Transforming Education in Uttarakhand through Cloud Computing Model: An Explorative Study

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Abstract

The education system in Uttarakhand, India, faces significant challenges, including inadequate infrastructure, limited availability of teachers, and difficulty in delivering quality education to remote areas. This study explores the potential of cloud computing to transform the education system in Uttarakhand, improving access, reducing costs, and enhancing collaboration. The study's implications suggest a 'TESU' model that cloud computing can play a critical role in bridging the digital divide and providing quality education to all in Uttarakhand. The findings of this study can inform education policy and practice in Uttarakhand, highlighting the need for further investment in cloud computing infrastructure and training for educators.

Keywords: Education, Model, Cloud Computing, Learners, MOOCs.

Practical Takeaways:

- Several existing models like SWAYAM, Coursera, and Unacademy are successfully operating in this domain. However, the proposed TESU model differs by not limiting itself to certification and learning; it also empowers users to design and upload courses.
- Unlike platforms like SWAYAM, which restrict course creation to government university professors, TESU allows any subject-matter expert or enthusiast to create courses. Post-verification, students can access these courses. Additionally, the model addresses internship anxieties for final-semester students (where universities struggle to meet project demands) and enables professionals to monetise their expertise by offering courses.

- NASSCOM's initiatives and events are often centred around major tech hubs like Bengaluru, Hyderabad, and Pune, with limited outreach in Tier-2 and Tier-3 cities.

  NASSCOM is often perceived as being more aligned with the interests of large IT service companies rather than SMEs and independent tech entrepreneurs.

- TESU Framework: A government-integrated cloud model (TESU) centralises resources, standardises certifications, and aligns courses with market demands for employability.

1. Introduction:

In recent years, the Indian government has emphasised the need to revamp the education system to make it more inclusive, accessible, and effective. In this context, technology has emerged as a powerful tool to bridge the gap between the haves and have-nots. Cloud computing, in

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particular, has the potential to transform the education landscape in Uttarakhand by providing scalable, cost-effective, and flexible solutions for storing and accessing educational resources.

Uttarakhand Open University, the only State Open University in Uttarakhand, has established its Learning Support Centres (LSCs) in remote locations across the state. This initiative has significantly contributed to fulfilling its mission of bringing 'education to the doorsteps of learners. (Joshi, Fulara, Tamta, Chaudhury, & Paliwal, 2022). In Uttarakhand, higher education is offered by 36 institutions, with 97% operating through conventional modes and only one university (3%), Uttarakhand Open University (UOU), dedicated entirely to the ODL (Open and Distance Learning) system. Cloud computing can facilitate remote learning, enable collaborative learning environments, and provide access to high-quality educational content to students in even the most remote areas of Uttarakhand. Moreover, cloud-based solutions can help reduce the digital divide, increase access to education, and improve learning outcomes. This paper proposes a case model for transforming education in Uttarakhand through cloud computing, with a focus on leveraging this technology to overcome the challenges faced by the traditional education system. The proposed model aims to explore the potential of cloud computing in enhancing the quality, accessibility, and affordability of education in Uttarakhand. By examining the current challenges faced by the education system in the region and identifying the opportunities offered by cloud computing, this research paper seeks to develop a comprehensive framework for harnessing the power of cloud technology to transform education in Uttarakhand.

2. Aim and objectives

Based on the abstract provided, the following two objectives can be derived for the study:

Objective-1: To evaluate the impact of cloud computing on improving access to quality education in Uttarakhand, particularly in remote and underserved areas, by addressing challenges such as inadequate infrastructure and limited teacher availability.

Objective-2: To develop and propose the 'TESU' model, demonstrating how cloud computing can reduce costs, enhance collaboration, and bridge the digital divide in Uttarakhand's education system, with implications for informing education policy and practice.

