Moodle learning management system, and a Network File System database setup. The technology uses an intranet network architecture by connecting two wireless antennas in different locations to create a wireless link. Once linked to the network, teachers, and students can access the e-learning system through local e-learning Uniform Resource Locators (URLs) without total reliance on internet connection and mobile data. As a result, the system makes sharing educational resources easier. It lets students access their lessons, modules, and assignments, take exams and quizzes and even watch video lessons on their laptops, smartphones, and tablets. Further a Technology Acceptance model survey questionnaire was used to assess teacher and student acceptance and intention to use the proposed system by finding its Perceived ease of use, Perceived usefulness, attitude towards use, and behavioral intention to use.

Keywords—Digital divide, NFS, Learning Management system, eLearning, Intranet

INTRODUCTION

The use of several learning platforms aside from face-to-face classroom settings has evolved. The Philippines' educational system has incorporated online, offline, and blended approaches to make learning and teaching more adaptable. Remote learning is a lifeline for education, but digital technology's benefits go beyond a crisis remedy. Digital technology changes how, when, and where people learn. Technology can give teachers,

and students access to specialized material beyond textbooks, in several media, across time and location.

Flexible learning is difficult in remote areas. As schools and community learning centers close, students' learning is dramatically harmed. The 2020 report titled Basic Education Learning Continuity Plan (BE-LCP) presents the Department's basic education initiatives, "Basic Education Learning Continuity Plan for 2020–2021 Adopted Due to Public Health Emergency COVID-19[1]." First, the Department of Education pushed distance learning above physical classes. This strategy includes online, TV, radio, and printed courses [2].

To preserve academic continuity, educational institutions turned to online learning. However, the existing situation has problems. The digital divide [3][4] has received particular attention from COVID-19 [5]. Due to some constraints, students in impoverished nations like the Philippines have limited internet access. Students want to use technology to finish homework and improve digital literacy but have limited online access.

In this paper, the researcher designed and developed a remote offline ICT tool [6] and a learning management system [7] to address the digital divide in remote areas with limited internet access by providing an alternative way of delivering a blended learning [8] approach. As a result, the researcher is able to develop standalone offline open educational resources access systems for remote learning and teaching-based eLearning without the full dependence on internet connection and mobile data.

Using a standard desktop PC configuration with a robust Moodle [9] learning management system will serve as a server. It is integrated into two wireless antennas [10] (master and station) that are set in different locations establishing a microwave link [11]. The system uses an intranet network [12] to establish the connection. The master is directly connected to the desktop PC that will serve as the server of the system. The station is connected to a wireless router that will serve as the broadcast through open access points. Once the network is established, teachers and students can access the ROLMS-NFS e-learning URL on their smartphones, tablets, and laptops.

This study will help teachers and students access courses, modules, and assignments on their smartphones and take quizzes and exams. The study also examines students' and teachers' acceptance and intention to use the remote offline learning management systems with network file systems to deliver blended learning to the hinterland and far-flung students.

METHODOLOGY

Research Design

Research designs are procedures that researchers follow when collecting, analyzing, interpreting, and reporting data in this research study [13]. The study started with gathering requirements as preliminary inputs for designing and developing the ROLMS-NFS system. Next, its development required the preparation of particular hardware and software components for configuration and installation. Next, the researcher evaluated the system on its prototype's functionality, efficiency, technical quality, and usability. The researcher conducted a series of tests on the network through a network functionality test that determines the latency and throughput of the system at two different distances. Finally, a technology acceptance model [14] test is conducted to evaluate the proposed system's acceptance and intention to use the students and teachers. Quantitative data from various

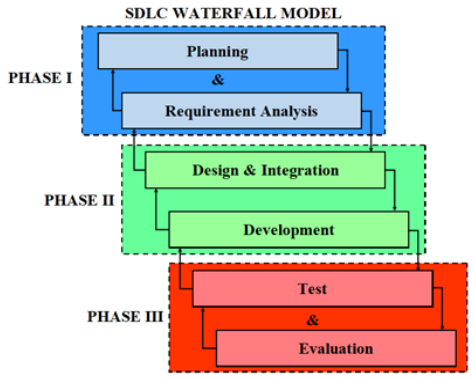
tests were collected and analyzed then results were presented.

