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EFFICACY OF CLOUD COMPUTING STRATEGIES IN DIGITAL PEDAGOGY: A TPACK MODEL PERSPECTIVE

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ABSTRACT
Cloud computing technologies offer diverse benefits to designing dynamic and engaging learning environments for teachers and students. Integrating different cloud computing technologies into educational practices has significantly changed different pedagogical approaches educators use in the classroom. the TPACK model provides intricate interactions in educational contexts involving technology, pedagogy, and content knowledge. This study explores the effectiveness of cloud computing techniques in digital pedagogy through the lens of the Technological Pedagogical Content Knowledge (TPACK) model. The major objective of the study is to investigate the extent to which cloud computing strategies align with the TPACK model in facilitating effective digital pedagogy. In this study, 30 Pre-service trainees were selected as a sample by using a purposive sampling technique. An experimental study was conducted along with a single-group pretest-intervention -post-test design. To implement the intervention cloud-based technologies were used to prepare the instructional package consisting of the modules related to the effectiveness of digital pedagogy aligning with the TPACK framework. To analyze and interpret the collected data, the "t" test was used. It was concluded that cloud computing strategies in education have significantly affected the digital pedagogy of pre-service teachers regarding the TPACK model.

Keywords: Cloud computing strategies, TPACK model, Digital Pedagogy, Pre-service teachers, Efficacy.

1. INTRODUCTION

Technology integration is now essential in today's quickly changing educational environment to satisfy the different needs of students and improve the quality of instruction and learning opportunities. The concept of "Cloud Computing" has gained significant prominence within the realm of Information Technology (IT) (Agustini et al., 2019). It represents a computing paradigm wherein virtual resources are utilized and shared among multiple users. Despite abundant technological developments, cloud computing has surfaced as a revolutionary instrument, providing educators with novel opportunities to rethink teaching strategies and cultivate inventive educational settings(Mo, 2024). Cloud computing plays a crucial role in societal progress and advancement. Through cloud computing, individuals can generate, modify, and store files in the cloud to suit their specific needs. Few self-services like Google Docs, Google Photos, Google Drive, One Drive, etc. are growing rapidly (Sahara et al., 2024). Cloud computing provides the benefit of accessing applications and data without time or location constraints, enabling seamless access to information and resources at any time and from any location. In contemporary e-learning, which emphasizes flexibility and transcending geographical barriers, cloud computing ensures that users can engage in education and research activities without being hindered by time limitations or spatial boundaries (Almajalid, n.d.; Mo, 2024).

In the twenty-first century, the Technological Pedagogical Content Knowledge (TPACK) framework and the basic principles of digital pedagogy have become integral to the integration of information technology into education (Rudyshyn et al., 2024; Sanosi & Mohammed, 2024). The interplay of technological, pedagogical, and content knowledge is highlighted by TPACK, emphasizing the value of effectively integrating these areas to improve digital pedagogy in the classroom.

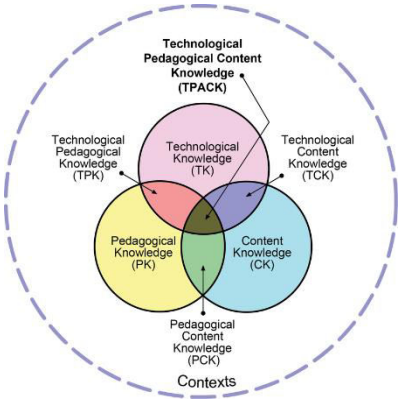

Figure 1: TPACK Framework and its Components

Figure 1 describes the Technological Pedagogical Content Knowledge (TPACK) which is the intersection of the different areas like technological knowledge, content knowledge, and pedagogical knowledge and mainly results in the intersection of these three frameworks(Agustini et al., 2019; Rodhiyah et al., 2024). Technological Knowledge describes the professional technical knowledge of the teachers. Content knowledge describes how much the teacher is competent enough with the subject knowledge. Pedagogical knowledge addresses how teachers demonstrate the professional knowledge of pedagogy (Suharno et al., 2023).