3. Literature Review:

Cloud computing has emerged as a transformative technology in education, offering numerous benefits and challenges. It provides access to advanced infrastructure and software, enhancing teaching effectiveness and student learning ((Anand, 2015). Cloud computing enables inclusive and equitable quality education, aligning with the UN Sustainable Development Goals (Haleem, Javaid, Qadri, & Suman, 2022). It facilitates better management of educational resources, including labs, research facilities, and libraries, while promoting collaborative work among students and teachers (Ruzaina & Afshar, 2017). The technology's advantages include cost reduction, improved computing power, and increased accessibility (González Martínez, Bote-Lorenzo, Gómez-Sánchez, & Cano-Parra, 2015). However, implementation challenges persist, such as security concerns and the need for careful service selection. Despite these challenges, cloud computing's potential to revolutionise education is significant, particularly in light of recent global events like the COVID-19 pandemic, which has accelerated the adoption of digital technologies in education (Haleem, Javaid, Qadri, & Suman, 2022).

Some papers that are relevant and align well with the research topic are as follows in Table1:

Table-1: Role of cloud computing

Scope of Cloud Computing in the Education Sector: A Review *(Anand, H.S., & India, P. (2015). Scope of Cloud Computing in Education Sector: A Review.)*	- Cloud computing can help deliver quality education by providing access to the latest hardware and software infrastructure. - There are certain issues that need to be addressed when implementing cloud computing in the education sector.
Understanding the Role of Digital Technologies in Education: A Review *(Haleem, P.A., Javaid, D.M., Qadri, P.M., & Suman, D.R., 2022). Understanding the Role of Digital Technologies in Education: A Review. Sustainable Operations and Computers.)*	- Digital technologies are essential tools for achieving quality education and have various applications in areas like emissions detection, energy efficiency, and greenhouse gas removal. - The COVID-19 pandemic has accelerated the adoption of digital technologies in education, leading to a paradigm shift where they serve as knowledge providers, co-creators of information, mentors, and assessors. - Technological improvements in education have made it more convenient for students, allowing them to use digital tools and devices instead of traditional methods, which increases their research interest.
Role of cloud computing technology in the education sector *(*Thavi, R.R., Jhaveri, R.H., Narwane, V.S., Gardas, B.B., & Jafari Navimipour, N. (2021). Role of cloud computing technology in the education sector. *Journal of Engineering, Design and Technology*.)	- The paper identifies various factors that influence the adoption of cloud computing in the education sector. - Cloud computing could enhance educational systems, especially in developing countries, and improve the scope for remote/distance learning.
Cloud-Based Architecture for Smart Educational System Using Modern Technology *(Vistro, D.M., Rehman, A.U., Abid, A., Farooq, M.S., & Idrees, M.S. (2020). Cloud-Based Architecture for Smart Educational System Using Modern Technology.)*	- Cloud computing is a revolutionary technology that is transforming the traditional IT system. - Cloud computing can change the way teaching is done, as students are moving towards modern technology, and educational institutions need to educate students and teachers about cloud computing and data storage. - Implementing cloud-based systems in educational institutions, especially in backward areas, is a challenge due to a lack

	of awareness about cloud computing.
Understanding the Status of Computer Education in the State of Uttarakhand: A Case Study of Roorkee *(Aggarwal, U. (2020). Understanding the Status of Computer Education in the State of Uttarakhand: A Case Study of Roorkee.* International Conference on Research in Management & Technovation*.)*	- The study aimed to analyse the impacts of e-initiatives in the education sector in the state of Uttarakhand. - The study specifically looked at the issues with e-initiatives in school education in Uttarakhand, with a case study of the city of Roorkee. - The study also examined the computer literacy and skills of school-going children in the region.
Selecting a suitable Cloud Computing technology deployment model for an academic institute. *(N., R., P., S., G., T., & G A. (2014). Selecting a suitable Cloud Computing technology deployment model for an academic institute.* Campus-wide Information Systems, 31*, 319-345.)*	- Selecting a suitable cloud computing deployment model is an important decision for academic institutes, as it can impact the requirements of various stakeholders. - The implementation of cloud computing in the educational sector is more common in Western countries compared to developing countries like India.

