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A COLLABORATIVE PLATFORM FOR RESEARCH AND EDUCATIONAL NETWORKS

Dr. Musa Sule Argungu, Hussaini Shuaibu, Shamsu Arzika Aliero,
Department of Computer Science
Abdullahi Fodiyo University of Science and Technology, Aliero, Nigeria
Correspondence Email: sm279aeg@ksusta.edu.ng

ABSTRACT
Information and Communication Technologies (ICTs) have become very important tools for quality higher education and research, Countries and institutions recognize that academic and research networks are essential components of national infrastructures. For example, cases were made for (National Research and Educational Network) NRENs as "public goods", because of their far-reaching implications on learning, teaching, research and many other scientific endeavors that have positive impact on economic growth and social development. The study purpose is aimed at the designing a frame work model as well as application for research and educational network that will enable researchers and students from various institute of higher learning to collaborate with each other. National research and education networks (NRENs) play a critical role in the development of communication network infrastructure and networked services for researchers and educators. In collaboration with other Researchers and Educational Network, the research will develop a roadmap for the development of NRENs in Nigerian university and region. This was based on the results of a literature review that was conducted to investigate whether the proposed framework model and application will improve collaboration between scholars and students of various universities in Nigeria. The research proposed a frame work model which was developed into an application. The application was tested and found to be of significant to the research and educational network in Nigeria Universities.

INTRODUCTION
The establishment of National Research and Education Networks (NRENs) was to improve education and research quality in the tertiary institutions, through the implementation of the topmost Information Communication Technology (ICT) strategic andaction plan (Azene, 2019), which also had led to the formation of Nigerian Research and Education Network (NgREN), like every other Research and Education Networks (RENs) world-wide (Okewu and Daramola, 2017). The necessity for an enterprise network within every institution exists to connect education and research institutions directly using high- speed fiber optics, switches, servers, routers, and high-capacity radios to establish connectivity, using cutting-edge monitoring software with the purpose of integrating all of the country's research and educational institutions through an innovative digital hub in order to respond to education and research resourcefulness (Chohan and Hu, 2022). As a matter of fact, the NgREN will provide a nationwide framework for interconnected campuses, interconnecting additional Regional Research and Education Network (RRENs) backbones, which will further connect on a global knowledge repository (Bankole and Assefa, 2017). Over 100 nations have developed RENs, with more than 20 in Africa, and NgREN is the first operating REN in West and Central Africa (Chergarova, 2020).
National research and educational network (NRENs) were originally started as high performance communication links to interconnect universities and research institutions in order to facilitate sharing of information among them. The Algerian Research and Education Network (ARN), the Egyptian Universities Network (EUN) and the Tunisian National University Network (RNU) are some examples where NRENs begun as university networks. The Tunisian National Academic Network, for example, was established in 1997 by the Tunisian Computing Center el Khwarizmi (CCK) to interconnect the campus networks of the various Tunisian universities, administrations, student's dorms, university restaurants, research centers and Technology Parks. Computing Center el

Khwarizmi (CCK) also manages a data center and provides a set of Internet and applications and services, including email, Telnet, FTP, web hosting, e-learning, library services (BIRUNI).
The growth of virtual research communities and large-scale international research projects has resulted in revolutionary changes to the ways scientific research is undertaken (Maciel, 2015)The term 'virtual research community' refers to a distributed group of researchers and associated scientific tools working together in a shared virtual platform using dedicated ICT infrastructures or e-Infrastructures (Andronico, 2011).
A critical element of an information infrastructure in this context is a national dedicated Internet infrastructure and service provider that supports the needs of research and education users. Arguably, modern network-enabled collaborative scientific research or education cannot be pursued without having access to such an infrastructure provided by these National Research and Education Networks (NRENs) (Foley, 2016).The lack of network infrastructure and NRENs in developing countries is therefore a potential barrier to participation in international research and education. The challenge here is how developing countries can build sufficient technological capacity in order to meaningfully engage with research and innovation in existing and new collaborative research communities both within and external to their own contexts.
European Commission-led investments in e-infrastructures have gone well beyond European Borders and have been used to either build e-infrastructures in various regions of the world or to extend them further in Africa, Asia and Latin America (Barjak, 2010). Prior to 2010, with few exceptions, African universities and research centers lacked access to dedicated global research and education resources because they were not connected to the global e-Infrastructure via high-performance national and regional networks (Spyridonis, 2015).
As a result, research centers and higher education institutions in Africa requiring such access for direct peering with external networks were not well represented in global research communities. One way of addressing this issue is through creating dedicated NRENs connecting research institutions in each African country to a Regional Research and Education Network (RREN) linked to the peer infrastructures on other continents. Since 2011, as part of this effort, the purpose of the Africa Connect projects has been to create international high-capacity networks for research and education in Africa and to support the emergence of NRENs throughout Africa. Africa Connect ran between 2011 and 2014 and was instrumental in establishing Ubuntu Net, a high-capacity data communications network for research and education communities in Eastern and Southern Africa. Ubuntu Net is overseen by the Ubuntu Net Alliance, a RREN for that region. AfricaConnect2 continues the work with RREN regional clusters that also include the West and Central African Research and Education Network (WACREN).
WACREN was originally conceived at the African Network Operators Group meeting on network technologies in 2006 (AfNOG 2006) held in Nairobi, Kenya and at the Regional Workshop on Research and Education Networks organized by the Association of African Universities (AAU) in Accra, Ghana in November 2006. Both meetings identified that there was a need to build organizational and technical capacity for NRENs as a requirement for a viable continent wide network. In a regional consultative meeting that followed in November 2009 as a pre-event to the Open Access Conference 2009, the AAU was given the mandate to identify a team to coordinate activities of working groups to produce documents for the establishment of WACREN. The WACREN board of directors was then constituted. According to its website, WACREN's mission is to build and operate a world class network infrastructure, develop state of the art services, promote collaboration among national, regional, international research and education communities and build the capacity of the research and education community. It consists of eleven NREN members with one associate NREN member and three NREN members in development.
Understanding emerging megatrends and trends has always been a vital issue for industries, for value networks and for the clusters of various industry branches, because big and rapid scientific and technological advances in continuous growth fields have been generated by a clear dynamism