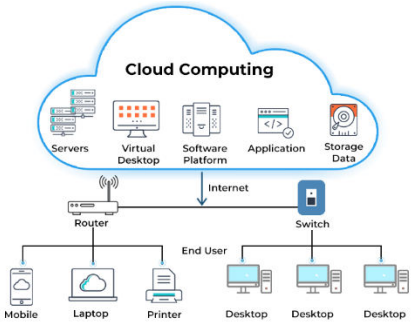

Figure 2: Cloud Computing and its Infrastructure

Figure 2 describes cloud computing as the delivery of different services via the internet which aligns with the different tools and applications including Data storage, networking, different servers, applications, software, etc. Content created by cloud-based technologies adds to open educational resources that are currently available to view. The other users can adapt the content reform and can utilize it according to their strategies. Accessing and using different cloud resources can promote collaboration between different individuals (Campbell et al., n.d.).

Does the use of the TPACK model enhance the digital pedagogy of the teacher in the classroom? This model is mainly addressed to increase the student's learning in the school, which is directly related to the teacher's pedagogy in the classroom. integration of technology in education has resulted in the form of digital pedagogies where this TPACK model framework catalyzes the learning-teaching process (Nazim et al., 2024). The TPACK model supports teachers in dealing with the different challenges they go through while integrating technology into education. It helps in solving the different concerns about maintaining the quality of the classroom learning process (Liontas -Inanc Karagoz, n.d.).

Despite the acknowledged potential of cloud computing technologies in enhancing digital pedagogy, a gap exists in comprehending how these strategies correspond with established educational frameworks like the Technological Pedagogical Content Knowledge (TPACK) model. While several studies have analyzed the advantages of integrating cloud computing into educational settings, there is still a need for a systematic evaluation of its efficacy in facilitating effective digital pedagogy within the TPACK framework. This study endeavors to bridge this gap by examining the influence of cloud computing strategies on the digital pedagogy of pre-service teachers, particularly in alignment with the TPACK model. The following are the framed research objectives:

1. Cloud computing technologies will significantly enhance pedagogical content knowledge.
2. Cloud computing strategies will significantly enhance technological pedagogical knowledge.
3. Cloud computing strategies will significantly enhance technological content knowledge.

The major significance of the research paper lies in its contribution to reflect the understanding of how cloud computing can be effectively leveraged to enhance teaching and learning experiences within educational contexts (Nofan, n.d.). By accepting a perspective rooted in the Technological Pedagogical Content Knowledge (TPACK) model, the paper offers a novel idea for the examination of the intersection between technology, pedagogy, and content knowledge, providing insights that can relate to both theory and practice in educational technology.

I. REVIEW OF RELATED LITERATURE

1. Cloud computing

The advent of cloud technology enables universal access to work, facilitating its retrieval and sharing without dependency on specific hardware or software applications. Implementing a cloud-based educational system offers numerous advantages to students, faculty, and educational institutions by enhancing the delivery of quality education (Yadav, 2007). Cloud computing services are experiencing a global surge, with a growth rate exceeding 25%. Simultaneously, a significant number of students are opting for online degrees, courses, and training programs, utilizing electronic resources such as recorded or offline videos to acquire knowledge. In this context, the role of cloud computing in online education systems becomes noteworthy. Cloud-based services enhance the effectiveness of computer hardware, systems, and other technologies. Modern educational systems prioritize mobile learning, distance education, and web-based collaborative learning, all of which benefit from cloud and related technologies. Notably, developing countries are also increasingly investing in modernizing various facets of the education sector, including teaching methods, learning resources, and educational administration (Paul & Aithal, n.d.)