Based on the recent research reviewed (Table 1), the following common findings and gaps have been identified:

i. **Common Benefits and Challenges:** Most studies highlight the numerous benefits of cloud computing in education, such as providing a reliable, scalable, and cost-effective on-demand computing infrastructure. However, these studies also identify challenges in their implementation, particularly in the context of educational systems.

ii. **Lack of Centralised Monitoring: A significant gap identified is the absence of a centralised** monitoring system for educational institutions in India. This is seen as a major factor contributing to low literacy rates and the poor quality of education in the country.

iii. **Geographical Disparities in Implementation:** The adoption of cloud computing in education is more prevalent in Western countries compared to developing nations like India. This indicates a disparity in the implementation and utilisation of cloud technologies in the educational sector across different regions.

iv. **Focused but Limited Scope:** Aggarwal, U. (2020) conducted a study focusing on a single state (Uttarakhand) and city (Roorkee), offering a "general review" and recommendations for improvement. However, this study lacks a detailed analysis of current e-initiatives, limiting its applicability to broader contexts.

v. **Absence of a Suitable Model for Learners:** None of the reviewed research papers has proposed or implemented a suitable cloud computing model tailored specifically for learners. This represents a significant gap in the literature, indicating the need for further research in this area.

This review highlights the need for more comprehensive studies that address these gaps, particularly the development of tailored cloud solutions.

Why 'TESU' model for Learners?

The market for online project preparation and training for students in India, specifically targeting BCA, BBA, MCA, and MBA programs, is significant and has been growing rapidly due to the increasing demand for skill-based education, remote learning, and the widespread use of online platforms. Here's an approximate estimate of the market size in terms of money and learners:

(a) **Market Size in Terms of Revenue:** The Indian EdTech market is expected to reach around $10.4 billion by 2025, growing at a compound annual growth rate (CAGR) of 39% from 2020 to 2025. **(Bain Company, 2020)**

(b) **Market Size in Terms of Learners:** India has a large student base in higher education, with over 38 million students enrolled in various undergraduate and postgraduate programs. Out of this, a significant portion is enrolled in courses like BCA, BBA, MCA, and MBA. With the rise of online learning, a considerable percentage of these students are now engaging in online platforms for project preparation and training. It is estimated that around 20% to 30% of these students (approximately 800,000 to 1.2 million learners) are actively using online services for their academic projects and training needs. **(KPMG & GOOGLE, 2021)**

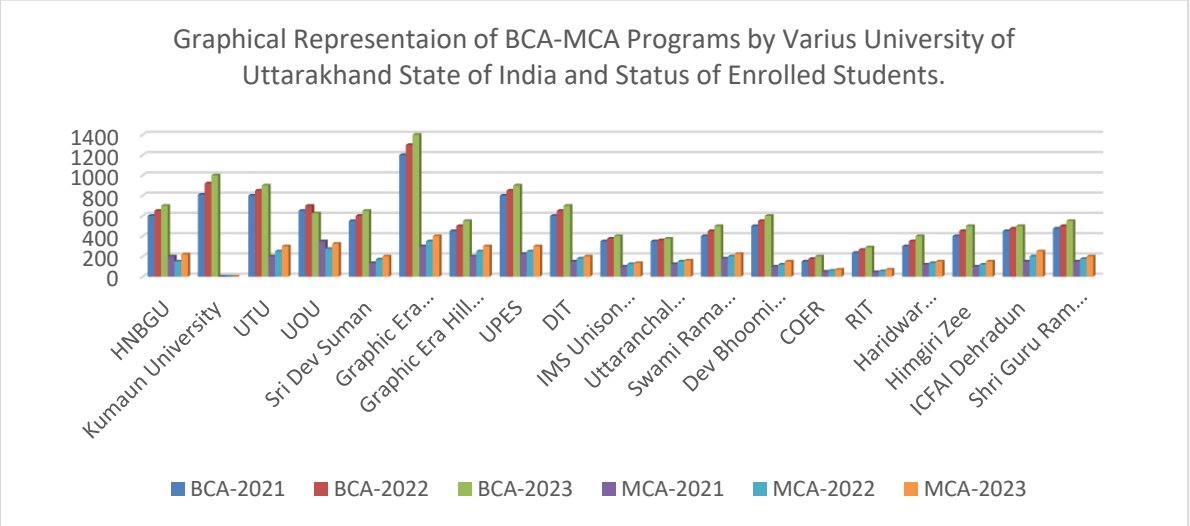


Figure 1: Enrolment Trends Across Various Universities in Uttarakhand (2021-2023)

(c) **Growth Factors**
COVID-19 Impact: The pandemic accelerated the shift to online learning, significantly boosting the market for online education and training.

