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Exploring Cloud Computing for Education in Rural Nepal: Possibilities, Challenges, and Prospect

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Abstract

Rural education is one of the most significant subjects to talk about and a matter to resolve soon. As rural education in Nepal is very challenging, effective solutions can be brought into action, one of which is the use of technology. This study's main goal is to investigate and evaluate the value and applicability of cloud computing for rural sector education in underdeveloped nations like Nepal. Through the infrastructure it offers, the usage of cloud computing in rural locations significantly increases the accessibility of essential educational computing services and applications to students and instructors. With applications in many different fields, cloud computing has experienced remarkable growth, and one of its most intriguing uses nowadays is in the educational sector. Due to the lack of schools, colleges, and universities in rural areas, the cloud computing system might be extremely helpful in increasing the education of students there. The primary goal of this study is to explore how formal, non-formal, and informal education are mixed for capital formation, empowerment, and self-sufficiency in rural communities. Its secondary goal is to chronicle the potential contributions of community learning centers in the process of rural transformation.

Keywords: Cloud computing, Data storage, Empowerment, Rural Education

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1. Introduction

Cloud computing is the term for the on-demand provision of computer system resources, primarily data storage (cloud storage) and processing power, without direct active supervision by the user. Large clouds usually distribute their functions across a number of locations, each of which is a data center. In order to achieve coherence, cloud computing relies on resource sharing and frequently employs a "pay-as-you-go" strategy, which can help minimize capital expenses but potentially result in unexpected operating expenses for users, unaware of them. Today, it is essential for children to leave school with a solid foundation of skills, such as the ability to create, collaborate, think critically, and communicate effectively. This can be promoted in rural areas of Nepal as well, such as the severely underdeveloped Karnali region, which lacks both educational and medical resources. Implementing cloud computing applications in schools is one strategy to promote an innovative atmosphere. Cloud computing offers innovative potential for remote learning as well as cost- and safety-effective benefits for the classroom and within everyone's means in rural places. The primary objectives of the review study are:

i. Collecting data on the current situation of technological literacy in the country

ii. Analysis of the prospects and significance of cloud-based education in the country

iii. Finally, finding appropriate methods of delivering cloud-based education in the country

1.1 Background Details

This review gives an overview of cloud computing in higher education, outlines the advantages and disadvantages of using the cloud in educational settings, and names a few key considerations that institutions of higher learning should take into account before implementing the cloud. Higher level managers and policy makers must first understand various aspects of cloud computing, identify the factors that influence cloud adoption decisions, analyze those factors, and then decide whether or not cloud computing should be adopted for their educational environment. This is because cloud computing in higher education has both benefits and risks [1]. This study has applied to be completed using a qualitative technique. The study comes to the conclusion that all students, academics, and

researchers have equal access to education through online learning. The nation's digital divide must be addressed, and this will present challenges and difficulties for online education. In rural places, the government should offer broadband Internet, 3G/4G wireless networks, and online learning tools. To address the computer literacy issue, instructions on how to use internet apps is required. This article noted that the main issues with online education are regular power supplies, fast internet, learning tools and materials, qualified teaching staff, information communication and technology infrastructure, and learning programs to conduct online classes [2]. The participants in a poll who agreed to follow-up interviews clarified the status of cloud acceptance and their main difficulties. The main causes of the delay in cloud adoption were discovered to be security, connection, availability, vendor location, and legal difficulties. According to the literature analysis, the two main factors that may be improved by suitable cloud adoption are availability and security. The study of the data reveals that most businesses and government agencies do not use cloud computing [3]. This research suggests a user-friendly cloud network infrastructure environment, particularly for the students who require distant learning and an online learning system. Cloud computing and machine learning go hand in hand; A large amount of client data, and machine learning algorithms to analyze the data and build chatbots is required. In order to improve the higher education system in rural areas during this COVID-19 epidemic, the current prototype has to be improved [4]. The success of cloud computing technologies in the classroom depends on pupils who are completely at ease with it and who have grown up with it. Since students frequently use cloud-based technology in their personal lives, adapting to the cloud computing in the classroom would be simple. It's important to inform and train teachers who might not be as knowledgeable about the benefits of cloud-based technologies. Cloud computing enables the efficient and cost-effective use of technology [5].

