A Role of Technology Integration in Improvizing Pedagogical Skills of Prospective Teachers to Meet the Challenges of 21st Century

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ABSTRACT

The 21st century has ushered in a wave of technological advancements that has raised revamping and reshaping the educational landscapes across the Globe. Teachers of the day are expected not only to be content-proficient but also techno-pedagogically proficient. By integrating technology into pedagogy one can foster engaging, inclusive and effective learning. The integration of Technology in teacher education has emerged as a pivotal factor in improvising and upgrading the pedagogical skills of prospective teachers to effectively address the dynamic demands of 21st century classrooms. This paper seeks to assess, how technology integration can upgrade and enhance the pedagogical skills and efficacy of teachers and prepare them combat the multifaceted challenges of 21st-century classrooms. The study explores various tools, platforms and resources available to assist teachers and learners in the advanced learning environment. The systematic review reveals the positive and strong correlation between the development of pedagogical competencies and the level of technology integration, emphasizing the need of institutional support, advanced training cum development programs and robust digital infrastructure.

This paper reveals the role of technology in transforming conventional teaching approaches, fostering innovative instructional practices and equipping the future educators with the requisite competencies for the Digital-age teaching and learning process. A thorough review of related literature and case studies the study highlights how technology integration supports critical thinking, collaborative learning, differentiated instructions, real time assessment strategies, classroom management and innovative teaching learning approaches with the integration of various digital and AI tools, furthermore the research underscores the importance of institutional support, continuous professional development and curriculum redesign in fostering technology-enriched pedagogy. The findings suggest that purposeful and strategic use of technology improves teaching efficacy and prepares prospective teachers to navigate and thrive in increasingly complex educational setups of the present Technology-thriven era.

Keywords- Technology Integration, Pedagogical skills, Technology-enriched pedagogy, Prospective Teachers, Digital Tools, AI Tools.

I. INTRODUCTION

The classroom of 21st century are undergoing rapid transformation resulting in innovative learning environment that are interconnected flexible and collaborative the use of ICT and AI tools and Technology is are the new paradigm of teaching learning in 21st century today innovative technology and pedagogy are the need of an hour those technological innovations are crisis driven but today they have and closed and influence almost every aspects and endeavour of human life and specially education sector it is the vital area that apply is technology at every level of teaching learning process and Technology integration is the powerful most tool to revamp higher education in 21st century, Revamping means improvisation and rewamping education means making changes to improve the education system at every level. Technology technology is changing the face of education across the glow facilitating quality information and innovative tools to educators and students around the world and today the knowledge of these powerful tools and technology is an utmost requirement so as to build a knowledge-based, info-savvy, techno- savvy society. Technology can help teachers improve their teaching skills. As there is a perceptible shift from desktop to laptop, from OHP to LCD, from chalkboard to a smart board F2F degree

to Nano virtual degree, from F2F Education to online education, from Telecast to webcast, from point to point network to Wi-fi so it is a time to make changes in the teaching and learning methods also and only technology integration can serve the purpose.

The use of Technology has proliferated in education and learning designs resulting in innovative learning environment in accordance with SDG of Sustainable Development Goals Agenda 2030, which include promote lifelong learning opportunities for all by 2030, the goal consists of 10 targets to guide countries along a transformative path to a sustainable education agenda as per the indicator 4.4.II SDG ICT skills determine the effective use of information and communication technology, the lack of such skills continues to be one of the key barriers keeping learners from harnessing the potential of ICT thoroughly.

II. REVAMPING HIGHER EDUCATION THROUGH IMPROVISING PEDAGOGICAL SKILLS WITH TECHNOLOGY INTEGRATION

Revamping Education means bringing required improvement and changes in education system and here are some ways to revamp education :
- Curriculum revision
- Personalized education
- Holistic and multidisciplinary education
- Regular curriculum and content development
- ICT in teaching and learning.
- Research and innovation.
- Industry interaction and placement Tie-ups.
- Teacher training and capacity building
- Teaching skills for present and future generation
- Mode of teacher education and methods of instruction.

Pedagogical Skills of Teachers:-
Pedagogical skills are teachers' ability to instruct students and manage the classrooms teacher masters the content, understand their students, teach the students, communicate with parents, collaborates with colleagues and make their strategies for effective teaching and learning outcomes. Pedagogical skills include the capacity to plan, initiate, lead and develope education and teaching.