(d) **Government Initiatives**: Programs like SWAYAM and Digital India have further fueled the adoption of online education (Ministry of Education, 2023)**.**

(e) **Increased Internet Penetration**: With the rise in internet accessibility and smartphone usage in India, even students from remote areas are now able to access online training and project preparation resources (Nasscom, 2024).

(f) To assess the current market size in terms of learners, a study was conducted through an online survey targeting students enrolled in BCA and MCA programs over the past three

years. This survey was distributed to various college and university authorities across Uttarakhand. After analysing the survey responses, the following details regarding the market size for BCA and MCA learners in Uttarakhand were obtained.

Description of Proposed 'TESU' Model

In Figure 2 of a cloud service architecture, there are several components depicted. This diagram is based on three layers:

Layer 1 and the innermost core of the system. This can also be called the Government Education Cloud Services Layer (GECS Layer). This Layer suggests the presence of cloud services specifically tailored for government education purposes, highlighting a specialised use case within the cloud environment. This layer has three components:

(a) Education Online Policy

The role of an Education Online Policy at the state level is crucial for shaping the future of digital learning. Such a policy typically encompasses several key functions:

i. **Accessibility and Inclusion**: Ensures that all students, regardless of location, socioeconomic status, or physical ability, have access to quality online education. It promotes digital literacy and provides the necessary infrastructure, such as internet connectivity and digital devices, to underserved areas.
ii. **Curriculum and Content Development**: Guides the creation and curation of online educational content that aligns with state educational standards. It ensures that digital resources are relevant, up-to-date, and cater to diverse learning needs.
iii. **Teacher Training and Support**: Establishes guidelines for training educators in effective online teaching methods. It supports professional development to help teachers integrate technology into their classrooms and adapt to new online teaching platforms.
iv. **Quality Assurance and Evaluation**: Sets standards for the quality of online education, including content delivery, student engagement, and assessment methods. It also includes mechanisms for continuous evaluation and improvement of online educational programs.
v. **Data Privacy and Security**: Provides regulations to protect student data and ensure privacy in the online learning environment. It addresses concerns related to cybersecurity and the ethical use of student information.
vi. **Equity in Funding**: Ensures equitable allocation of resources to schools for implementing online education, particularly in rural or economically disadvantaged areas. It may also involve partnerships with private sector companies or non-profits to fund digital education initiatives.
vii. **Policy Advocacy and Public Awareness**: Advocates for the importance of online education and its role in modern learning. It works to increase public awareness about the benefits and challenges of digital learning, fostering a culture of acceptance and support.
viii. **Innovation and Research**: Encourages innovation in educational technology and pedagogy. It supports research initiatives to explore new online learning methods, tools, and their impact on educational outcomes.

By effectively implementing these roles, an Education Online Policy can help bridge the digital divide, enhance learning outcomes, and prepare students for the demands of the modern workforce.

(b) Certification : The **Certification Layer** in an online education model plays a crucial role in validating and recognising the knowledge, skills, and competencies that students acquire

through digital learning platforms. Here's how it functions within the context of a state's online education system:

1. **Standardisation of Credentials**
   - Ensures Consistency: The Certification Layer establishes a standardised system for awarding certifications across various online courses and programs, ensuring that credentials are consistent, reliable, and recognised across the state.
   - Alignment with State Standards: It aligns certifications with state educational standards, ensuring that online learning outcomes meet or exceed the expectations set for traditional education models.
2. **Accreditation and Quality Assurance**
   - Validates Program Quality: This layer plays a critical role in accrediting online courses and programs, ensuring that they meet the required quality standards. Accredited programs are more likely to be trusted by employers, educational institutions, and other stakeholders.
   - Monitoring and Evaluation: It involves regular monitoring and evaluation of online education providers to maintain the credibility and integrity of the certification process.
3. **Recognition and Transferability**
   - Facilitates Recognition: Certifications awarded through this layer are designed to be recognised by employers, higher education institutions, and professional bodies both within and outside the state. This helps students transition smoothly into the workforce or further studies.
   - Enables Credit Transfer: It allows for the transferability of credits and certifications between different institutions, both online and traditional, facilitating lifelong learning and mobility for students.
4. **Validation of Learning Outcomes**
   - Assesses Competency: The Certification Layer ensures that certifications accurately reflect the learner's competency in a subject area through assessments, practical exams, or project-based evaluations.
   - Supports Personalised Learning: It may also recognise micro-credentials or modular learning, where students can earn certifications for specific skills or knowledge areas, supporting personalised and flexible learning pathways.
5. **Enhancing Employability:** Bridges Education and Employment: Certifications serve as a bridge between education and the labour market by validating skills that are directly relevant to industry needs. This layer can work closely with employers to ensure that certifications are aligned with current job market demands.
   - Supports Career Advancement: For working professionals, the Certification Layer offers opportunities for upskilling and reskilling, helping them to advance in their careers through recognised and relevant credentials.
6. **Equity and Accessibility**
   - Broadens Access to Credentials: By providing accessible certification options, this layer ensures that learners from diverse backgrounds, including those in remote or underserved areas, can earn recognised credentials that enhance their educational and employment opportunities.
   - Supports Non-Traditional Learners: It recognises and certifies informal and non-traditional learning experiences, making education more inclusive for those who may not follow conventional educational pathways.
7. **Innovation and Adaptability**
   - Adapts to Technological Advances: The Certification Layer keeps pace with technological and educational innovations, incorporating new assessment methods, such as AI-driven evaluations or blockchain for secure credentialing.