2. Methodology

Many rural and remote areas in Nepal, including Karnali, lack access to quality educational resources and institutions. Cloud computing can bridge this gap by providing access to a wide range of educational materials, courses, and online tools, enabling students in these regions to receive a quality education that may not be available locally.

With the rise of cloud computing, classroom equipment like smartphones, tablets, laptops, and desktops are all connected to a wealth of educational resources. Cloud computing

for education is expected to reach $25 billion in market value by 2021 from an estimated $8 billion in 2016. It has been beneficial for both teachers and students to be able to assign and complete classwork online because it is flexible and affordable. Cloud computing enables the sharing of educational resources through the cloud, allowing students who live distant from their institutions to access them from home. This method can also be made more flexible by using online conferences or live classrooms.

Traditional brick-and-mortar educational infrastructure can be expensive to establish and maintain in remote areas. Cloud-based education reduces the need for physical infrastructure, making it a cost-effective solution for delivering education to regions with limited resources.

2.1. Method of Computation and Implementation

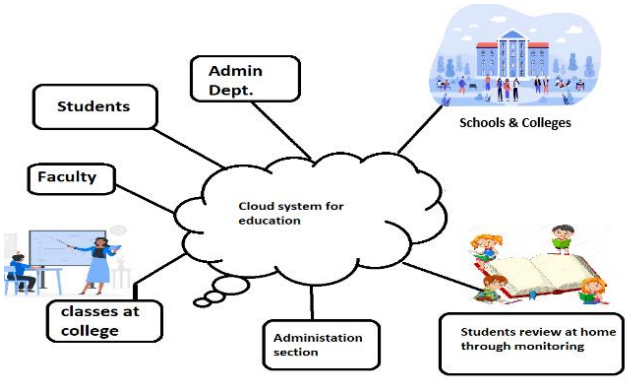

Figure 1. Cloud System for Delivering Education

One vital aspect of educational sector enhancement is offering faculty, staff, and students' cloud-based learning software. If effectively controlled by the government, a single faculty group with government training can support the computing system. Its services include things like an online classroom, which offers video conferencing in a virtual classroom, assignment administration, classroom statistics, and more. Students and educators can access the instructional resources from any computer, smartphone, or tablet via the company's cloud-based software. Lessons, tests, and exercises can be made interactive by the teachers, who can then display or distribute them to the students. Systems are cloud-based, making it simple for both parties to access course information. and can be made accessible by connected displays to the professors or by students' personal devices. One well-known illustration is Coursera,

which makes a range of online courses available from reputable colleges and instructors via its cloud platform. Additionally, it gives degrees recognized by universities and offers courses on particular career skills. In order to obtain a master's degree in computer and information technology, for instance, Coursera students can enroll in online computer science courses provided by the University of Pennsylvania.

It is best suited for a country with a large geographic area because it is difficult for the government to build schools and colleges in a timely manner when insufficient preparation isn't always done. Therefore, if the internet is made accessible to gadgets and devices as well, this computing strategy is advantageous. This is achievable and far cheaper for all, even with scarce resources and labor.

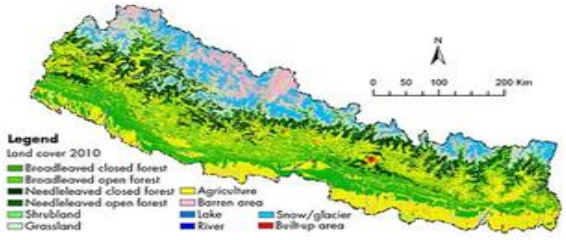

Figure 2. Geography of Nepal

2.2. Prospects of Cloud-Based Education and Contrast with Traditional Approach

2.2.1 Cloud-based Education

Advantages

i. Inclusivity and Accessibility

a. Reach into Remote Areas: Students in remote or underdeveloped areas can access instructional content as long as the internet connection is available thanks to cloud-based education.

b. Reduced Need for Expensive Physical Infrastructure: By lowering the demand for expensive physical infrastructure like computer laboratories, libraries, etc., it increases access to education for a larger audience.