within the global competitiveness and by searching for new knowledge (Olsmats, 2014)
The development and innovation in telecommunications contribute increasingly to the educational evolution through the use of services and technological tools. The NRENs are physical telecommunication networks of high speed, unique in each country and independent from the commercial internet. They are designed to be an essential infrastructure for the development of education and research in a country, facilitating the reliable, efficient and cost-effective exchange of computer resources through services for communication and collaboration among researchers. Each country decides which groups will benefit from its national research and education network, and many choose to expand connectivity and services to libraries, hospitals, laboratories and governmental organization (Hashem, 2012) The orientation to use telecommunications for educational purposes already generates research works, commercial products and adapted services, and they become a hinge element for collaboration and scientific development of all countries. In order to identify emerging generic technologies which probably generate the greatest economic and social benefits, future study processes as Foresight - as a set of systematic attempts to look at in the long term the future of science, technology, economy or society Networks. (Fernández, 2003)Could resolve the research question: What are the most important trends related to advanced technology services in the NRENs?

LITERATURE REVIEW

ICT democratization refers to the process by which a wide range of technical and non-technical citizens get access to innovations through communication technology gateways as infrastructure (Singh and Kumar, 2022). In order to facilitate effective educational involvement, ICTs are integrated into networks and services that have an impact on the accumulation and flow of public and private information and knowledge on a local and worldwide scale. The Internet service provision, telecommunications equipment and services, information technology equipment and services, media and broadcasting, libraries and documentation centers, commercial information providers, network-based information services, and other related information and communication activities are all covered by ICTs in accordance with the "United Nations Economic Commission for Africa" (Rothe, and Loisen, 2022), (Jambal, 2022). The terms ICTs and IT are used interchangeably and broadly, though ICT is associated with the field of education while IT is associated with the field of computers, software and telecommunication networks (Akpan and Obong, 2022). The IT automation refers to information processing interactions between information suppliers and users, as well as the development and implementation of information-processing technologies that aren't necessarily related to educational development. It is noteworthy that the majority of nations in the world now offer ICT teacher training in a range of formats and levels after realizing how crucial ICT is to both teaching and learning in the twenty first century digital electronic society. It has always been, and will continue to be, of utmost importance to all humanity that ICT- based development ought to bepursued. The relationship between educations and technology is currently changingdramatically, especially in the areas of the IoT , Information Centric Networking (ICN) for universal Internet access for education, big data, ubiquitous learning, and emerging technology for educational pedagogies (Barakabitze, 2019).
In this study, ICTs primarily refer to the internet infrastructures and mobile electronic devices, but they may also refer to hybrid solutions, such as the use of traditional media such as newspapers, radio, digital media, and television in conjunction with technologies merely providing novel approaches of dealing with an already existing resource, namely information, whether codified or untapped for public consumption and societal enlightenment. The establishment of NRENs offers endless opportunities for boosting learning quality and promoting sound research outputs within the academic institution in attainment of corporate developmental goals (Manhibi, 2019). In a similar development, in order to connect Europe's nationalresearch and education

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networks with a high-bandwidth, high-speed, and highly resilient pan- European backbone, connecting Europe's researchers, academics, and students to each other and to the global community, the Gigabit European Academic Network (GEANT) wascreated (Ricart, 2020).