Integrating pedagogical skills with AI tools and ICT Technology can elevate the quality of teaching and learning experience is thereby making learning more engaging, personalized and interesting. Now, what is pedagogy - it is the way, involved in teaching the theory the practice involved in educating. So, it is an art of teaching that describes all strategies, methods, techniques, the teacher use to teach effectively

Few pedagogical skills which are required for the 21st century teachers are communication skill, ICT skills, classroom management skills, assessment skills, explanation skills, questioning skills collaborative skills, decision-making skills and so on.

What is Technology Integration:-
Before we discussed how to shift our pedagogy or the role of teacher in a classroom i.e. integrating technology, it is important to first define, what is technology? Now, let's understand what is technology integration - It is the use of Technology resources like computers, mobile devices like smartphones, laptops, digital cameras, social media platforms and networks, software, applications, world wide web in daily classroom practices and management of school. Technology integration is a broad umbrella that covers so many tools and practices which teachers can use for making the teaching task more interesting and effective Technology integration is the amalgamation of teaching school and activities with the technology using technology in teaching learning process besides access to variety of tools that match the task and provide Deeper understanding of content plus effective learning outcomes.

III. REVIEW OF RELATED LITERATURE

Skills, thereby upgrading pedagogical competencies and techno-pedagogical skills of future educators.

Global Perspectives: According to Kohler and Mishra (2000) TPACK, the technological pedagogical content knowledge framework outlines the intersection of technology, pedagogy and content knowledge essential for effective teaching in the digitized era. Similarly, UNESCO(2011) emphasized the need for teacher education programs to incorporate ICT competencies to meet global educational standards Mumtaz,S.(2000). One of the earlier comprehensive reviews on ICT use in teacher training contexts.

Anderson, T., & Dron, J. (2011). Highlights how evolving technology shapes pedagogical models and teacher competencies.

National Studies: Mishra (2018) observed that Indian teacher education institutions are gradually incorporating ICT tools, digital tools in their training programmes. However, the implementation is inconsistent and challenging due to infrastructural gap and lack of training.

Singh and Sharma (2020): analyzed that teachers training program strategically incorporated with digital platforms and technical training, exhibit improved lesson-planning and student-engagement

Rana and Rana (2020): reports lack of clarity in ICT education policy, Ministry of Education, Nepal regarding technology integration, insufficient funding for teachers training and incapability of teachers to handle technical challenges

Mumtaz,S.(2000): One of the earlier comprehensive reviews on ICT use in teacher training contexts.

Onal Insights: A study by Yadav 2021 in rural Uttar Pradesh highlighted the potential of mobile learning and digital classrooms in improving particle skills and competencies of teacher trainees, though it is also noted the limitations due to digital literacy and resource constraints.

Technology can help teachers Improve their skills and self-efficacy in teaching and here are some ways the teachers can use following technologies to improvise their pedagogical competences and skills.

There are various innovative teaching strategies for upgrading teachers which are as follows

Flipped classroom: This model reverses the conventional teaching approach by delivering instructional content such as lectures through digital media or video Lectures to study at home and the home assignments are done in the classroom by interactive activities, open discussions and brainstorming techniques.

Blended learning: This approach combines traditional face to face instructions with online learning components it seeks to leverage the strengths of both in person and digital learning environment it creates more flexible and personalized learning strategies and experiences it is a bland of in person and online activities Which enhances the overall learning experience and offers more flexibility in accessing and interacting with the course content

Active learning : This approach involves strategies that engage students in the learning processes through activities discussions active participation rather than passive listening it encourages students to think critically creatively and apply their knowledge actively.

Personalized Learning: This approach tells us the educational experience to the individual needs, preferences and pace of the learning so it is a innovative methods of teaching to align with the unique learning styles and strengths of each learner

Problem- based Learning : It is an instructional method where students learn through solving real world problems it promotes critical thinking collaboration and application of knowledge to the practical situations and case studies

Project -based learning : It is a storage centric methodology where students complete projects on the basis of their acquired knowledge and skills to the real world challenges. PBL emphasizes hands on, collaborative learning which fosters critical thinking and problem solving skills

Enquiry- based Learning: Is an approach where students actively explore and investigate topics, they raise questions and conduct research to construct their understanding this method encourages curiosity critical thinking and deeper understanding of the subject matter

Cloud Computing Teaching : It is a cloud based technology which enhances the learning experiences and helps in storing and accessing data collaborating on projects and utilizing online tools and resources for teaching and learning

Mistake LED teaching: This approach emphasizes the values of mistakes as opportunities for learning and growth instead of penalizing mistakes this approach encourages reflection, analysis and understanding through the process of committing errors and correcting those errors

Collaborative Learning: This approach involves students working together in groups to achieve shared learning goals it promotes communication skills teamwork collaborative skills and exchange of innovative ideas in education and research

Peer teaching: In this technique students involve taking the role of teacher to explain concepts or assess their classmates in understanding specific topics this approach reinforces understanding through teaching and encourages collaboration and cooperative learning.