ii. Cost-Effectiveness

Lower Infrastructure expenses: Using cloud services can drastically cut the expenses of purchasing and maintaining physical gear, software, and infrastructure.

a. Pay-as-You-Go Models: A lot of cloud services are pay-as-you-go, allowing organizations to scale their usage in accordance with their requirements.

iii. Flexibility and scalability

a. Resources that can be quickly scaled: Cloud platforms can easily scale to account for changes in demand, ensuring that resources are accessible when required.

b. Adaptability to Different Devices: A greater number of students can participate in cloud-based education because it is available on a variety of devices, including laptops and smartphones.

iv. Collaboration & communication

a. Real-time Collaboration: Cloud-based tools make it possible for students and teachers to work together in real-time on group projects and conversations.

b. Instant Feedback and Assessment: Using digital platforms, teachers can give students feedback right away.

v. Resource Exchange

a. Digital libraries and repositories: Large-scale digital libraries can be hosted via cloud platforms, giving users access to a variety of educational resources like books, articles, films, and simulations.

vi. Personalization and Customization

a. Adaptive learning: Cloud-based platforms can employ data analytics and machine learning algorithms to tailor learning experiences to the preferences and abilities of specific students.

vii. Recovery from Disasters and Security

a. Data security: Cloud service providers frequently have strong security measures in place to guard against loss or unauthorized access to sensitive educational data.

b. Disaster recovery: Cloud services frequently include redundancy and backup alternatives, ensuring that educational resources are not lost as a result of unanticipated circumstances.

viii. Current Content

a. Real-time updates allow for the updating of educational materials, giving students access to the most recent data and resources.

ix. Effect on the Environment

a. Reduced Carbon Footprint: Because cloud computing allows for more effective resource usage than conventional on-premises systems, it may be more environmentally friendly.

x. Cultural Exchange

By promoting international connections and cultural exchange, cloud-based education exposes students to a larger range of viewpoints and experiences.

xi. Teachers' Professional Development

a. Online workshops and training: Cloud-based platforms give instructors the chance to participate in ongoing professional development, which is essential for sustaining high standards in education.

xii. Making Decisions Based on Data

Cloud-based education platforms frequently offer thorough analytics, allowing organizations to make data-driven decisions to enhance teaching and learning results.

Disadvantages

i. Dependence on Internet Connectivity

Learning may be disrupted if there are issues with internet connectivity, which can be a challenge in areas with limited access.

ii. Security Concerns

Institutions need to ensure that sensitive data is protected and that students' privacy is maintained.

iii. Learning Curve

Both students and educators may need time to adapt to new technologies and platforms.

2.2.2 Traditional Educational Methods

Advantages

i. In-Person Interaction

Face-to-face Interaction: Allows for immediate feedback, personalized attention, and stronger interpersonal relationships between students and teachers.

ii. Hands-On Learning

Certain subjects, like lab-based sciences or arts, may be better suited to in-person instruction where physical resources are required.

iii. Established Pedagogical Methods

Traditional methods have been refined over many years and have a proven track record of effectiveness.

iv. Structured Learning Environment

A physical classroom provides a controlled environment with fewer distractions.

Disadvantages

i. Geographical Limitations

Accessibility is restricted to those who can physically attend a specific location, potentially excluding individuals from remote or underserved areas.

ii. Limited Flexibility

Fixed schedules and locations may not accommodate the diverse needs and schedules of all learners.

iii. Cost and Resource Allocation

Institutions must invest in physical facilities, maintenance, and resources like textbooks.

iv. Less Adaptability

It can be more challenging to quickly adapt to changes in curriculum or teaching methods

2.3. Cloud Computing in Rural Education

The entire community, including teachers, students, and parents, benefits from cloud computing in education. With the aid of cloud computing, students can access their assignments and course materials from any location with an internet connection, teachers can instantly upload lesson plans, and the relevant administrations can collaborate and, ultimately, save money on data storage and resource management. Government should concentrate on giving technology learning materials like laptops or smart phones focusing on the learning capacities of the students in remote areas if it is expensive for government to provide books to youngsters.