DEVELOPMENT OF ROLMS-NFS

ROLMS-NFS was developed using developmental research. The study uses developmental research principles [15] in developing a remote offline LMS with a network file system [16]. The Software Development Life Cycle (SDLC) provides a systematic way for building and delivering software applications. The software industry uses the SDLC process to design, develop and test high-quality software [17]. The waterfall model [18] consists of a sequence of interconnected stages that flow downward in a waterfall-like pattern. These phases include planning and requirements analysis, design phase, development phase [19] testing and evaluation. The models contain well-defined limits and responsibilities for the researcher [20].

Figure 1

There are three major phases of this model, which serve as a guide in implementing the system.



Planning And Research Analysis (Phase I)

This phase focused on research objectives and requirements, gathering hardware and software design decisions. The researcher will design and collect data from the Department of Education's websites [21][22] and the issues they encounter in offering excellent learning modalities to develop a Remote Offline Learning Management System.

In designing ROLMS-NFS, the researcher interviewed IT and computer engineering specialists and did online research [23][24] [25] [26]. Ideal tools and equipment for model requirements enhancement.

Design & Integration and Development (Phase II)

This phase identified the ROLMS-NFS components and information flow. Students and teachers can use the technology to access remote offline learning management systems without the internet. The system consists of a standard desktop PC set with a robust Moodle learning management system [27][28][29] as our LMS server and two Ubiquiti PowerBeam 5AC Gen [30] 2 Antennas as our wireless connection (point-to-point link) between our ROLMS-NFS server. The Intex IT-G101R [intex] has been configured as a repeater, so the Ubiquiti PowerBeam 5AC Gen 2 Antennas and the WiFi Router may communicate. Students could use their smartphones to access lessons, modules, assignments, and quizzes while connected to System Wireless router access points.

Figure 2

ROLMS-NFS system's network topology and design architecture.

Figure 3

The system Architecture of ROLMS-NFS.

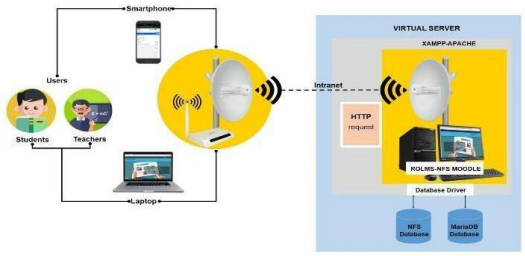


Figure 4

Screenshots of the Develop ROLMS-NFS eLearning environment.