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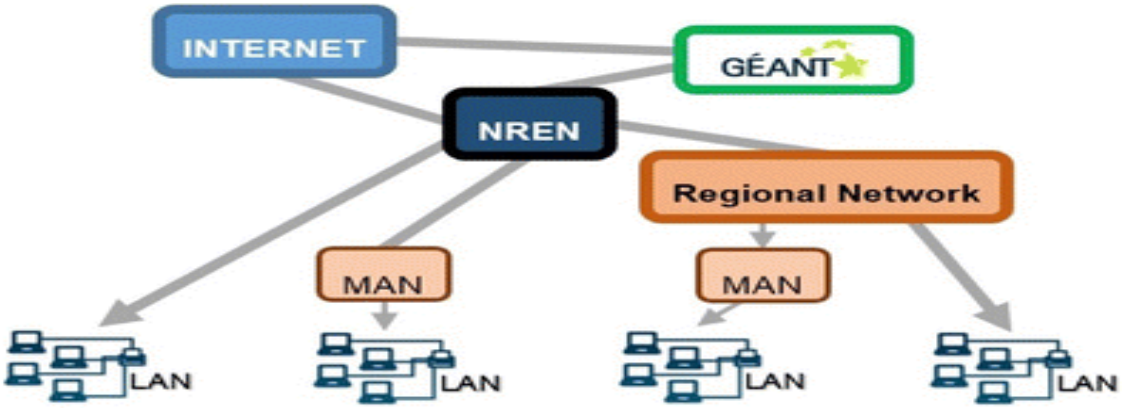

Figure 1: Development of National Research and Education Networks (NRENs)

Fornetworked academic and educational institutions with reference to Figure 1, the establishment of NRENs or networks of academic and educational institutions have fueled the global expansion of the Internet infrastructures, which had necessitated the implementation of top ICT policy, being established in Africa (Zennaro et al., 2020). On the African continent, successful and sustainable NRENs have enabled a number of educational and research institutions to benefit from enhanced Internet connections, collaborate globally and access essential e-resources for teaching and research (Mwale and Chita, 2020). The current efforts are to enable creation of long-term NREN that concentrated on the offering of technical and services-oriented solutions while focusing on the business model and financial plan. The strategies that have succeeded elsewhere on the continent should be reinforced in order to advance NRENs into being dynamic and (Abbott, 2015) Define the notion of e-Infrastructure as allows a shared, open (and unbounded), heterogeneous and evolving socio-technical system consisting of a set of IT capabilities and their users, operations and design communities'. Abstractly, the building blocks of e-infrastructures are as follows:

i. The bottom layer includes network services, scientific tools and datasets;
ii. The middle layer is the Grid layer containing networked data processing centers and middleware software as the 'glue' of resources; and finally
iii. The upper and highest level includes researchers and scientists that perform their everyday activities, work together and share and access data and services, possibly through a science gateway, irrespective of their geographical location.

(Andronico, 2011) As noted above, NRENs play a major role in the deployment of e-Infrastructure services. while the term 'e-Infrastructure' in a European context evokes images of high-speed networks linking high performance computers, in the context of developing countries it is seen as one of the most significant forces and challenges of modernization. For instance, participation of developing countries in high performance computing or Grid initiatives is still the exception rather than the norm. (Mulhanga, 2015). Some evidence of emerging e-infrastructures in Africa exists (Abbott, 2015) The development of NREN-based e-Infrastructure services in Africa would enable African researchers to directly participate in international research programmes directly affecting Africa including, for example, rural development, agriculture, climate change, and infection as disease research (HIV/AIDS, malaria, etc.).

(Bukvova, 2010) Notes that there is no clear definition on research collaboration in the literature, many forms of collaboration work, such as casual discussion on a research idea, are hard to be measured as evidence of collaboration. For the purpose of this paper, research collaboration is regarded as joint work between researchers in achieving research objectives. While it is possible for individual researchers to learn all the knowledge and skills needed to solve a complex research problem, this learning process can be very time-consuming and may prohibit one from being

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specialized. Thus, researchers, when addressing complex problems, need to pool expertise together and obtain cross-fertilization through interdisciplinary collaborations (Johari, 2012).

METHODOLOGY

There are many commonly way of findings Research materials online. We Thus, this research adopts the Design Research Methodology (DRM) for its exceptional ability to Design a user login interface that will provide solution to the lack of having access to research and educational materials. It will show the methods to design, a collaborative plate form for research and educational networks. Also, its ability to provide a mechanism for evaluating some measurable metrics that might be used to elevate the performance makes design research method a suitable choice for this research (MUSA, 2018).

