Economic Sciences
https://economic-sciences.com
ES (2026) 22, 5(S), 141-146 | ISSN:1505-4683

# Effectiveness of Online Learning in Transforming Education: An Era of Digital Transformation

**Dr. D. Rose Mary[1], Dr. Ravi Sankar Kummeta[2], Dr. Kaustav Shyamal Mukherjee[3], Mr. D. Subramanyam[4], Dr. V. Ramani[5], Dr.A.Rupaveni[6]**

[1]Associate Professor, University Institute of Management and Commerce, Guru Nanak University, Ibrahimpatnam, R.R District, Telangana, Email:rosemary.dara@gmail.com
[2]Associate Professor, School of Management Studies, Guru Nanak Institutions Technical Campus, R.R District, Telangana. Email:ivar.shankar@gmail.com
[3]Associate Professor, Teerthanker Mahaveer Institute of Management and Technology, Teerthanker Mahaveer University, Moradabad, Uttar Pradesh. Email:drkaustavm@gmail.com
[4]Assistant Professor, School of Management, Guru Nanak Institutions Technical Campus, R.R District, Telangana. Email:maheshnba2017@gmail.com
[5]Associate Professor, Department of Business Management, V.V.Sangh's Basaveshwara Institute of Information Technology, Hyderabad, Telangana. Email:ramaniveeradi@gmail.com
[6]Professor, Marwadi Siksha Samithi Ramnath Guljarilal Kedia College of Commerce, Hyderabad, Telangana. Email:rupa2contact@gmail.com

***Abstract***

*Online learning has emerged as a disruptive force in the educational environment with the advent of the digital era. This research looks at how well online learning environments are able to support a new wave of digital revolution while also challenging established educational paradigms. The research clarifies the benefits and drawbacks of online learning via an extensive analysis of the literature and actual data. With its unmatched accessibility and mobility, online learning allows students to study at their own speed and in their own way, overcoming geographical constraints. Moreover, the integration of multimedia resources, interactive tools, and adaptive learning algorithms enhances engagement and facilitates deeper comprehension of complex concepts. However, while online learning holds immense potential, it also presents inherent challenges such as technological disparities, digital divide, and issues pertaining to quality assurance and academic integrity. Furthermore, the absence of face-to-face interaction can impede socialization and collaborative learning experiences, posing a significant hurdle in the attainment of holistic education. Ultimately, it underscores the imperative for stakeholders to adapt and innovate to harness the full potential of online learning in reshaping the future of education.*

***Keywords:*** *Online learning, Digital transformation*

## 1. Introduction

Digital technology has changed today's society and had a steadily significant impact on practically every aspect of activity. Universities are witnessing a dramatic shift in teaching and learning due to digitalization. Digitalization aims to provide better chances for productive learning by digitising information transmission, student evaluation, student aid, and the administrative process Brink et al., (2020). While we can establish a certain degree of comfort and familiarity with the use of digital devices in the classroom, we also know that students' experiences with these tools can make teaching and learning more challenging (Uğur, 2020). There has been a significant change in education with the usage of laptops and computers in the classroom, wireless connections between projectors and smartboards and computers or laptops, recording capabilities for lectures that students may access at any time, and a trend away from handwritten notes in favour of laptop notes. The Covid-19 outbreak of 2019 had a significant impact on education globally, leading to a shift in all educational institutions' curricula from traditional classroom teaching to online training.

Digital technology became the main educational medium for students and universities during the pandemic because of educational institutions

Economic Sciences
https://economic-sciences.com
ES (2026) 22, 5(S), 141-146 | ISSN:1505-4683

having to adopt several digital platforms with varying competences and tactics to promote learning Mustapha et al., (2021). Higher education's shift to online instruction during the epidemic had an impact on students, instructors, and academic achievement (Maqableh & Alia, 2021). Higher education offers the programme in three formats: face-to-face learning, hybrid learning, and distance learning (DL).Higher education was not prepared for this situation. However, there are benefits to using technology in the classroom, like enabling students to watch lectures that have been recorded before and after class, participate in more interactive operations, and work more effectively as a team under the guidance of the instructor (Mahlangu, 2018). Mahlangu (2018) goes on to say that latent opposition, the absence of tools and technology that promote adaptivity, quality assurance, and insufficient lecturer training to utilise digital tools are some of the difficulties associated with hybrid and remote learning. Since the epidemic has spread, higher education institutions are attempting to work together via digital platforms by adhering to the same premise.