2. Digital pedagogy

Digital pedagogy orientation refers to how teachers perceive the role of information and communication technology in the teaching-learning process (Lane, 2014). Digital pedagogy practice assesses teachers' ability to implement teaching-learning standards by evaluating how well their professional teaching aligns with these standards. Competence in digital pedagogy measures teachers' skills in using information, communication, and technology during the teaching-learning process. Teachers' orientation, practice, and competencies collectively indicate the presence and relevance of digital pedagogy in the learning process. (Cabanero et al., 2022)

3. TPACK Framework

The framework offers a valuable resource for designing teacher education programs and evaluating teachers' competence in integrating technology (Hsu & Chen, 2019). The TPACK survey outlined in this study offers a method for gauging teachers' self-perceived TPACK and is emerging as a valuable instrument for researchers studying the enhancement of TPACK in both practicing and aspiring teachers (Baran & Thompson, 2011). The TPACK survey is undergoing translation into multiple languages and adaptation to diverse teacher education settings globally (Jazeel et al., n.d.). The growing interest in utilizing the TPACK framework and survey for designing and evaluating teacher knowledge across international contexts underscores the widespread influence of TPACK as a burgeoning research and development tool for teacher educators worldwide.

II. METHODOLOGY

For this study, a sample of 30 teacher trainees was selected by using a purposive sampling technique. The researcher used an experimental study adopting a single-group experimental design (pre-test treatment post-test) in this study. This methodology involves assessing participants' main characteristics or behaviors before introducing the treatment or intervention. Following the implementation of the treatment, participants are assessed again to determine any changes or effects resulting from the intervention. This design allows for the evaluation of the treatment's efficacy within the same group of participants, providing insights into the effectiveness of the intervention over time. The following are the considered tools for the study:

1. Diagnostic test: A diagnostic test was conducted to identify the acceptance of cloud computing strategies in the learning-teaching process along with the selection of the samples. This test consists of the items related to the skills needed for the assessment of the strategies in the classroom.
2. Assessment Tool: The tool was prepared by the researcher to validate the usage of cloud computing strategies instructional packages in the classroom.
3. Pre and Post tests: After the intervention, the progressive test was done to assess the effect of cloud computing strategies on the teaching-learning process concerning the TPACK model.

A. Intervention of the study

The Cloud Computing Enriched Instructional Package was used as an intervention strategy to implement Cloud Computing Instructional Strategies concerning digital pedagogy in the classroom. The package consists of a series of items related to the assessment of the TPACK model focusing on all three main areas i.e., Technology, Pedagogy, Content Knowledge, and their interplay. The tool package was validated by the experts by using the validation scale developed by the researcher.

B. Procedure of the study

In this study, before the implementation of the cloud computing package, a validated pre-test was administered for the assessment of the competency level of the BED teacher trainees related to their digital pedagogical skills. After that, the validated cloud computing enriched instructional package was implemented for 03 months. The prepared modules in the package were implemented one after the other. After given intervention, a post-test was administered to assess the competency level of the teachers. The scores obtained by the sample of the study were analyzed by using the Test of Significance – 't' test statistical technique.

III. ANALYSIS OF THE STUDY

A. Research Hypothesis 1

There exists a significant difference between the mean scores of pre-tests and post-tests in enhancing the usage of cloud computing strategies in digital pedagogy concerning their technological knowledge.

I. MEAN SCORES OF PRETESTS AND POST-TESTS IN ENHANCING THE USAGE OF CLOUD COMPUTING STRATEGIES IN DIGITAL PEDAGOGY CONCERNING THEIR TECHNOLOGICAL KNOWLEDGE.