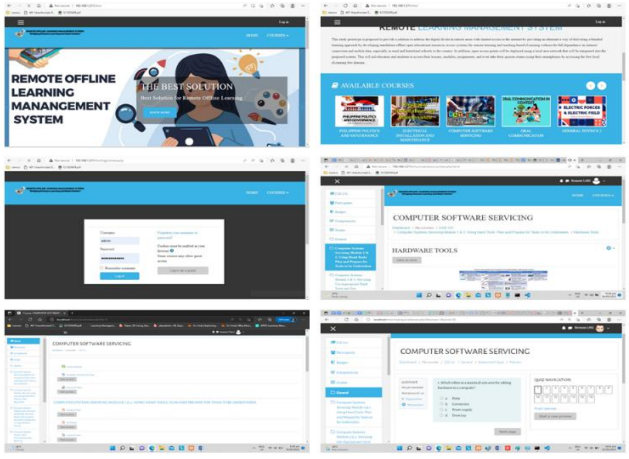


Figure 5

ROLMS-NFS Network File System user interface

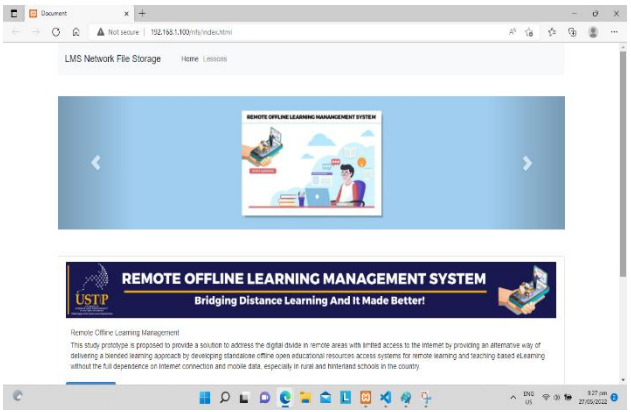


Figure 6

Network File System sample courses and lesson

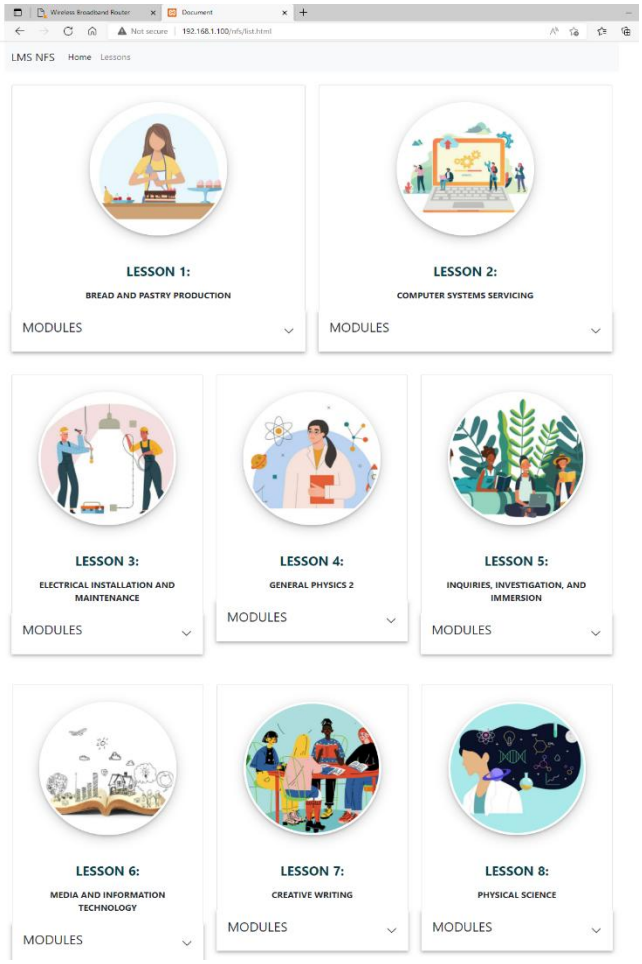
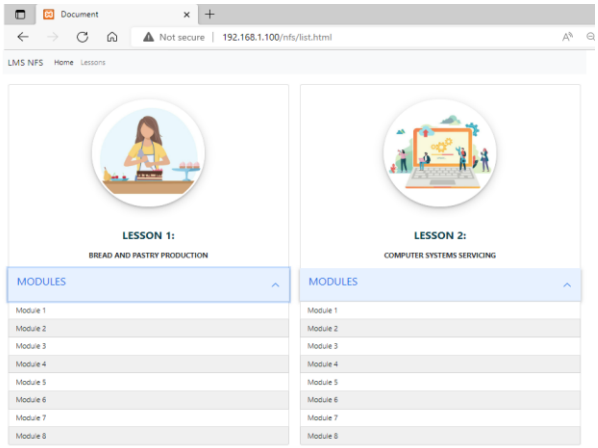


Figure 7

Network File System sample lessons



Test amd Evaluation (Phase III)

The researcher was able to design and develop a working prototype and underwent a functionality test to ensure that the system worked adequately. As a result, the system's user interface is refined based on user commentaries of the experts and researcher observations. Moreover, the prototype is approved and deployed. This validation included the course content and the user interface navigating the features and contents of ROLMS-NFS, like navigating the course content, answering the quizzes, and playing the video lessons that are uploaded in the course.

To test the RO-LMS-NFS functionality in terms of connectivity. The system underwent a network functionality test using Ping [31][32] test and Iperf [33][34]. Test at different distances of 71.2 meters and 2.27 km by evaluating the result of latency [35][36]and throughput [37].

Figure 8

The first testing site of the ROLMS-NFS systems at 71.2 meters

Figure 9

The second testing site ROLMS-NFS at 2.27 kilometers

Finally, a technology acceptance model questionnaire is given after they use the system to find the stakeholders, the teachers, and students' acceptance and intention to use the ROLMS-NFS system. Before using the ROLMS-NFS, teachers and students are given a brief orientation and training to get acquainted with the system. Teachers were first given their access accounts to upload lessons in the LMS and able to set up other elements such as creating subjects or courses, enrolling students, posting announcements, and others to facilitate learning in their subjects.

Respondents

The convenient sampling method [38] was used because of the limited resources available. The primary data for the study were collected through a survey questionnaire and were distributed to the teachers and students in one National High School in Pugaan, Iligan City. Fourteen (14) teachers and thirty-two (32) students agreed to participate in the conduct of testing. The researcher personally administered the distribution to provide convenience to participants.