Everything about education was altered by digitalization, which influences learning techniques. Both professors and students have acclimated to the unique mode of instruction. Universities everywhere are being compelled by the ongoing Covid-19 Epidemic to modernise and expedite their procedures in the direction of digitising higher education. Because of social alienation, even colleges with conventional teaching methods are pushing to include digital technology into their curriculum. Universities have embraced online learning on a big scale, and higher education globally has had to fast adapt resources and techniques to fit into an online learning structure Mustapha et al., (2021). The new approach created unique difficulties for both teachers and students who want technical support, as we shall elaborate in more detail. Although the digital revolution in education has been going on for a while, Covid-19 has made it more rapid, which influences students' experiences (García-Morales et al., 2021). To lessen the impact of inadequate self-regulation abilities and learning techniques, teachers typically consider the differences in students' ability profiles while organising lectures. Higher education held the view that distance learning will alter the nature of the learning process (Loukomies & Juuti, 2021). Learning, media, and technologies have the power to profoundly influence practice and understanding in the middle of the Covid-19 pandemic. However, a move toward online and multimedia educational designs, and also a rise in “remote” instructional and educational approaches, has resulted from the nationwide closure of colleges.

## 2. Literature Review

The digital transformation taking place in the education industry dictates the future path of an education managerial approach. In order to provide universities a competitive advantage, the goal of this research project is to develop a qualitative approach that bolsters the notion of utilizing the digital age as a driving element. Generating a competitive edge is a pertinent, ever-evolving, and essential concept in strategy development. Mohamed Hashim et al. (2022). Building a competitive edge has been more difficult in the education sector recently due to global trends including digital transformation and social media in most global businesses. The process of creating a competitive benefit is now quickly evolving, contextual, and short-term due to these factors together. By offering empirical perspectives into identifying the significant modifications and their relationship to evolutionary learning, these outcomes support the development of strategic management techniques in higher education.

E-learning is becoming an essential part of the educational structure in the twenty-first century. electronic technology are spreading and being used in study, instruction, and every other aspect of public life at an exponential pace. There are differences in viewpoints between the general public and scientific researchers on the digital change of education. However, with the advent of COVID-19, the use of electronic methods in education has shifted from being only an issue of innovation to being crucial to the running of

Economic Sciences
https://economic-sciences.com
ES (2026) 22, 5(S), 141-146 | ISSN:1505-4683

educational facilities and the educational system. et al., Sych (2021). The authors analyzed over fifty theories that reflect the modern educational system, instructional strategies, and this procedure of the digital evolution of education in order to reach conclusions about the importance of technological innovation in education and the major advancements in their field. The authors' findings about the level of higher education's digital transformation in Ukraine were made possible by their examination of the experiences of the country's top universities. It has been possible to identify the trends in higher education growth throughout the digital transformation age via the compilation of scientific literature as well as personal experiences and study.

Concerns regarding digitization in higher education institutions (HEIs) are shared by a sizable portion of educational stakeholders. Digital competencies are becoming more and more important in all settings, but especially in the workplace. Because of this, one of the main goals of colleges is now to equip aspiring managers with the abilities they need to solve problems and find solutions, with information literacy being one of those talents Akour & Alenezi, (2022). The study of educational technology advancements in higher education is now the subject of discussions and debates, with a range of initiatives, policies, and strategies put forth. Children of today have grown up with digital technology from the day they were born. Our society still has a wide variety of digital divides that have an impact on the digital futures of the younger generation. The degree of preparation that today's pupils receive for living in a technologically advanced society is different. Higher learning and instructing need to undergo a significant digital revolution in order to fulfill the demands of the current generation and the fully digital world they will live in.

The curriculum of higher education “organizations are changing significantly. These variations are caused by a variety of circumstances. These elements involve, but are not limited to, online education, technological change, nanodegrees, and learners who are digitally natives. Students use digital technology to enhance their learning because it provides a variety of tools that may be used to integrate organized instructional settings into higher education curriculum. Alenezi (2023). The growth of technology brought forth by the fourth revolution in industrial history requires HEIs to address the DT in each of its forms. The use of digitization techniques in educational organizations is a developing subject that has lately attracted attention since it allows us to describe the different relationships among participants in a technologically enabled educational setting.This study aims to provide a comprehensive analysis of the unique components of the approach universities and colleges have taken to achieve digital transformation. Furthermore, how digital learning fits into the environment of contemporary higher education.

## 3. Research Methodology

The purpose of this study is to investigate how well online learning is transforming education in the age of a digital shift. Leveraging methodologies from deep learning (DL) systems, specifically the proposed framework incorporating Fuzzy Inference System (FIS) coupled with Long Short-Term Memory (LSTM) networks (referred to as FLSTM), the research assesses the impact of online learning on educational outcomes.

Data for this study are sourced from various online learning platforms and educational databases. The dataset includes information on student demographics, course enrollment, engagement metrics, and academic performance indicators. In particular, public educational archives and datasets from well-known distance education platforms like Coursera, edX, and also Khan Academies are used.