Research Design

The central aim of this research is to design a collaborative platform for research and educational network, with the intent to better research purposes. The preferred solutions entail increasing having access to educational material and minimising the lack of having access to research and educational material. This research utilises the DRM approach to guide in achieving the stated research goals. In order to effectively and scientifically answer the research questions in this research, a research design comprising the strategies, tools and methods organised in a logical sequence was delivered(John, 2015). It could be seen as the application of research theory to product development. The aim of the design process is to produce a model or representation of the research.

A Flow Chart For Research And Educational Network

A flowchart is a type of diagram that represents a workflow or process. A flowchart can also be defined as a diagrammatic representation of an algorithm, a step-by-step approach to solving a task. The flowchart shows the steps as boxes of various kinds, and their order by connecting the boxes with arrows. This diagrammatic representation illustrates a solution model to a given problem.

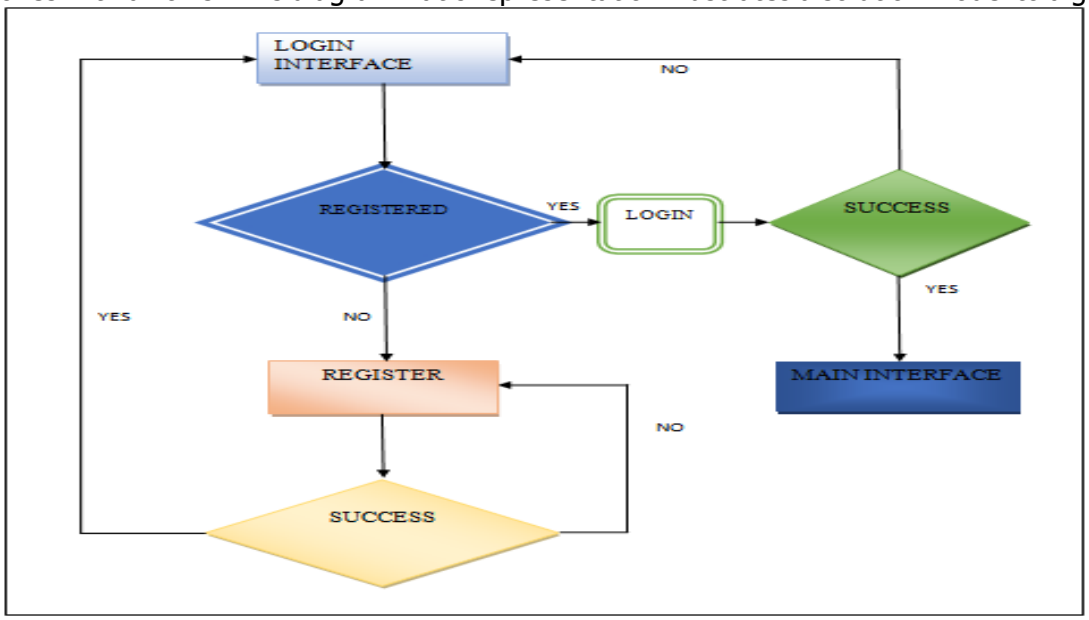

Figure 2: Flow Chart for Research and Educational Network Application

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Conceptual Model Of Collaborative Plate Form For Research And Educational Network

The basic model described in this section has informed the design of application. Given the ecosystem context, the application model requirements of users with access requirements of applications and the platform itself. The application model does not currently have a simple, consistent representation in formal notation because these rules evolved from practical experience instead of a top-down theoretical design. Balancing the different requirements of a complex ecosystem is a large scale engineering problem that requires layers of abstraction (Rene, Jeffrey, Chad, & Nick, 2020). We present a conceptual model for reasoning about the application in Internet of Things (IoT) systems during the implementation phase. The development of the conceptual model draws inspiration and uses similar concepts from a number of requirements engineering frameworks (Mouratidis, Argyropoulos, & Shei, 2016). It is used to model the hardware, software and social components of systems in order to analyze their accessibility. The hardware architectural components of application are emphasized in the model (Orestis, Haralambos, Andrew, Emmanouil, & Christos, 2017).