Interactive lessons : This approach aims to foster rather dynamic and engaging classroom environment interactive lessons can take various forms can be of various forms including where group discussions hand on activities simulations cases studies collaborative projects besides teacher can use interactive white boards or other resources to facilitate participation and feedback so that students can take active participation in learning.

Virtual reality : This technology creates a simulated environment that users can interact with and have unique learning experience it can be used to transport students to virtual world that simulates historical events scientific phenomena or complex concepts this technology enhances experiential learning enabling students to visualize abstract concepts and engage with subject matter in a new way

Generative AI : Artificial intelligence in education involves integration of ai tools and technologies to enhance the learning experience of both teacher and tot ai can be applied in various ways such as personalized learning automated assessment adaptive learning platforms virtual assistants data analysis ai integration makes learning more efficient adaptive and engaging

3D printing : It is also known as additive manufacturing which involves creating physical objects layer by layer or 3D models teacher and students can design and print three dimensional models that represent scientific structures historical artifacts mathematical concepts or prototypes

Jig saw technique: It is a cooperative learning strategy where students work collaboratively to become expert on specific topics and then share their knowledge with their peer group this promotes teamwork communication and shared responsibility for active learning methods

Gamification: This approach integrates game elements into non-gaming contexts such as education to enhance engagement and motivation points levels challenges and rewards are used to make learning more enjoyable interesting and engaging

Crossover teaching; In this approach educators from different subjects and disciplines collaborate to integrate content from multiple disciplines and approaches and this interdisciplinary approach aims to exhibit interconnectedness of different subjects and enhance the relevance of learning and create new learning environment

Various instructional tools like interactive white boards smart boards students response system PowerPoint presentations, animated PowerPoint presentations can be used to integrate Technology for upgrading the pedagogical skills of teachers into techno-pedagogical skills.

AI tools that teacher can use in 2024 are as follows:

Brisk Teaching- A Chrome extension that helps teacher create curriculum SS writing adjust reading levels and translate text helps in generating quizzes lesson plans rubrics and presentations.

Canva, Prezi, Slidebean, Powtoon - design and content- creation tool like graphics invitation cards flyers Facebook covers.

Education Co-pilot- tool for designing lesson plans and material tracking students progress and customizing lesson plans.

Magic schools- avoid range of AI tools its a hub of tools for educators for performing different task created two teaching managing and assessing.

PowerPoint speaker coach- a tool for rehearsing presentations that provides rehearsal reports and feedback

Quizizz- an AI tool has to generate interactive activities from existing resources content

Kahoot, Yippity, Hot potato ,Classtools, - are the AI tools for quiz creation

Sendsteps.ai, Gamma , Beautiful AI, SlidesAI ,Kroma AI, Tome, Simplified -To prepare Animated and interactive presentations.

Grammarly - For communication and linguistic skills.

Scribble map- To draw and share maps.

Visualize- For resume creation.

Wordle - For poster creation.

Stoodle- to learn and teach online with partners.

Edmodo- T teachers can connect and coordinate with parents students colleagues.

Canva magic write- helps creating outlines editing and creating content brainstorming ideas.

HeyHi- supports personalized adaptive learning identifying learning apps tracking performance and automating grading of students.

Quilbot- Is an AI detector which clearly distinguishes between AI generated and AI refine text and helps the teachers to maintain academic integrity

Maestra- AI transcription and translation tool which can convert audio and video files to text accurately in seconds adding def and hard of hearing students transcription and translations are available in 125+ languages so it is helpful to break language and accessibility barriers.