Pre-processing the data is part of the research approach in order to handle outliers, missing numbers, and data consistency. To extract pertinent characteristics from the information, such as pupil performance structures, rates of graduation, and performance patterns, characteristic engineering approaches are used.The dataset is augmented to a significant scale to enhance model robustness, using techniques like data generation through synthetic data generators.

Economic Sciences
https://economic-sciences.com
ES (2026) 22, 5(S), 141-146 | ISSN:1505-4683

For model development, a neural network architecture is constructed with configurable parameters. The framework includes multiple layers, incorporating LSTM units and FIS components tailored to the characteristics of online learning data. Model training and testing are conducted on cloud-based servers utilizing Tensor Flow with Apache Spark and Cassandra for efficient processing and storage.

Performance assessment involves evaluating multiple models, including standard LSTM, FLSTM, and hybrid models combining FIS with LSTM or Bidirectional LSTM (Bi-LSTM). Evaluation metrics such as accuracy, precision, specificity, and functional measurements related to student learning outcomes are employed. Comparative analysis is conducted to discern the effectiveness of online learning approaches in transforming education, with a focus on interpreting and contrasting various evaluation criteria and metrics.

The overall goal of this study approach is to shed light on how well online learning contributes to the advancement of education in the digital age by making use of sophisticated deep learning frameworks and performance assessment methods.

## 4. Results

The table 4.1 compares F1-values (%) of different neural network architectures (LSTM, FLSTM, Bi-LSTM) across varying data sizes. As data size increases from 10 to 50, F1-values generally improve for all architectures. Bi-LSTM consistently outperforms LSTM and FLSTM, reaching the highest F1-value of 97% at 50 data points.

**Table.4.1. Performance Metrics for F-value**

| Data | | F1-value | |
|---|---|---|---|
| | LSTM | FLSTM | Bi-LSTM |
| 10 | 94.8 | 94 | 94.5 |
| 20 | 96 | 94.3 | 95.5 |
| 30 | 96.7 | 94.5 | 96.2 |
| 40 | 97.2 | 94.6 | 96.6 |
| 50 | 97.6 | 94.7 | 97 |

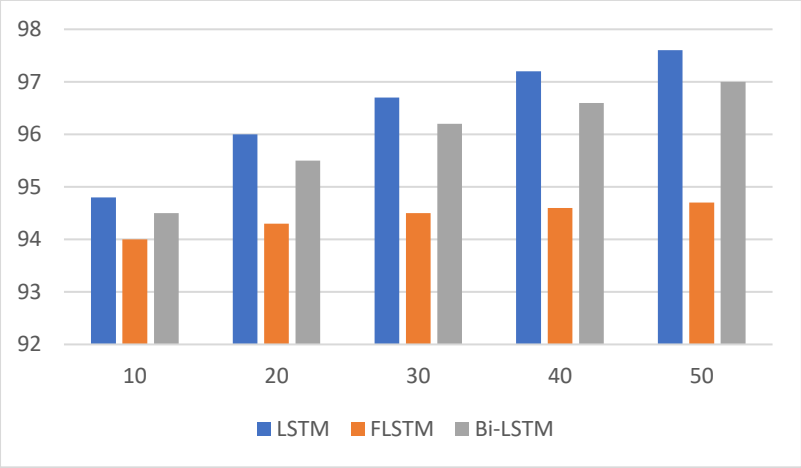


**Fig.4.1. Performance Metrics for F-value**

The table 4.2 presents performance measures in percentage for LSTM, FLSTM, and Bi-LSTM models. Accuracy, recall, precision, specificity, and F1-value are provided. LSTM achieves the highest accuracy and F1-value, while FLSTM and Bi-LSTM show similar performance across metrics with slight variations.

Economic Sciences
https://economic-sciences.com
ES (2026) 22, 5(S), 141-146 | ISSN:1505-4683

**Table.4.2. System's performance metrics**

| Performance Measures (%) | LSTM | FLSTM | Bi-LSTM |
|---|---|---|---|
| Accuracy | 98.86 | 95.07 | 98.04 |
| Recall | 98.81 | 95.06 | 98.04 |
| Precision | 98.9 | 95.07 | 98.03 |
| Specificity | 98.9 | 95.07 | 98.03 |
| F1-value | 98.86 | 95.07 | 98.03 |