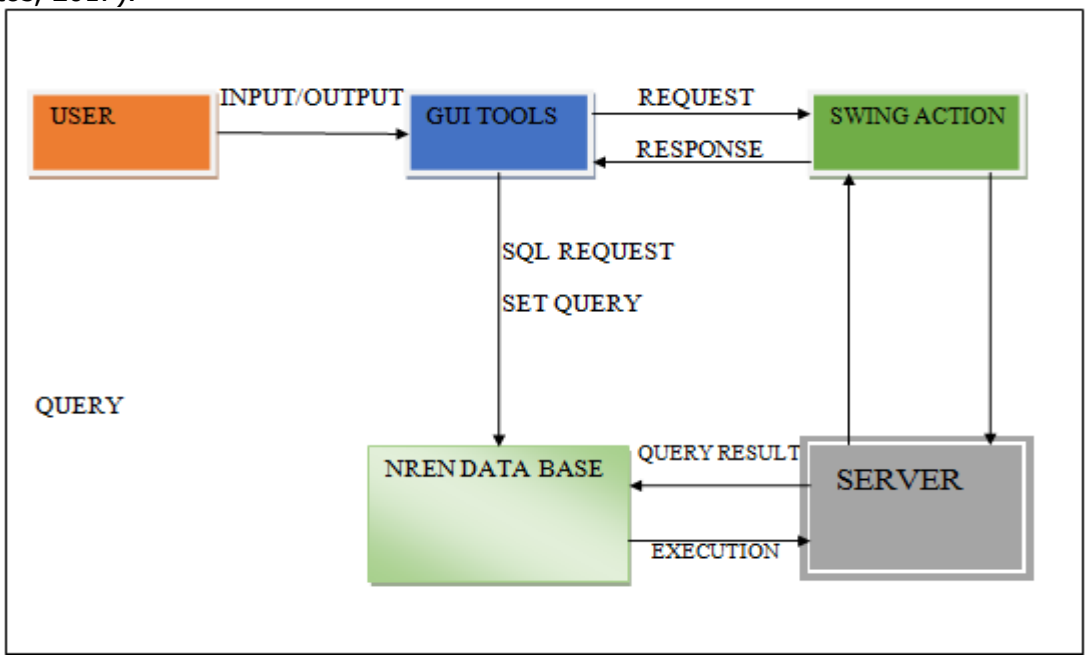

Figure 3: conceptual model of collaborative plate form for research and educational network

To achieve the desired goal of improving the performance of the accessing research material regarding jobs completion times, network consumption, storage and computing element usage, this research develops a conceptual model for the proposed mechanism. Some design metrics are carefully selected and used by this research to help in realizing the effectiveness of the performance metrics. These design metrics include number of jobs; file size the conceptual model for the proposed mechanism describes the desired and improved solution, following a critical review of related works.

Proposed Framework Model For Research And Educational Network

A system Framework or Architecture is the conceptual model that defines the structure behavior and more views of the system, organizing in the way that supports reasoning about the structure of the system which comprise the system components the relationship between them and provides a plan for which product can be produced and the system developed that will work together to implement overall system (Dattatreya & Steven, 2013). The bellow diagram will represent the system architecture of our design methodology:

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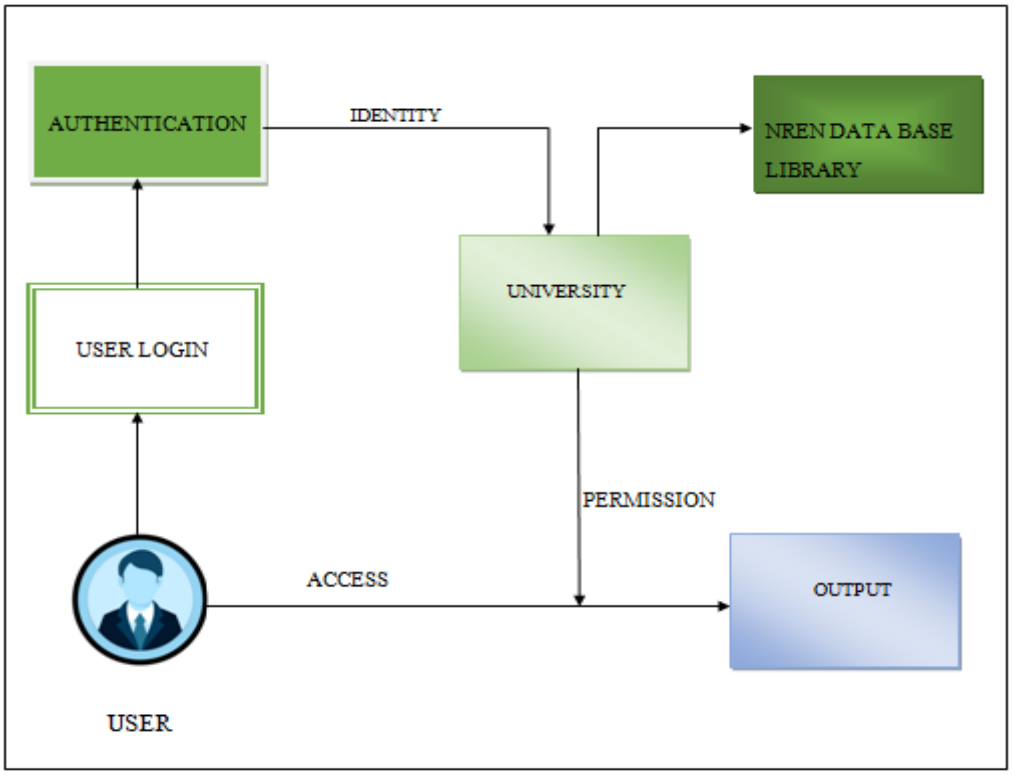