S.No.	Test	N	Mean	SD	't' value	Level of Significance
1.	Pre-Test	30	30.4	5.14	16.81	Significant at 0.01 level
2.	Post-Test	30	61.5	7.41		

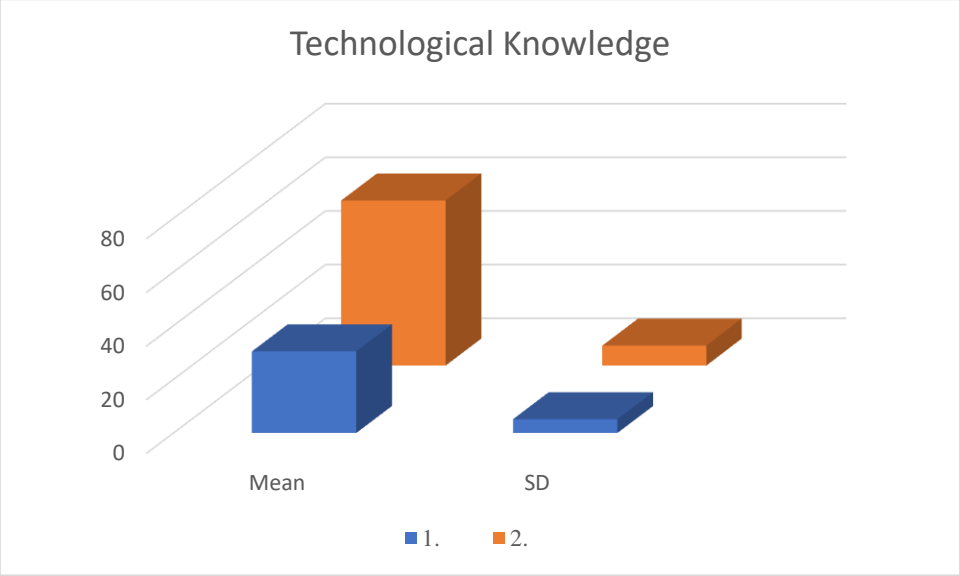

Figure 1: Comparison of Mean scores of Pre-Tests and Post tests concerning their Technological Knowledge

Table 1.0 infers that, since the calculated 't' value of 16.81 is more than the tabular 't' value of 2.89, the difference in performance between the Pre-Test and Post-Test is significant at 0.01 level. Thus, the researcher has failed to reject the study's formulated hypothesis. The accepted hypothesis concluded that the cloud computing instructional package has enhanced the usage of digital pedagogy concerning technological knowledge. The considerable increase in mean score from the pre-test to the post-test further supports the effectiveness of the instructional package in improving participants' understanding and utilization of digital pedagogy concepts, specifically in the context of cloud computing, and further improving their technological skills in the teaching-learning process.

B. Research Hypothesis 2

There exists a significant difference between the mean scores of pre-tests and post-tests in enhancing the usage of cloud computing strategies in digital pedagogy concerning their content knowledge.

II. MEAN SCORES OF PRETESTS AND POST-TESTS IN ENHANCING THE USAGE OF CLOUD COMPUTING STRATEGIES IN DIGITAL PEDAGOGY CONCERNING THEIR CONTENT KNOWLEDGE.

S.No.	Test	N	Mean	SD	't' value	Level of Significance
1.	Pre-Test	30	32.4	5.35	16.70	Significant at 0.01 level
2.	Post-Test	30	62.3	7.56		