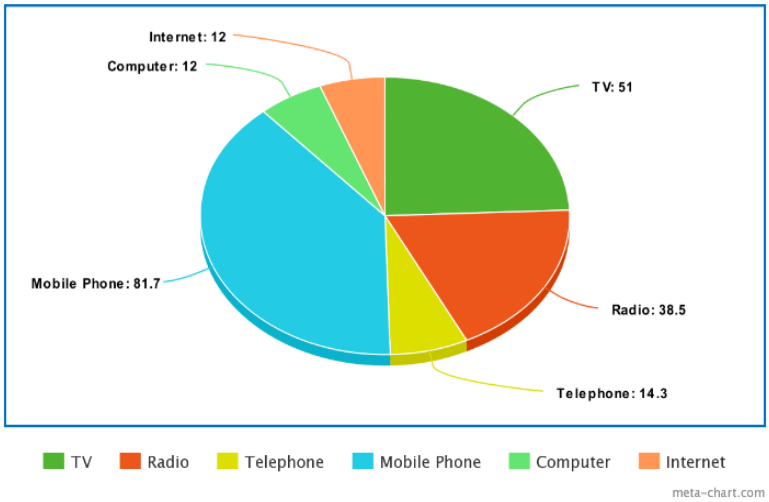

Figure 3. Use of Various Communication Medias in Country

As illustrated in figure 3. In this nation, the two most popular forms of communication are the mobile phone and television. This is also in some ways a good thing because mobile phones can help deliver cloud-based education. However, it does not apply to rural places, such as the Karnali region, where people do not have any access to these media and where a lack of internet connectivity can also be a significant impediment.

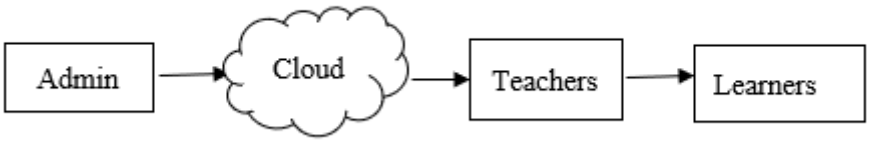

Figure 4. Cloud-based Education Structure

All of the participants in the cloud education process, including students, teachers, and the technology used, can be included in the cloud system. This idea unites every component of the cloud-based education system. To exchange knowledge and educate people, researchers, students, and educational resources can all be linked and collaborated on.

Table 1. Literacy Rate of Nepal

Statistics	**Census 2011**	**Census 2021**	**2011-2021 output**
Overall literacy	65.9%	76.3%	10.4%
Male literacy	75.1%	83.6%	8.6%
Female literacy	57.4%	69.4%	2.0%

In ten years, Nepal's literacy rate has improved by 10.4%. The population, both male and female, is therefore exposed to educational institutions. With increased awareness among parents and public entities, children are receiving educational facilities. A number of reasons have contributed to Nepal's education rate consistently rising by 10.4% every year. First and foremost, government programs and policies that attempt to increase access to education have been crucial. This expansion has been facilitated by investments in new school construction, particularly in rural regions, and the implementation of initiatives to boost enrolment and

lower dropout rates. Second, there is now more emphasis on sending kids to school as a result of parents and communities' growing understanding of the value of education.

Additionally, the improvement of the educational system has benefited from outside assistance from NGOs and international organizations. The use of cloud-based and digital education platforms, among other technical developments, have improved learning accessibility and attractiveness, particularly in rural areas. This steady increase in the education rate demonstrates progress in creating possibilities for young people in Nepal and underlines the country's commitment to enhancing its educational system.