Figure 4: Proposed Framework Model for Research and Educational Network

Performance Evaluation and Metrics

Some performance metrics are used to evaluate the application performance. Four performance metrics namely jobs completion times, network usage, storage and computing element usage are used to evaluate the application performance. In addition, these metrics are evaluated using design metrics such as number of jobs and file size.

i. Job Completion Time

Job completion time, otherwise known as mean job execution time (MJET) is defined as the average time a job takes to execute, from the moment it is scheduled to Computing Element, to the moment when it has finished processing all of the required files. It is calculated by summing the total time taken by each job and divided by the total number of jobs (Meroufel & Belalem, 2013), as shown in the following formula:

$$Jobs\ Completion\ Times = \frac{\sum TotalJobsTime}{n} \quad \text{.....(3.1)}$$

Where, Total JobsTime; is the total time taken by each job.

n; is the total number of jobs processed.

ii. Effective Network Usage

The replication process of downloading a file needs network bandwidth to access a file. The network usage to access a file is calculated as:

$$ENU = \frac{(Nremfile + Nfilerep + Nlocfile)}{(Ntime\_remfile + Ntime\_filerepe)} \quad \text{.....(3.2)}$$

where $N_{remfile}$is the number of times the computing elementreads file from storage element on different regions multipliedby size of file, $N_{filerep}$is the total number of file replicationsthat take place during job execution multiplied by the size ofthe file, $N_{locfile}$is the number of times the computing elementreads file from storage element on the same sub region orregion multiplied by size of file,

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$N_{time_remfile}$is the time takento access the remote file, and $N_{time_filerepe}$is the time taken toreplicate the file(Priyanka, Rajesh, & Anju, 2014)

iii. Storage Element Usage

Storage element usage of a site is the percentage of capacity reserved by files according to the total capacity for the underlying storage. The percentage of storage used (SU) by files in MB is specified by storage used within region under this strategy. This can be calculated as:

$$SU = \frac{(Stotal - \sum_{i=0}^{n} Avalstr)}{Stotal} * 100 \quad \text{.....(3.3)}$$

Where $S_{total}$is the total storage capacity of a region and

$A_{valstr} = S_{reg} - S_{usage}$,

Where S_{reg} is maximum storage capacity and Susageis storage space consumed(Priyanka, Rajesh, & Anju, 2014).

iv. Computing Element Usage (CE Usage)

The computing capacity of the node is the factor which decides how fast a job can be processed by the node. The available computing capacity Aval cap of the node is calculated as

$A_{valcap} = Comp_{node} - Comp_{usage}$ ..... (3.4)

Where $Comp_{node}$is node's CPU computing capacity (MHz) and $Comp_{usage}$is CPU usage of node (Priyanka, Rajesh, & Anju, 2014).Low CE usage, on the other hand, would mean that some CEs have long queues while others are underused.

RESULTS AND DISCUSSION

A. User Interface For The Developed Application

The user interface (UI) is **the point at which human users interact with a computer, website or application.** The goal of effective UI is to make the user's experience easy and intuitive, requiring minimum effort on the user's part to receive maximum desired outcome. UI is created in layers of interaction that appeal to the human senses which will enable the user to get authenticated to have access to the research materials from the dashboard