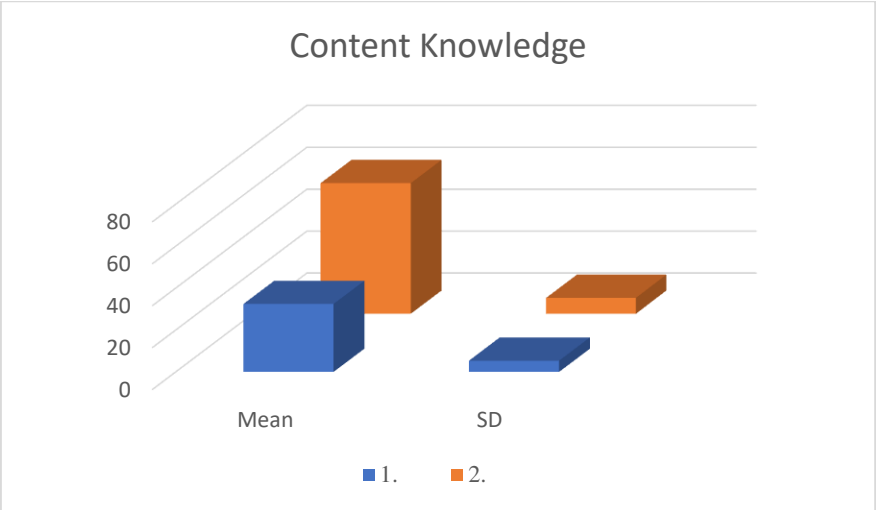

Figure 2: Comparison of Mean scores of Pre-Tests and Post tests concerning their Content Knowledge

Table 2.0 infers that, since the calculated 't' value of 16.70 is more than the tabular 't' value of 2.89, the difference in performance between the Pre-Test and Post-Test is significant at 0.01 level. Thus, the researcher has failed to reject the study's formulated hypothesis. The accepted hypothesis concluded that the cloud computing instructional package has enhanced the usage of digital pedagogy concerning content knowledge. The considerable increase in mean score from the pre-test to the post-test further supports the effectiveness of the instructional package in improving participants' understanding and utilization of digital pedagogy concepts, specifically in the context of cloud computing, and further improving their content knowledge skills in the teaching-learning process.

C. Research Hypothesis 3

There exists a significant difference between the mean scores of pre-tests and post-tests in enhancing the usage of cloud computing strategies in digital pedagogy concerning their pedagogical knowledge.

III. MEAN SCORES OF PRETESTS AND POST-TESTS IN ENHANCING THE USAGE OF CLOUD COMPUTING STRATEGIES IN DIGITAL PEDAGOGY CONCERNING THEIR PEDAGOGICAL KNOWLEDGE

S.No.	Test	N	Mean	SD	't' value	Level of Significance
1.	Pre-Test	30	30.9	5.46	20.22	Significant at 0.01 level
2.	Post-Test	30	63.3	7.42		

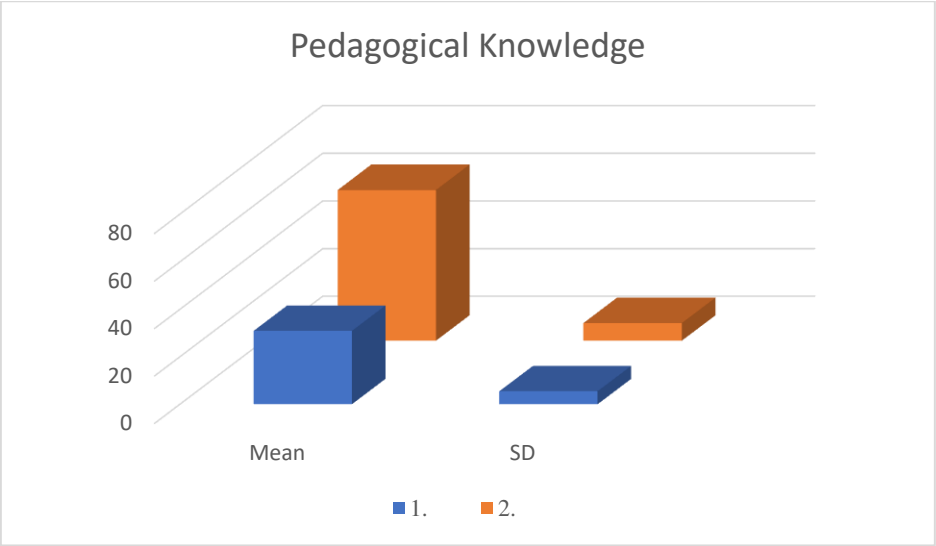

Figure 3: Comparison of Mean scores of Pre-Tests and Post tests concerning their Pedagogical Knowledge