Research Instrument

A Technology Acceptance Model questionnaire [39] primarily used to gather data on the respondents' acceptance and intention to use the system. This questionnaire has two components. The first uses a nominal scale to determine participant demographics. It includes gender, age, years of teaching in the Department of Education (not just at the Department of Education), Academic Rank, years of using LMS for teachers, and Gender, Age, and years of using LMS for students. The second section included 18 items measuring four TAM constructs: Perceived Ease of Use, Perceived Usefulness (PU) [40], Attitude Toward Usage (ATU) [41], and Behavioral Intention to Use (BIU) [42] [43]. These items anchored a seven-point Likert scale, from 1: Strongly Agree, 2: Moderately agree, 3: Slightly agree, 4: Neutral, 5: Slightly disagree, 6: Moderately disagree, and 7: Strongly disagree.

Table 1

Modified Technology Acceptance Model Questionnaire

Part II: Your Views about Remote Offline Learning Management Systems - Network File System.

The following items describe statements about offline remote learning management systems. Indicate your agreement or disagreement with the following statements by checking your response using this scale

1 Strongly agree | *2 Moderately Agree* | *3 Slightly agree* | *4 Neutral* | *5 Slightly disagree* | *6 Moderately disagree* | *7 Strongly disagree*

Section II: Perceived Ease of Use (PEU)	1	2	3	4	5	6	7
I feel that using an ROLMS-NFS would be easy for me. (PEU1)							
I feel that my interaction with ROOMS-NFS would be clear and understandable. (PEU2)							
I feel that it would be easy to become skillful at using ROLMS-NFS. (PEU3)							
I would find ROLMS-NFS to be flexible to interact with. (PEU4)							
Learning to operate ROLMS-NFS would be easy for me. (PEU5)							
It would be easy for me to get ROLMS-NFS to do what I want to do. (PEU6)							
I feel that my ability to determine ROLMS-NFS ease of use is limited by my lack of experience. (PEU7)							
Section III: Perceived Usefulness (PU)	1	2	3	4	5	6	7
Using ROLMS-NFS in my job would enable me to accomplish tasks more quickly. (PU1)							
Using ROLMS-NFS would improve my job performance. (PU2)							
Using ROLMS-NFS in my job would increase my productivity. (PU3)							
Using ROLMS-NFS would enhance my effectiveness on the job. PU4							
Using ROLMS-NFS would make it easier to do my job. (PU5)							
I would find ROLMS-NFS useful in my job. (PU6)							
Section IV: Attitude Toward Usage (ATU)	1	2	3	4	5	6	7
I believe it is a good idea to use a ROLMS-NFS. (ATU1)							
I like the idea of using a ROLMS-NFS. (ATU2)							
Using a Learning Management System is a positive idea. (ATU3)							
Section V: Behavioral Intention to Use (BIU)	1	2	3	4	5	6	7
I plan to use a ROLMS-NFS in the future. (BIU1)							
Assuming that I have access to the ROLMS-NFS, I intend to use it. (BIU2)							

NETWORK FUNCTIONALITY LATENCY AND THROUGHPUT TEST

Table 2

Result for network functionality latency test using ping test at 71.2 meters and 2.27 kilometers distance

Network Functionality Latency Test			
Ping Test 71.2 Meters			
Packet Sent	**Packets Receive**	**Percent Loss**	**Average Round Trip Time**
100	100	0%	10 milliseconds
Ping Test 2.27 Kilometers			
Packet Sent	**Packets Receive**	**Percent Loss**	**Average Round Trip Time**
100	100	1%	6 milliseconds

Based on the ping test, the researchers performed at different distances at 71.2 meters and 2.27 kilometers. The data shows that based on 100 packets sent by the client pc and received by the ROLMS-NFS server, they both received 100 packets. At 71.2m, the test gathered a data loss of 0%, while at 2.2km, the test gathered a 1% loss. The result

means the connection is fine and has an acceptable packet data loss at both distances. Both distances gathered a great result with an average round trip time of 10 milliseconds in 71.2 meters and 6 milliseconds in 2.27 kilometers, respectively. The 2.27km recorded a lesser round-trip time than the 71.8 meters since the 2.27 km link uses an antenna dish while the 71.8 m link does not use a dish in the testing.