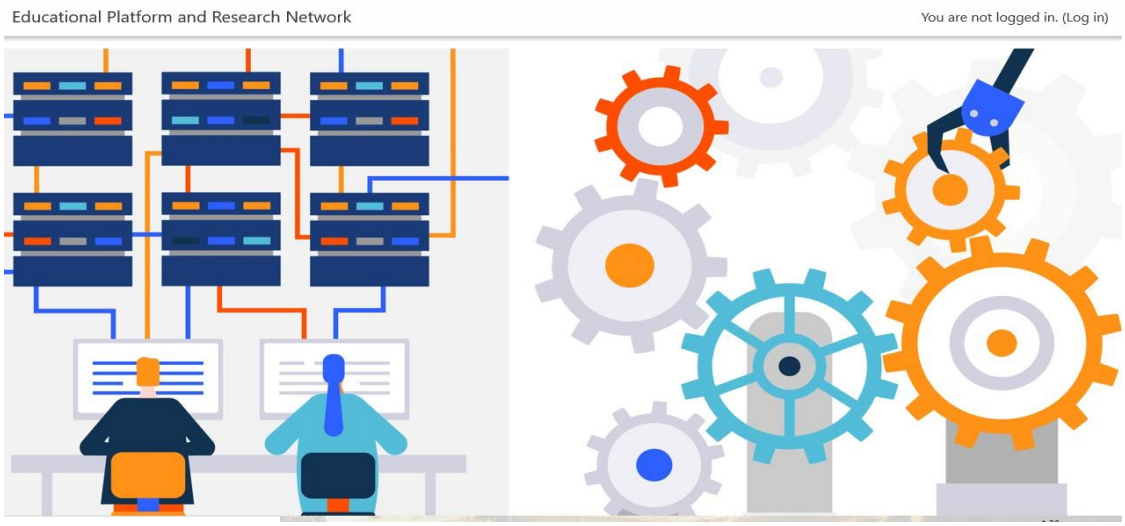

Figure 5: User Interface for the Developed Application

B. A User Login For The Developed Application

The user must be authenticated before the whole process occurs. The application will provide a secure login to the application. By clicking on the Log in button, the user will be redirected to login form where the user must enter a valid username and password to be authenticated and use the application. If the user provides an invalid credential, then the login will fail and the end-user won't

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be able to log in.

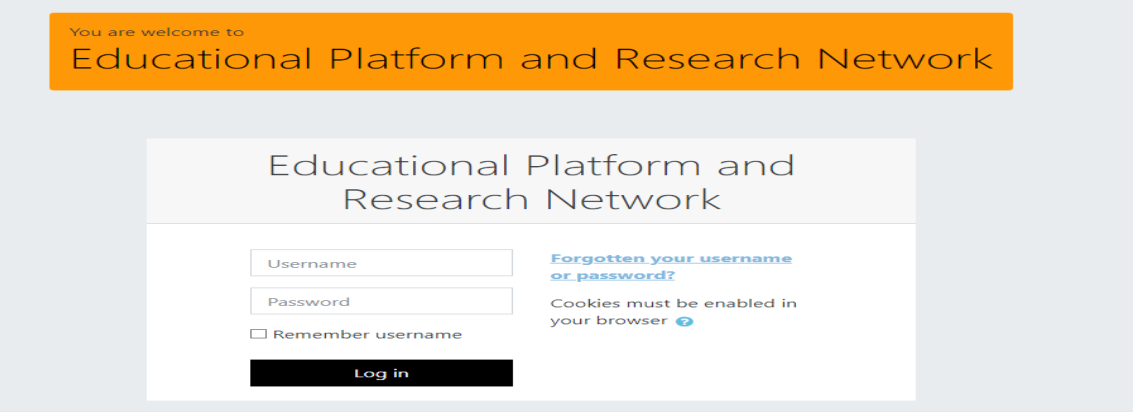

Figure 6: User Login for the Developed Application

C. Resource Upload

Uploading refers to transmitting data from one computer system to another through means of a network. Common methods of uploading include: uploading via web browsers, FTP clients], and terminals. Uploading can be used in the context of clients. This context is only available and used by the administrators.