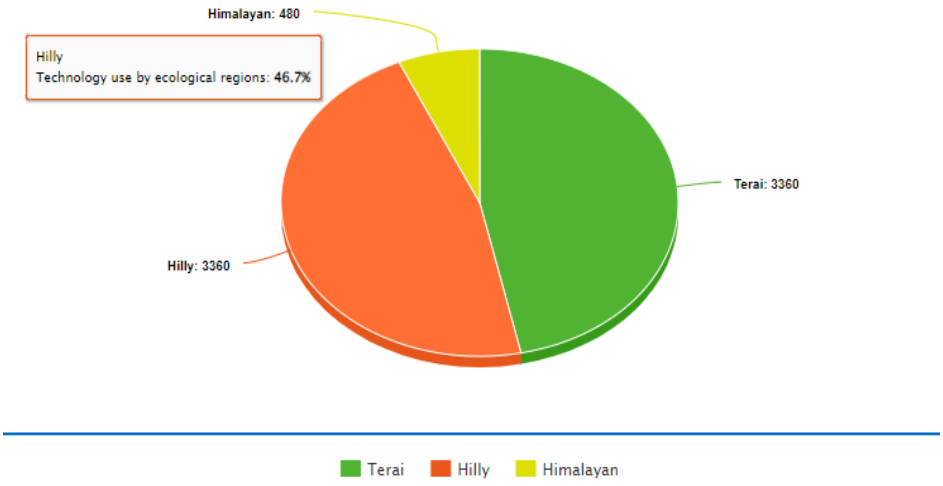

Figure 5. Technology usage in Different Regions of Nepal

As shown in Figure 5, The hilly region comprises the largest number of people using different technologies. Though the hilly region is geographically vast for development activities due to the presence of highly developed cities like Kathmandu and Pokhara, the literacy rate, income rate, and living standard of people residing in those areas are high.

2.3.1 Strategies for Luring Students to the Cloud Computing based Energy

To deliver cloud computing-based education to the Karnali region or any other backward region of Nepal, the following steps can be taken:

1. **Infrastructure Development:** Establishment reliable internet connectivity infrastructure in these regions. This might involve satellite-based internet or the expansion of existing networks to cover remote areas.

2. **Access to Devices:** Ensure that students and teachers have access to devices like smartphones, tablets, or low-cost laptops that can connect to the internet and access online educational resources.

3. **Local Content Creation:** Encourage the creation of locally relevant educational content and resources. This can include translating materials into local languages and addressing specific cultural and educational needs.

4. **Teacher Training:** Provide training for teachers on how to effectively use cloud-based educational platforms and tools. Empowered educators are crucial for the success of online education.

5. **Community Engagement:** Involve local communities and parents in the education process. Their support and engagement can help ensure that students are motivated and receive the necessary support.

6. **Government Initiatives:** Collaborate with the government to develop policies and initiatives that promote cloud-based education in remote regions. This can involve subsidies for internet access or partnerships with educational organizations.

7. **Monitoring and Evaluation:** Continuously monitor the effectiveness of cloud-based education in these regions and make adjustments as needed to improve the quality of education delivered.

8. **Public-Private Partnerships**: Engage with private sector companies and organizations that can provide resources, funding, and expertise to support cloud computing-based education initiatives in Karnali and similar regions.

By addressing infrastructure challenges, fostering local engagement, and leveraging cloud computing technology, it is possible to deliver quality education to underserved regions like Karnali in Nepal ultimately assisting in bridging the educational discrepancy and empowering students in these fields.Smartphones, tablets, laptops, and desktops are becoming more and more typical classroom equipment, and owing to cloud computing, the devices are connected to a variety of instructional materials.

3. Results and Discussion

Because of cloud computing, students' backpacks are lighter, and can work from anywhere, if an internet connection is available because of the instant access and store materials related to homework and tests on distant servers. Without having to be in the same room, students can work on group tasks with classmates.

As a result, increasing numbers of students are replacing their notebooks and binders with computers and iPads, and increasing numbers of professors are adopting online tools to distribute and monitor homework.