- Encourages Continuous Improvement: It fosters an environment where online education providers continually update and improve their offerings to meet evolving standards and learner needs.

8. **Policy and Governance**
   - Guides State Policy: The Certification Layer provides a framework for state policies related to online education, ensuring that certifications are integrated into the broader educational and workforce development strategies.
   - Ensures Accountability: It holds online education providers accountable for the quality of their programs and the validity of the certifications they issue, thereby protecting students and maintaining public trust.

By fulfilling these roles, the Certification Layer enhances the credibility, recognition, and impact of online education in the state, contributing to a robust and flexible education system that meets the needs of a diverse learner population.

(c) Cloud Deployment

Cloud deployment in online education not only enhances the efficiency and effectiveness of educational delivery but also makes it more accessible, scalable, and adaptable to the evolving needs of learners and educators.

Second Layer (Technical Controlling Layer): The second layer has the following layers

1. **Cluster Controller**: This component is responsible for managing and coordinating the resources within a cluster of servers in the cloud environment
2. **Storage Controller**: The storage controller manages the storage resources in the cloud, ensuring data is stored and retrieved efficiently.
3. **Node Controller**: Node controllers are responsible for managing individual nodes or servers within the cloud infrastructure.
4. **Walrus:** A part of the cloud deployment process or a tool used in managing cloud services.

Third Layer: User-Defined Application Layer.

The third layer of the proposed TESU Model is the User-Defined Application Layer, which offers several key functionalities:

1. **Course Selection and Setup**: Users can browse and select subjects for learning based on their interests or professional needs. Additionally, professionals have the option to create their own courses and syllabi, tailored to specific industry or academic requirements.
2. **Course Verification:** Before any course becomes available to learners, it undergoes a verification process. This ensures that all content aligns with educational standards and policies set by the governing body.
3. **User Enrolment and Examination**: Once a course is verified, users can enrol and participate in the course. The system manages the examination process, allowing learners to demonstrate their understanding of the material.
4. **Certification**: After successfully completing the course and examination, learners receive a certificate. This certification is approved by the government layer, adding credibility and recognition to the learner's achievements.

   This User-Defined Application Layer empowers both learners and professionals by providing flexibility in course selection and creation while ensuring that all educational content meets established standards.

Overall, these components and elements in the diagram represent the various aspects and functionalities involved in managing cloud services, particularly in the context of education and government sectors.

4.Result Analysis:

After exploration of the various literature and survey analysis, the following points can be

considered: -

(a) A significant gap identified is the absence of a centralised monitoring system for educational institutions in India.

(b) A suitable model is needed that benefits not only learners but also the government and business sectors.

(c) A model (TESU) is proposed that was based on a centralised monitoring system as well as a revenue-generating business model.

(d) After analysing the chart of BCA and MCA as a case study for Uttarakhand, the following results are given below:

BCA Programs: Most universities show a positive trend in BCA student numbers. The overall growth indicates a healthy interest in BCA programs.