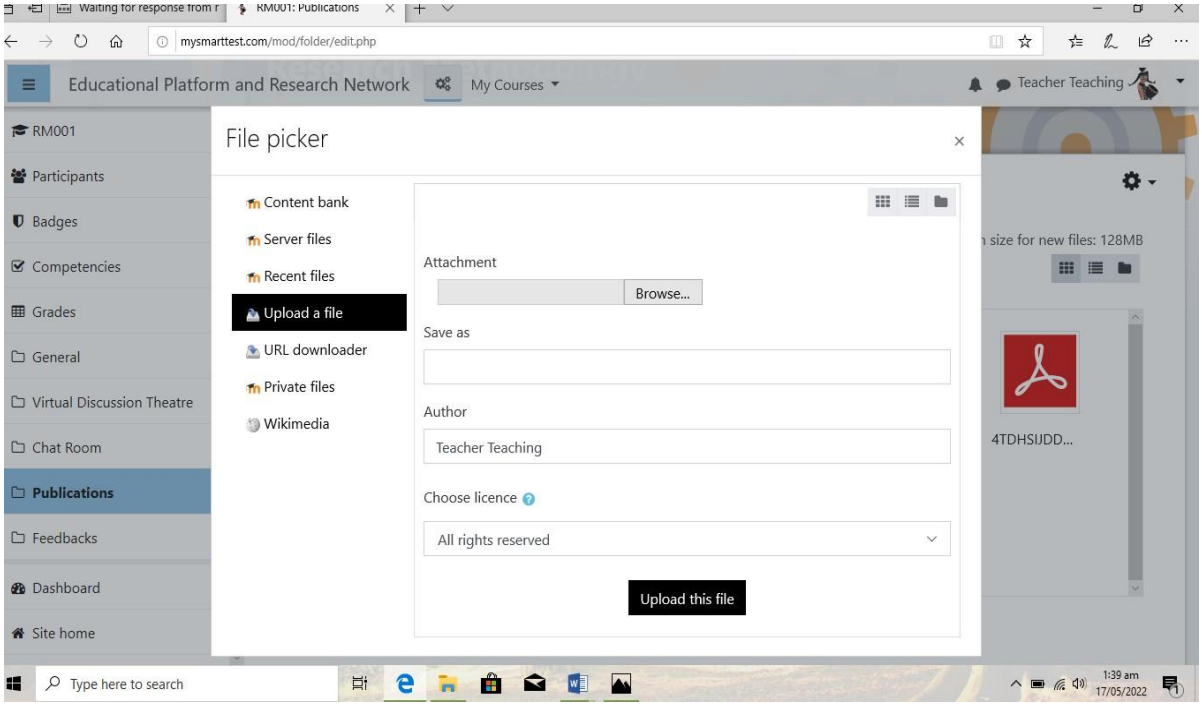

Figure 7: Resources Uploaded page

D. Resource Download

In computer networks, download Page means were to receive data from a remote system, typically a server such as a web server, an FTP server, an email server, or other similar system., from the dashboard environment u will navigate through the icons and click on private it will redirect u to where you will see research material click on any one of the material and click on download. A researcher can easily download journals, books and conferences etc.

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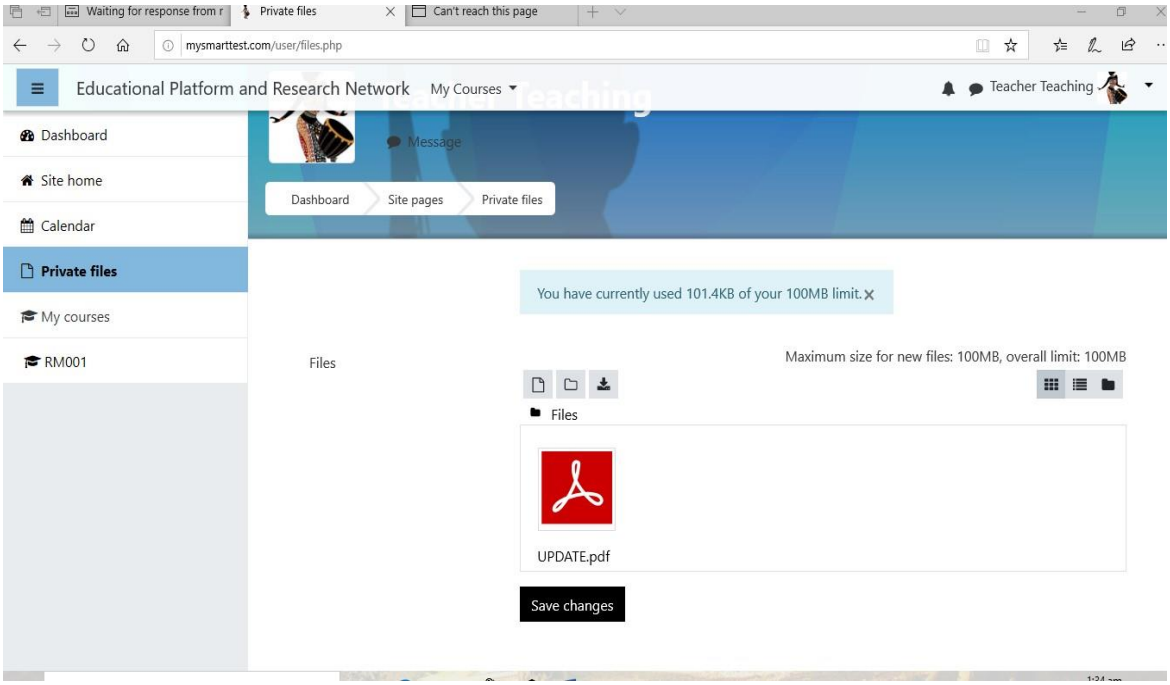

Figure 8: Resource Download Page

CONCLUSION

Research and Educational Network plays a central role in establishing a healthy communication between the Scholars and Student. The healthy communication between the Scholars and Students and the stakeholders can undoubtedly contribute to well progress of the university in many ways.

- Ensure that all needed information is available and displayed on the page where and when it is needed. The information should be up-to-date even during local or regional holiday.
- Make sure that user of the platform can easily find and contact with the persons in charge of the platform. Furthermore, ensure that users can easily send and receive feedback via email or any other means of communication.
- Designers should allow students to participate in designing educational platform since they are the primary users of these platform, their suggestions and criticisms regarding the platform should be looked into which can serve as guide to the designers.

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