Coursebox: So grading and assessment ai tool which automate grading based on marking rubric and criteria so very useful tools for teachers

ChatGPT; It's a versatile and easy to use AI tool which is a cure to all the challenges and help teachers as well as students in all the classroom activities, extracurricular programs and creating attention grabbing content

Initiatives of MHRD and UGC on promotion of Academic excellence through technology in HEIs

National mission on education through ICT (NMEICT): under the national mission on education through ICT founded by the ministry of human resource development Government of India a proper balance between content generation Research and critical areas waiting to imparting education and connectivity for integrating a knowledge with the latest advancement remains being attempted the main aim of this mission is to tap the potential of vice City in pedagogy and learning at Higher Education levels.

Consortium for education communication (CEC)- is one of the inter University centre set up by the University grant commission of India it has been established with the goal of addressing the needs of Higher Education through the powerful medium of television along with appropriate use of emerging ICT the Consortium for educational communication is a premium institution for development and dissemination of educational e-content through new ICT base technology with emphasis on learner centric pedagogy for the benefits of wave learners across the country it is one of the largest repositories of digitized educational content in the country and the national coordinator for Massive Open Online Course (MOOCs)or SWAYAM platform.

SWAYAM PRABHA - is a group of 34 DTH channels devoted to telecast high quality educational programs on 24* 7 from class 9 to PG. The content are provided by NPTEL IITs, UGC CEC IGNOU NCERT and NIOS. The INFLIBNET Centre maintains the web portal.

SWAYAM - indigenous MOOC platform offering online courses from all disciplines with three cardinal principles of education policy access equity and quality.

e-PG Path--shala- an initiative of MHRD executed by UGC offers interactive e-content in 70 subjects across all disciplines from class 9th to PG e-content is available in open access at www.epgp inflibnet.ac.in.

e-Adhyayan - is a platform to provide 700 + ebooks for the postgraduate courses all the ebooks are derived from e PG Pathshala courses it also facilitates playlist of video contents UGC ,MOOCS(online courses).

National Digital Library of India (NDLI)
Provides a framework of virtual repository of learning resources with a single windows search facility. This repository host contents of multiple subjects domain such as agriculture technology natural sciences management religion and others more than 3.8 crore ebooks journals audiobooks question banks are available on this repository in more than 200 languages.

Virtual labs- provides a fully interactive simulation environment to perform experiments collect data and answer questions to assess the understanding of knowledge acquired.

E-Yantra- enables the effective education across engineering colleges in India on embedded systems and robotics it is an initiative by IIT Bombay that AIIMS to create the next generation of embedded system engineers with a practical outlook to provide practical solutions to sum of the real world problems.

FOSSEE- Promotes the use of open source software in education institution through instructional material such as is booking tutorials documentation textbook companions awareness programs such as conferences training workshops and internships.

IV.   INDIAN RESEARCH INFORMATION NETWORK SYSTEM (IRINS)

Is a web based research information management service developed by in flip net centre in collaboration with Central University of Punjab it facilitates the academic R&D organisations and faculty members scientists to collect curate and showcase the scholarly communication activities and provide an opportunity to create scholarly network it helps the research scholars to locate the courses in the subject interest and research focus of the department and organisation it provides more significant exposure for their research contribution to the international community and brings funding opportunities from the national and international agencies.

Shodhganga: The reservoir of Indian thesis-this initiative provides a platform for research scholars to deposit their pH diseases and make it available to the entire is colony community in open access.

Shodh Gngotri: repository of Indian research in progress-repository of Indian research in progress ,M.Ed Dissertation, synopsis, research proposal Emeritus fellowship research papers and research articles.

e-shodh Sindhu- provide access to qualitative electronic resources including full text bibliography and ebooks and e-journals.

Shodh shuddhi- this MHRD initiative provides access to plagiarism Detection Software to all universities and institutions in India since September 1 ,2019.

VIDWAN -Expert Database and National Researchers Network - is a premier database of profiles of scientist and faculty members working in leaning academic institutions and other R&D organizations involved in teaching and research in India.It provides important information about experts background contact address skills and accomplishment and also offers opportunity to work for collaborative research with other organizations and institutions.

V.   BENEFITS OF TECHNOLOGY INTEGRATION

1. Technology is future-oriented.
2. Learning becomes engaging.
3. Helps improving skills and competences.
4. Increases collaboration Reduce work load and bring efficacy.
5. Enhances productivity and increase motivation.
6. Create interactive environment.
7. Improves Research ability.
8. Provide easy and quick access to information.
9. Makes communication easy and interesting.
10. Helps to give immediate feedback.