Table 3

Result for Iperf network functionality throughput test at 71.2 meters and 2.27 kilometers distance

iPerf Network Functionality Throughput Test			
Throughput at 71.2 meters		*Throughput at 2.27 kilometers*	
Transfer	**Bandwidth**	**Transfer**	**Bandwidth**
70.9 Mbytes	59.4 Mbits/sec	11.4 Mbytes	9.41 Mbits/sec
iPerf Network Functionality Bidirectional Throughput Test			
Throughput at 71.2 meters		*Throughput at 2.27 kilometers*	
Transfer	**Bandwidth**	**Transfer**	**Bandwidth**
66.6 Mbytes	55.8 Mbits/sec	11.4 Mbytes	9.64 Mbits/sec

Data shows the result of the iPerf throughput test and bidirectional throughput test at different distances. The 71.2 meters distance recorded a higher transfer rate in both throughput and bidirectional throughput tests. It recorded 70.9 Mbytes and 66.6 Mbytes transfer sent data in both tests while recording throughput of 59.4 Mbits/sec and 55.8 Mbits/sec.

On the other hand, the 2.27 km link recorded a much lower transfer rate resulting in both throughput and bidirectional throughput tests with minimal difference. It recorded 11.4 Mbytes and 9.41 Mbytes transfer sent data in both tests while recording throughput of 11.4 Mbits/sec and 9.64 Mbits/sec. Although at 2.27km distance recorded a lower result, the system's functionality does not greatly affect the ROLMS-NFS system is still working accordingly with any problem at all.

ROLMS-NFS Technology Acceptance Model Analysis and Results

In total, 46 individuals completed the survey comprising 32 (69.57%) students and 14 (30.43%) teachers. Out of the 46 respondents 33 (71.74 %) were female and 13 (28.26%) were male. Most of the respondents (69.56%) were at the age range of 20 or less since the majority of the respondents are students. For the teachers' academic rank, most senior high school teachers have a position of Teacher 1 with 42.86%. And 35.71% of the teachers hold an academic rank of Teacher 2. Both Teacher 3, Master 1, and Head Teacher 1 gathered 7.14%, respectively.

As expected, majority of the students and teachers had not used an LMS with 91.30%, while the rest varied in their experience with LMS as follows: Those who had used LMS for less than a year at 6.52 %; and 2.17 %, had used LMS for more than a year to 3 years. Table 4 has the rest of the figures and information.

Table 4

Demographic information

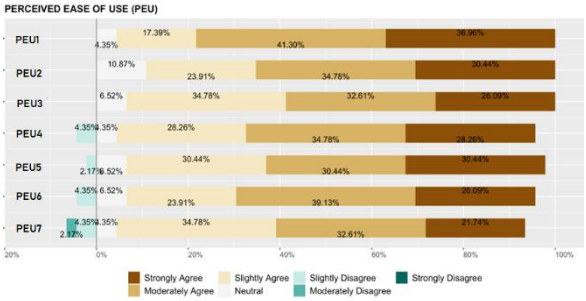
Respondents		*Frequency*	*Percentage*
Participants			
Students		32	69.57 %
Teachers		14	30.43 %
Gender			
Female		33	71.74 %
Male		13	28.26 %
Age			
20 or less		32	69.57 %
21-25 yrs. Old		4	8.70 %
25-30 yrs. Old		3	6.52 %
31-35 yrs. Old		3	6.52 %
36-40 yrs. Old		2	4.35 %
41 and up		2	4.35 %
Teacher's Academic Rank			
Teacher 1		6	42.86 %
Teacher 2		5	35.71 %
Teacher 3		1	7.14 %
Master Teacher 1		1	7.14 %
Head Teacher		1	7.14 %
How long have you, or have been using a Learning Management System?			
Have not used a Learning Management System.		42	91.30 %
Experience in years	Less than a year	3	6.50 %
	1-3 years	1	2.20 %
	3-5 years		
	More than 5 yrs.		