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Table 3.0 infers that, since the calculated 't' value of 20.22 is more than the tabular 't' value of 2.89, the difference in performance between the Pre-Test and Post-Test is significant at 0.01 level. Thus, the researcher has failed to reject the study's formulated hypothesis. The accepted hypothesis concluded that the cloud computing instructional package has enhanced the usage of digital pedagogy concerning their pedagogy knowledge. The considerable increase in mean score from the pre-test to the post-test further supports the effectiveness of the instructional package in improving participants' understanding and utilization of digital pedagogy concepts, specifically in the context of cloud computing, and further improving their pedagogical skills in the teaching-learning process.

IV. DISCUSSION

The results of the intervention demonstrate a direct impactful relation between the TPACK Framework and the utilization of digital teaching methods facilitated by cloud computing strategies. This connection highlights the crucial role of seamlessly integrating technology, teaching techniques, and subject matter expertise in educational contexts. Through the adoption of cloud computing, educators can smoothly integrate various digital tools and materials into their instructional approaches, thereby improving the delivery and impact of their teaching. The TPACK Framework offers educators a comprehensive framework to navigate the intricate process of incorporating technology into their teaching practices, ensuring that digital resources are aligned with educational objectives and pedagogical principles. Consequently, these findings not only affirm the relevance of the TPACK Framework in modern education but also emphasize the transformative potential of cloud computing in cultivating innovative and student-centered learning environments.

V. EDUCATIONAL IMPLICATIONS

1. Educators can utilize diverse cloud-based tools to create dynamic and interactive learning environments.
2. Training programs can equip teachers with the skills to use cloud-based technologies effectively in teaching.

3. Educators can design curricula aligned with the TPACK model, integrating cloud computing strategies.
4. Educators can use cloud tech for diverse student needs, accessing collaborative platforms and vast educational content.
5. Schools can provide devices, and the internet, and teach digital skills to bridge the digital gap in underserved areas.
6. Educators can use cloud tools for comprehensive assessment and targeted feedback.

VI. RECOMMENDATIONS

Cloud computing strategies are increasingly prevalent in education, with the NEP 2020 emphasizing technological integration within the educational landscape. However, there remains a significant need for further research to comprehensively understand this concept from various perspectives. The present study has the delimitation related to digital pedagogy only. It can further be studied with different dimensions like integration with LMS, content creation and distribution, remote learning and teaching, personalized learning experiences, etc. therefore, the present study opens new windows for conducting further research. Based on the present study, researchers recommend that similar studies be conducted in different departments and institutions, districts, and states of India. This study was delimited to the particular institution. In this study, the researchers have used the intervention of cloud computing strategies with general pedagogies. Educators can refer to different specific pedagogies. Studies can be conducted to find the effect of cloud computing strategies on different dimensions of educational learning and relate it with different model frameworks of education. Moreover, this experiment was conducted on the pupil teachers. Furthermore, future studies could explore the impact of cloud computing strategies on various educational learning dimensions and their correlation with different educational model frameworks. This approach would provide a comprehensive understanding of how cloud computing influences teaching and learning processes across different educational paradigms. Overall, the suggestions outlined herein offer a roadmap for researchers to advance the understanding and implementation of cloud computing strategies in educational settings, ultimately enhancing teaching effectiveness and student learning outcomes.

VII. CONCLUSION

This paper provides insight into cloud computing strategies on the digital pedagogical skills of teacher trainees concerning the TPACK model framework. The different components of the TPACK model were considered to see the changes in the digital pedagogical studies of the trainees. These different kinds of interventions and results marked on them will surely bring out positive changes in the teaching-learning process. The findings are interesting and signify the possible usage of cloud computing strategies to enhance the pedagogical skills of the trainees in the teaching-learning process.

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