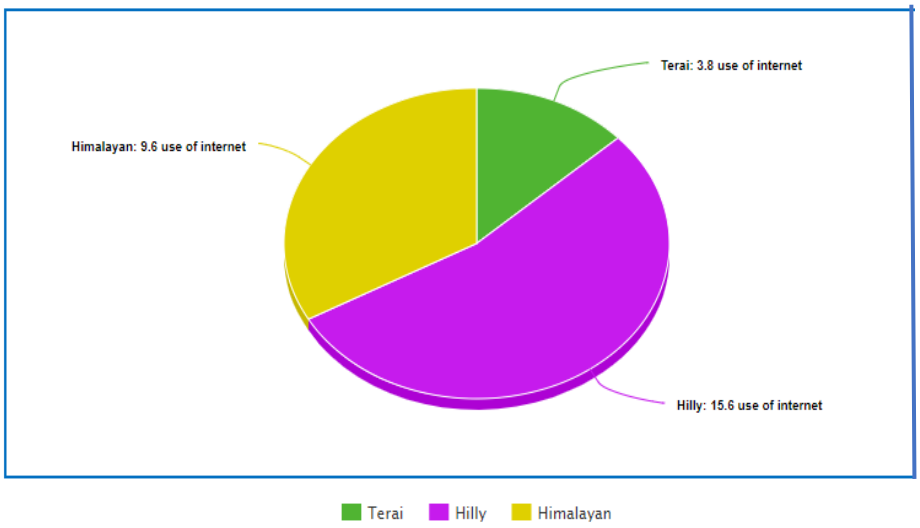

Figure 6. Use of Internet in Different Ecological Regions of Nepal by Number of Users

Out of the overall population, the hilly area, which is one of Nepal's most ecologically developed regions, is home to the bulk of internet users. The flat Terai region, which shares much of its border with India, lacks internet access due to its lower-than-average literacy rate and lower than average living standards.

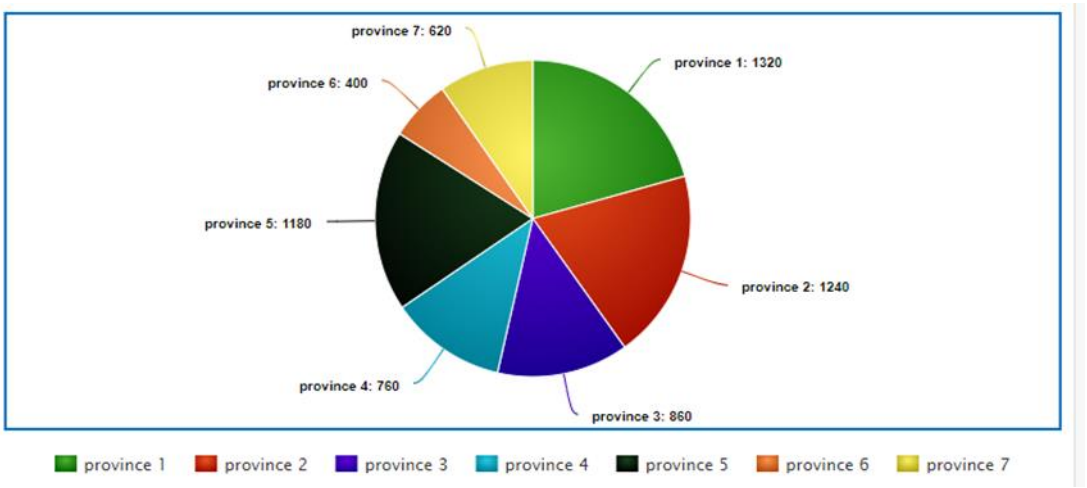

Figure 7. Use of Technologies and Medias in Different Provinces by People's Number

It is observed that the province 1 uses technology the most. With districts like Morang and Jhapa that have well developed infrastructures and readily available facilities, this is Koshi province. A major factor in the Sunsari district's development is its close proximity to India.

3.1. Major Issues with Cloud-based Education Implementation in Nepal

i. **Limited Internet Connectivity:** Access to reliable and high-speed internet remains a challenge, especially in rural and remote areas. This limits the reach and effectiveness of technology-based education.

ii. **Lack of Infrastructure:** Many schools and educational institutions in Nepal lack the necessary infrastructure, such as computers, electricity, and digital learning resources, to implement technology-based education effectively.

iii. **Language Barriers:** Most online educational content is available in English or Nepali, which can be a barrier for students who speak other regional languages.

iv. **Teacher Training:** Teachers often lack training in using technology for teaching purposes. This can hinder the effective integration of technology into the classroom.

v. **Digital Divide:** There is a significant digital divide between urban and rural areas. Students in urban centers have more access to technology and online resources, while those in remote regions have limited access.