Table 2: Analysis of Annual Growth of BCA Students

Number of Universities Analysed: 19			
Growth from 2021 to 2022		Growth from 2022 to 2023:	
Mean:	9.52%	Mean:	7.71%
Standard Deviation:	3.82%	Standard Deviation:	5.23%
Minimum:	2.86%	Minimum:	-10.71%
Maximum:	16.67%	Maximum:	14.29%

From Table 2 Analysis of BCA and MCA Student Numbers Trends (2021-2023)

BCA Student Numbers Trends (Overall Trends):

- Increase in Numbers: The average number of BCA students has increased from 530 in 2021 to 617.89 in 2023.
- Yearly Growth: The average growth rate from 2021 to 2022 was 9.52%, and from 2022 to 2023, it was 7.71%

MCA Student Numbers Trends (Overall Trends):

- Increase in Numbers: The average number of MCA students has increased from 151.58 in 2021 to 200.26 in 2023.
- Yearly Growth: The average growth rate from 2021 to 2022 was 15.45%, and from 2022 to 2023, it was 18.86%.

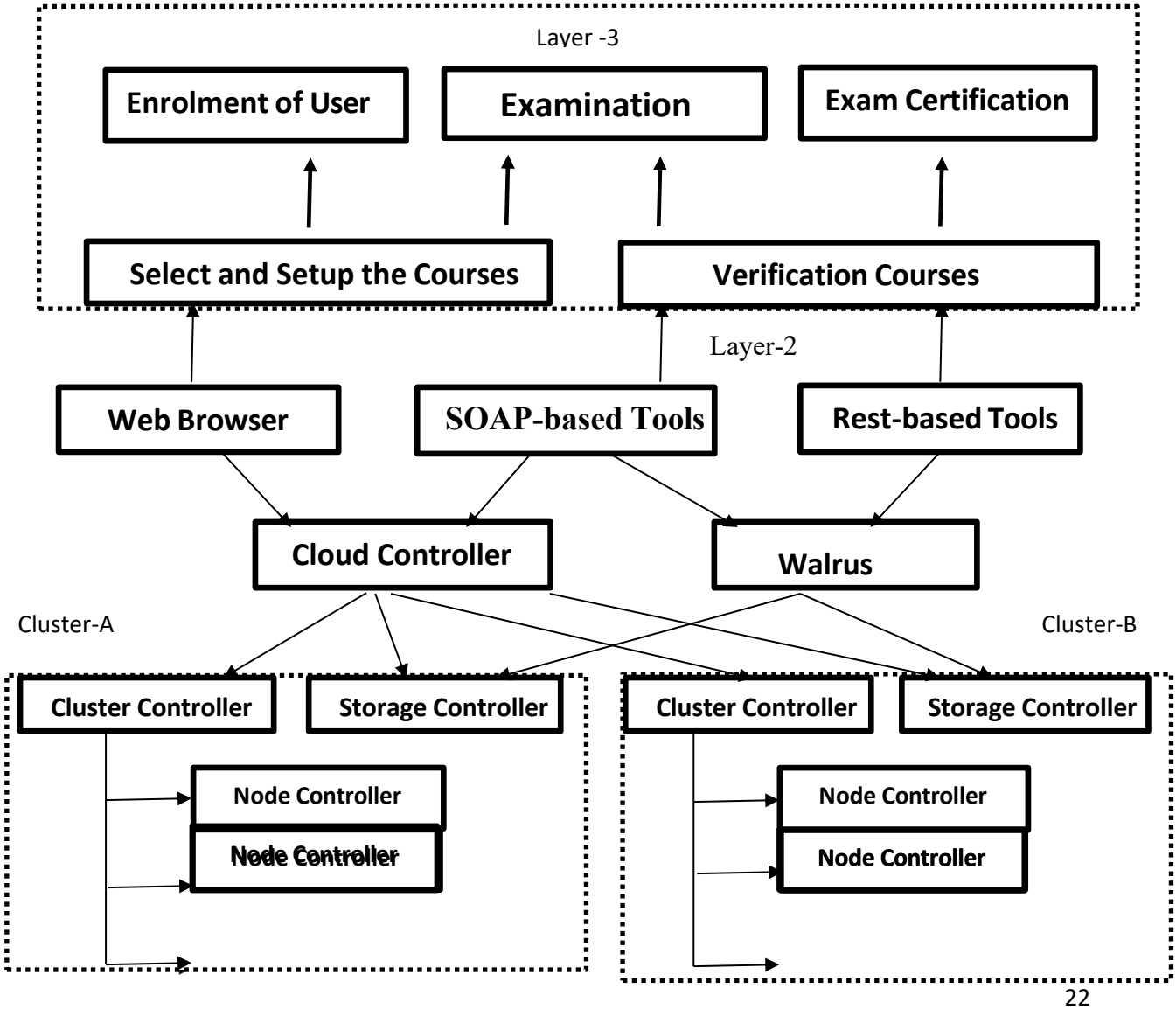
(e) If a cloud platform were to capture a portion (e.g., 50%) of the mentioned education programs, a substantial part of the overall education program could be adjusted accordingly. Since universities typically require a project and internship in the final semester, offering these through courses on a cloud platform would not only benefit learners but also generate revenue for the government. Under the proposed TESU model, any program on the cloud platform would be affiliated with the government, ensuring compliance with all established standards.