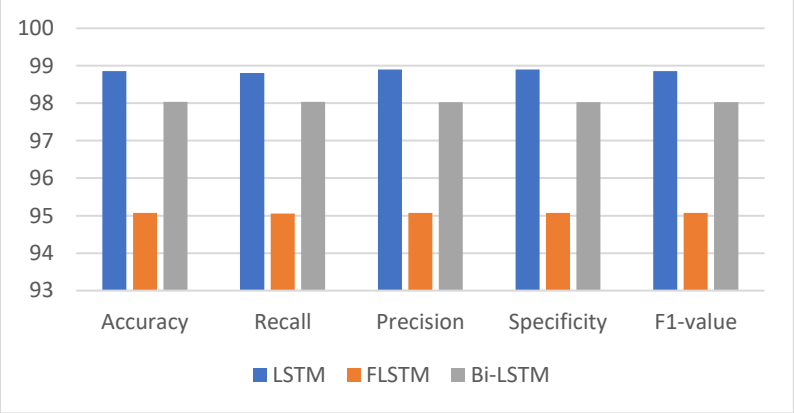


**Fig.4.2. System's performance metrics**

## 5. Conclusion

In summary, there is no denying the effectiveness of virtual schooling in transforming education in the framework of the digital change period. As technology continues to advance and permeate various aspects of our lives, education must adapt to meet the emerging requirements of learners worldwide. By examining it from the perspectives of adaptability, ease of and creativity, online learning has shown itself to be an effective means of making education, lowering entrance barriers, and promoting inclusion.

Online learning's capacity to cross geographic barriers and provide everybody access to education, no matter where they are in the world, is one of its main advantages. For those who live in rural or underdeveloped regions and may not have experienced accessibility to traditional educational tools, this has very significant ramifications. Furthermore, since online learning is flexible, students may adjust their coursework to meet their schedules and accommodate a range of responsibilities and lifestyles.

Additionally, a wide range of dynamic and captivating materials are available on online learning platforms, from simulated scenarios to multimedia lessons, which enhance the learning process and accommodate various learning preferences. By providing adaptive feedback and suggestions to maximize learning results, the integration of modern technologies like AI and ML further customizes learning paths.

Moreover, online education promotes global communication and cooperation between teachers and students. Through discussion forums, virtual classrooms, and collaborative projects, individuals can exchange ideas, perspectives, and experiences, enriching the learning process and cultivating a global community of learners.

However, challenges persist, including the digital divide, concerns about the quality of online education, and issues surrounding digital literacy. Highlighting these obstacles needs a concerted attempt from educators, and technology developers to ensure equitable access to online learning resources, maintain high standards of educational content, and provide necessary support and training to empower learners to navigate digital platforms effectively.

In essence, the effectiveness of online learning in transforming education amidst the digital transformation era hinges on its ability to

democratize access, enhance flexibility, foster innovation, and promote collaboration. By leveraging the power of technology, online learning has the potential to revolutionize education, empowering individuals to pursue lifelong learning opportunities and adapt to the ever-changing demands of the modern world. We must fully use online learning as we keep moving into the information age in order to improve educational opportunities and make them more accessible, equal, and inclusive for everyone.

**References**

1. Brink, H., Packmohr, S., & Vogelsang, K. (2020). The digitalization of universities from a students' perspective. In *6th international conference on higher education advances (HEAd'20)* (pp. 967-974). UniversitatPolitècnica de València.
2. Mustapha, I., Thuy Van, N., Shahverdi, M., Qureshi, M., & Khan, N. (2021). Effectiveness of Digital Technology in Education During COVID-19 Pandemic. A Bibliometric Analysis. International Journal Of Interactive Mobile Technologies (Ijim), 15(08), 136.
3. Maqableh, M., & Alia, M. (2021). Evaluation online learning of undergraduate students under lockdown amidst COVID-19 Pandemic: The online learning experience and students' satisfaction. Children and Youth Services Review.
4. Mahlangu, V. P. (2018). The good, the bad, and the ugly of distance learning in higher education. *Trends in E-learning*, *10*, 17-29.
5. Uğur, N. G. (2019). Digitalization in higher education: A qualitative approach.
6. García-Morales, V. J., Garrido-Moreno, A., & Martín-Rojas, R. (2021). The transformation of higher education after the COVID disruption: Emerging challenges in an online learning scenario. *Frontiers in psychology*, *12*, 616059.
7. Loukomies, A., & Juuti, K. (2021). Primary students' experiences of remote learning during covid-19 school closures: A case study of Finland. *Education Sciences*, *11*(9), 560.
8. Mohamed Hashim, M. A., Tlemsani, I., & Matthews, R. (2022). Higher education strategy in digital transformation. *Education and Information Technologies*, *27*(3), 3171-3195.
9. Sych, T., Khrykov, Y., &Ptakhina, O. (2021). Digital transformation as the main condition for the development of modern higher education. *Educational Technology Quarterly*, *2021*(2), 293-309.
10. Akour, M., & Alenezi, M. (2022). Higher education future in the era of digital transformation. *Education Sciences*, *12*(11), 784.
11. Alenezi, M. (2023). Digital learning and digital institution in higher education. *Education Sciences*, *13*(1), 88.