vi. **Government Initiatives:** The government of Nepal has shown interest in promoting technology-based education through initiatives like the use of tablets in schools and the development of e-content. However, progress has been gradual.

vii. **Online Learning Platforms:** Some private organizations and universities in Nepal have started offering online courses and programs, but these options are often concentrated in urban areas and may not be accessible to all.

viii. **COVID-19 Impact:** The COVID-19 pandemic accelerated the adoption of technology-based education in Nepal, with many schools and colleges resorting to online classes. However, this shift highlighted the digital divide and access issues in the country.

ix. **Content Localization:** Efforts were being made to create digital content that is more culturally and linguistically relevant to Nepal. Localizing content can make technology-based education more effective in the country

x. **Challenges in Assessment:** Online assessment and evaluation methods were still in the development phase in many educational institutions, making it difficult to conduct fair and secure exams online.

Despite, considerable success in Nepal's technology-based education, issues with infrastructure, connectivity, and teacher preparation continue, especially in rural and isolated locations. The digital gap is still a major issue, and initiatives are being undertaken to overcome it and use technology to improve accessibility and effectiveness of education. For information on the most recent advancements in the area of technology-based education in Nepal, contemporary sources and government updates can be examined.

3.2. Internet & Technological Barriers

The primary barrier to internet availability and delivery is the geographical and physical nature of the location. The key difficulty for cloud computing is addressing the security and privacy concerns of rural educational centers considering its use. The fact that

the Educational Center's valuable company data will be stored outside the firewall raises severe issues. Even if only one site is attacked, hacking and other attacks on cloud infrastructure will harm several rural centers. Another difficulty with cloud computing is that data saved in the cloud is not totally safe. Data is vulnerable to theft and hacking since it is stored online. By using security software, encrypted file systems, data loss software, and security devices to monitor anomalous activity across servers, these dangers can be reduced. An ongoing, quick internet connection is required for cloud computing. In essence, this is a rather recent technological development. Additionally, it is really dependent on the internet to function freely, just like all other advancements. In other words, crucial communications and procedures would be severely hampered in the absence of the internet. Existing poor literacy rates are a barrier to education in rural areas, as there aren't sufficient tutors for government schools.

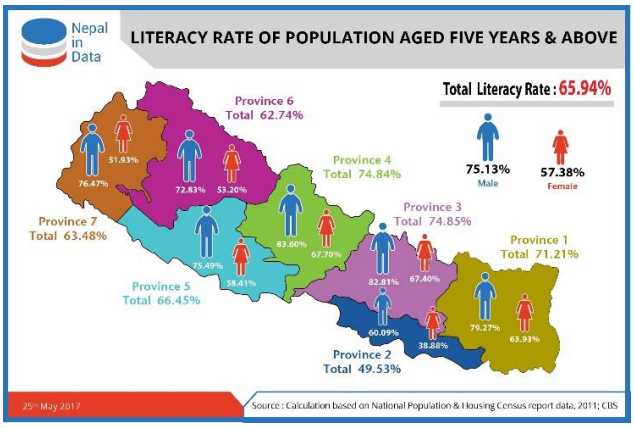

Figure 8. Literacy Rate of aged 5 and above Population [18]

Figure 8. illustrates how low the literacy rate is in Nepal. Even although it is improving over time, there is a competitive divide between male and female literacy in Nepal. Due to the government's focus on women's education and empowerment, these behaviors are now increasingly widespread in Nepal.

Examining the Challenges

- Extreme geographic circumstances
- Internet access is not always available, and ISPs are unable to reach remote areas.

- The students' poor financial situation
- Their lack of technological expertise, non-basic computer skills, and limited English proficiency.