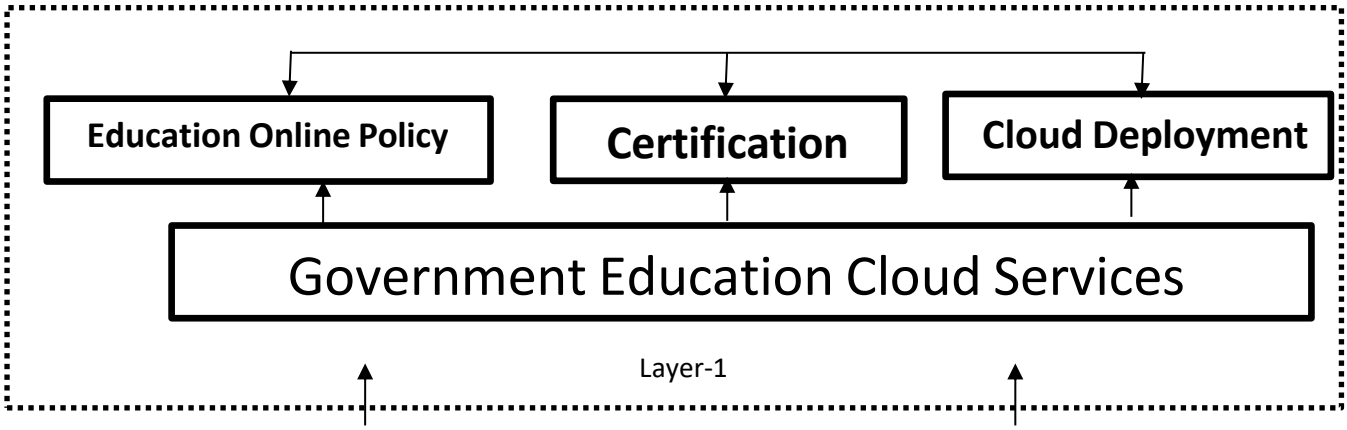
Conclusion:

This case study proposes the use of cloud computing as a solution to address the lack of

investment in higher education infrastructure in the Indian state of Uttarakhand. The article introduces a cloud computing model for higher educational institutions in India, based on the Cloud Eucalyptus framework. As previously mentioned, every university in the state requires students to complete a project and internship during their final semester. If these projects and internships are delivered through courses on a cloud platform, it would not only benefit learners but also create a revenue-generating opportunity for the government. Although this study focuses on BCA and MCA program courses, the model can be expanded to include other courses for additional benefits.In India, many young people show a strong interest in government jobs, which leads to the misconception that degree courses are more valuable than certification or skill courses. As a result, there is generally less interest in skill-based education or certification programs. The TESU model, by offering government-certified credentials, not only supports the completion of degree programs but also serves as a bridge between companies and learners, providing education that meets market demands.Platforms like Unacademy, Coursera, and SWAYAM have already set benchmarks for online education by making learning more engaging and effective. The proposed TESU model offers a unique approach. This model not only focuses on engaging students but also functions as a business model that incorporates blended learning. It is controlled by the government and designed to generate revenue for both the government and MOOC course developers.

Figure 2: Proposed Model (TESU) Based on Eucalyptus





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