VI.   LIMITATION AND CHALLENGES IN TECHNOLOGY INTEGRATION

Organizational challenges- Lack of readiness and resistance to accept new. Conventional organizational culture does not support effective use of technology,Lack of funds, human support and inadequate infrastructure and inequitable access to technology and resources.

Research challenges – ambiguity in research goals and policy goals, many technolgies are created without understanding classroom needs, a plethora of tools, applications and platforms leads to confusion among users.

Dearth of trained teachers- Insufficient technology skills and proficiency in using digital tools and technologies, Many a times, teachers attitude and beliefs are misaligned with innovative, non-conventional, technology-based pedagogies.

Students' engagement- Digital divide and unequal access to resources leads to disparities, dissatisfaction and frustration among learners, potentially exacerbating existing inequities and inequalities. Besides misalignment of technology with existing curricula.

Lack of Expert Technical Staff- Dearth of trained technical staff to assist with technolgy integration also causes obstacles.

Lack of Administrative and Technical Support: Poor administrative support makes it difficult for teachers to integrate technology into their teaching practices.

Data Privacy and Security Concerns- Concerns about data privacy particularly using online learning platforms or data collection tools.

Technophobia- Teachers' technophobia, their lack of self-efficacy and familiarity with the required pedagogical and technical knowledge necessary to conduct online classes. Technical, pedagogical and content knowledge (TPACK) framework can help teachers deal with the problem

VII.   CONCLUSION

The ubiquity of information Technology and communication has significantly reshaped the structure of learning in higher education. New teaching pedagogy's learning skills and assessment methods have emerged to adapt according to Present and demands of future. We must bear in mind that technology by itself cannot alter the pedagogical picture of educational institutions. Technological advancements are transforming educational systems radically across the globe, making it imperative for educators to adapt to digital tools and platforms. Technology integration is no longer optional, it has become essential for enhancing pedagogical skills in today's digital era by embracing technological tools, applications and platforms. By doing so, educators can become facilitators of enriched, engaging, effective and lingering learning experiences. And forward-thinking approach that blends pedagogical knowledge skills with digital competence is the cornerstone of quality education in the 21st century. Therefore, upgrading pedagogical competencies and techno-pedagogical skills of future educators, institutions should priortize, upgrading digital infrastructure and continuous training program. A strategic and systematic approach to embedding technology in pedagogy will empower teachers to thriven, lead and innovate in digitally evolving environment.

REFERENCES

[1]   Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: A review of the literature. Journal of Information Technology for Teacher Education, 9(3), 319–342.

[2]   Koehler, M. J.& Mishra, P. (2009). What Is technological pedagogical content knowledge (TPACK)? Contemporary Issues in Technology and Teacher Education, 9(1), 60-70.

[3]   Harris, J., Mishra, P., & Koehler, M. J. (2009). Teachers' technological pedagogical content knowledge and learning activity types. Journal of Research on Technology in Education, 41(4), 393–416.

[4]   Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. Journal of Research on Technology in Education, 42(3), 255–284.

[5]   UNESCO. (2011). ICT Competency Framework for Teachers. Paris: UNESCO.

[6]   Anderson, T., & Dron, J. (2011). Three generations of distance education pedagogy. International Review of Research in Open and Distributed Learning, 12(3), 80–97.

[7]   Kirkwood, A., & Price, L. (2014). Technology-enhanced learning and teaching in higher education: What is 'enhanced' and how do we know? A critical literature review. Learning, Media and Technology, 39(1), 6–36.

[8]   Voogt, J., Fisser, P., Good, J., Mishra, P., & Yadav, A. (2015). Computational thinking in compulsory education: Towards an agenda for research and practice. Education and Information Technologies, 20(4), 715–728.

[9]   Mishra, S. (2018). ICT in Teacher Education in India. Journal of Educational Technology,15(2), 45-52.

[10]   Govindarajan, V. & Srivastava, A. (2020). Digital India and teacher education: Challenges and opportunities. International Journal of Educational Technology in Higher Education, 17(1), 1–13.

[11]   Singh, R. & Sharma, V. (2020). Enhancing pedagogical skills through technology integration in teacher education. International Journal of Educational Research, 9(4), 112-120.

[12]   Yadav, R. (2021). Challenges and Opportunities of ICT in rural teacher training programs. Indian Journal of Educational Development,7(3), 78-85. https://doi.org/10.1186/s41239-022-00375-1

[13]   www.researchgate.net

[14]   https://files.eric.ed.gov

[15]   https://www.jetir.org