PERCEIVED EASE OF USE (PEOU)

On the perceived ease of use of ROLMS-NFS, most respondents (either teacher or student) strongly agreed that they could use the ROLM-NFS with ease. The majority of respondents answered slightly to strongly agree with the combined percentage in each seven items, ranging from 83.13% in items PEU2, PEU6, PEU7, 91.30% in items PEU4 and PEU5, 93.48% in PEU3, and up to 95.65% in PEU1. The distribution shown in below:

Figure 10

Overall data Perceived Ease of Use (PEU)

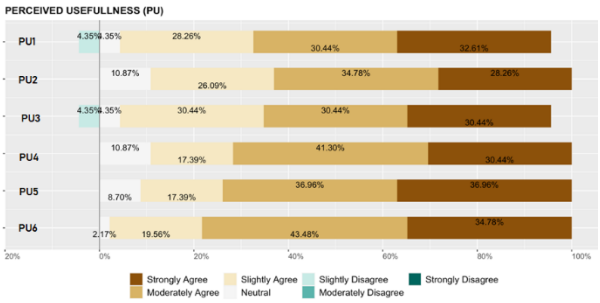


PERCEIVED USEFULNESS (PU)

Most of the respondents believed that ROLMS-NFS is useful in their job and can help their performance better. The majority of respondents answered slightly to strongly agree with the combined percentage in each six items, ranging from 83.13% in items PU2 and PEU4, 91.30% in items PU1, PU3 and PEU5, up to 97.83% in PEU6. The distribution shown below:

Figure 11

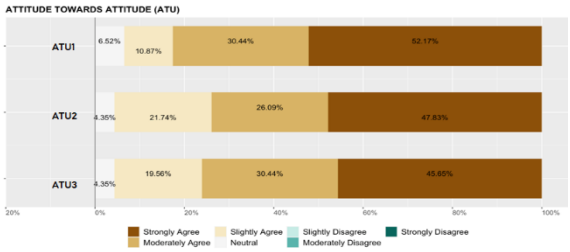
Overall Data Perceived Usefulness (PU)



ATTITUDE TOWARDS ATTITUDE (ATU)

Most of the respondents have a good outlook on using the ROLMS-NFS. The majority of respondents answered slightly to strongly agree with the combined percentage in each three items, ranging from 93.48% in ATU1 up to 95.65% in ATU2 and ATU3. The distribution shown in table below:

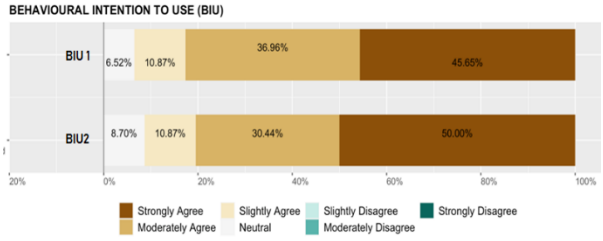
Figure 12
Overall Data Attitude Towards Use (ATU)



BEHAVIORAL INTENTION TO USE (BIU)

Most respondents are willing to use the ROLMS-NFS as an alternative way of delivering remote online learning. In BIU1, the majority of respondents, or 93.48%, answered slightly up to strongly agree with the combined percentage of 93.48%. While in BIU2, 91.30% answered slightly up to strongly agree. The positive response between students and teachers shows that they intend to use the ROLMS-NFS. The distribution is shown below:

Figure 13
Overall data Behavioral Intention to Use (BIU)



CONCLUSION

This study presents the design and development of a Remote offline learning management system with a network file system using intranet networks. The following conclusions are drawn from the requirement analysis, implementation, and evaluation of the system network functionality and the stakeholder's acceptance and intention to use the system.

The researcher designed and developed a working offline learning management system with a network file system that can provide access to local educational resources in far-flung, hinterland schools through an intranet network. The results from the network functionality test: throughput and latency gathered acceptable results from different distances (71.2 meters and 2.27 km). The test revealed that the ROLMS-NFS features and capabilities are not significantly affected even at greater distances. It is fully functional and accessible and works accordingly without any problem at all.

Finally, the evaluation from the stakeholders' students and teachers showed a positive result regarding ROLMS-NFS four constructs of TAM Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Attitude Toward Usage (ATU), Behavioral Intention to Use (BIU). In addition, the stakeholder's acceptance and intention to use the proposed system revealed that both stakeholders see a positive outlook toward the ROLMS-NFS.

With the use of ROLMS-NFS, students and teachers can access ROLMS-NFS e-learning through an e-learning hot spot on the particular assigned area using the given ROLMS-NFS URL. Although the system utilizes an intranet network, it has shown it is capable of delivering an alternative way of blended learning that can be useful to teachers and students to facilitate

online learning and teaching in the hinterland and far-flung students.

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