3.3. Potential Strategies & Solutions for Tackling the Barriers for Cloud-Based Education in Country

A multifaceted strategy is required to overcome obstacles in providing cloud computing-based education within a nation. This includes suggestions for public policy, upgrades to the physical environment, and community involvement. Here are some possible remedies and tactics:

- **Policy Recommendations**

a. Digital Education Framework: Establishment of a comprehensive framework that outlines the goals, standards, and guidelines for cloud-based education. This should encompass curriculum design, assessment methods, and teacher training.

b. Data Privacy and Security Regulations: Implementing strict data protection laws to safeguard the personal information and learning data of students and educators.

c. Internet Access Mandates: Enforcing policies that ensure affordable, reliable, and high-speed internet access in all regions of the country, especially in remote and underserved areas.

d. Licensing and Certification for Cloud Service Providers: Setting up a certification process for cloud service providers to ensure that the specific educational standards and security protocols are met

e. Accessibility Standards: Mandating that educational resources and platforms be designed with accessibility in mind to cater to learners with disabilities.

f. Incentives for EdTech Adoption: Providing incentives, such as tax breaks or grants, to educational institutions and organizations that invest in cloud-based education technology.

- **Infrastructure Improvements**

a. Broadband Expansion: Invest in the expansion of broadband infrastructure to connect rural and underserved areas, enabling seamless access to cloud-based education resources.

b. Cloud Data Centers: Develop and expand data centers with advanced computing capabilities to support the scalability and reliability of cloud-based education platforms.

c. ICT Training for Educators: Provide training and professional development for educators to effectively utilize cloud-based tools and platforms for teaching.

d. Device Accessibility: Ensure students have access to affordable devices (e.g., laptops, tablets) by implementing subsidy programs or low-cost initiatives.

e. Power Infrastructure: Strengthen power grids and ensure consistent electricity supply to support uninterrupted access to online education.

- **Community Involvement**

a. Community Wi-Fi Initiatives: Encourage community-driven initiatives to set up local Wi-Fi networks in areas with limited internet access.

b. Parent and Guardian Involvement: Engage parents and guardians in the education process, providing them with resources and training to support their children's online learning.

c. Local Content Creation: Foster the development of locally relevant educational content and applications that can be hosted on cloud platforms.

d. Feedback Mechanisms: Establish channels for feedback from students, educators, and parents to continually improve the quality and accessibility of cloud-based education.

e. Collaborative Learning Spaces: Encourage the creation of local learning hubs or community centers equipped with digital resources for students who may not have suitable home environments for online learning.

A nation can strive toward developing an inclusive and successful cloud computing-based education system that caters to the requirements of all students, regardless of their location or socioeconomic background, by putting these solutions and tactics into practice. Collaboration between governmental organizations, educational institutions, technological suppliers, and the general public is necessary for this strategy.

4. Conclusions

As a result, cloud computing can be a fantastic solution to the illiteracy and skill gap among rural residents and peasants. Cloud computing can be used to educate kids in hard-to-reach regions without built-in schools and in places with challenging topographical conditions. Children in rural communities frequently walk long distances to school while wearing only their socks. As children and students will be the future builders of the nation, a quicker answer is required. The children are impacted by the flooding, wide rivers, and hazardous roadways. In order to properly teach kids, cloud computing may be helpful. not smartphones or computers. Additionally, the establishment of an IT center and large educational delivery displays placed strategically can be very helpful for this purpose. The lack of internet service in those locations, which needs to be remedied by the government, is the most difficult issue of all.

For a nation like Nepal, cloud-based education is essential for a number of compelling reasons. Despite its rich cultural past and stunning natural surroundings, Nepal's education system confronts several obstacles because of geographical and infrastructure constraints. These problems can be solved, and the country's educational system will benefit significantly from cloud-based learning.

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Author's biography

Biplov Paneru (https://orcid.org/0000-0003-2003-0648) is pursuing a Bachelor of Engineering in Electronics and Communication at Nepal Engineering College, Pokhara University. He has been actively engaged in Research and Development activities related to computer vision, embedded systems, image processing, etc. He is a research and development engineer in rocketry at the National Innovation Center of Nepal and a freelance software developer on Upwork. This research was conducted as part of the product development process, and its prototype was successfully created and implemented.

Bishwash Paneru is pursuing a Bachelor of Engineering in Chemical Engineering at Institute of Engineering, Puclhowk Campus. He has been actively engaged in Research and Development activities related to fuel conversion, green hydrogen, pyrolysis, water treatment, Machine Learning etc. He is a research intern at Environ Renewables and has been researching in field of green hydrogen, ML algorithms and alternative energy. He is also a chemical engineering freelancer at upwork.