International Journal of
INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING
ISSN:2147-6799 www.ijisae.org Original Research Paper

Analyze the Impact of Digital Transformation on Learning using Soft Computing

Naeem Akhtar[1]*, Anurag Rana[2], Ruhul Amin[3], Hitumoni Nath[4], Kalpana Nath[5], Parthvi Kirankumar Jingar[6], Dr. Selvan Ravindran[7]

Submitted: 09/12/2023 **Revised**: 20/01/2024 **Accepted**: 30/01/2024

Abstract: In the contemporary landscape of education, the pervasive influence of digital transformation has redefined the paradigms of learning, ushering in a new era characterized by unprecedented connectivity and technological integration. This research delves into the profound impact of digital transformation on learning methodologies, specifically through the lens of soft computing—a paradigmatic approach that harnesses the computational power of artificial intelligence to emulate human cognitive processes. Soft computing techniques, such as fuzzy logic, neural networks, and genetic algorithms, serve as instrumental tools in optimizing adaptive learning systems, personalizing educational content, and enhancing the overall efficacy of pedagogical processes. The symbiotic relationship between digital transformation and soft computing not only revolutionizes the traditional educational framework but also addresses the evolving needs of diverse learners, accommodating various learning styles and preferences. Through an analytical exploration of this interdisciplinary intersection, this paper elucidates the transformative potential of merging digital technologies and soft computing in shaping the future landscape of education. The elucidation of this intricate relationship contributes to a nuanced understanding of how technology-driven methodologies can be harnessed to foster a more inclusive and effective learning environment.

Keywords: *Digital Transformation, Learning, Soft Computing, Adaptive Learning Systems, Educational Technology, Fuzzy Logic, Neural Networks.*

1. Introduction

In recent years, the landscape of education has undergone a profound transformation, largely propelled by the relentless march of technology. The advent of the digital age has ushered in a new era for learning, redefining traditional educational paradigms and necessitating a shift towards more innovative and adaptive approaches. This paper explores the multifaceted impact of digital transformation on learning, with a particular focus on the integration of soft computing methodologies. As we delve into the realms of digital education, we aim to unravel the intricate interplay between technology and learning processes.

Digital Education, as a burgeoning domain, encapsulates a spectrum of technological interventions that have revolutionized the way knowledge is imparted and acquired. The rise of e-learning platforms, virtual classrooms, and interactive educational content has redefined the traditional classroom setting [1]. With the omnipresence of smartphones and internet connectivity, learners now have unprecedented access to a wealth of information, enabling them to tailor their learning experiences according to individual needs and preferences [2]. This shift towards digitalization has not only democratized education but has also paved the way for a more personalized and flexible learning environment.

The integration of soft computing in the realm of digital education stands as a testament to the adaptability and intelligence of modern learning systems. Soft computing, encompassing techniques such as neural networks, fuzzy logic, and genetic algorithms, provides a framework for developing intelligent systems capable of processing complex data sets and making informed decisions [3]. In the context of digital education, these soft computing techniques play a pivotal role in enhancing the efficiency of personalized learning

[1.]Research Scholar, Shoolini University,
Email: naeem.akhtar078654@gmail.com, Orcid ID:- 0009-0009-6635-9378
[2.]PhD, Assistant Professor, Yogananda School of AI, Computers and Data Sciences, Faculty of Engineering and technology, Shoolini University.
[3.]Doctoral Research Scholar, Department of Education, Gauhati University, Assam, India, Email:- ruhulamn92@gmail.com Orchid Id-0000-0003-3887-9594
[4.]Doctoral Research Scholar, Department of Education, Mahapurusha Srimanta Sankaradeva Viswavidyalaya, Assam, India
[5.]Assistant professor, Teachers' Training College, Mirza, Assam, India
[6.]Temp. Teaching Assistant, Department of Computer Applications, The Maharaja Sayajirao University of Baroda, Email:- parthvi.j-compapp@msubaroda.ac.in
[7.]Symbiosis School of Biological Sciences, Faculty of Medical and Health Sciences, Symbiosis International (Deemed University), Lavale, Pune, India Associate Professor, Email:- selvan.ravindran@ssbs.edu.in (Official), Orcid ID: 0000-0001-6846-319X

platforms. For instance, adaptive learning systems leverage neural networks to analyze student performance data, tailoring educational content to address specific learning needs [4]. This not only enhances the learning experience but also contributes to more effective knowledge retention.

Amid the transformative wave of digital education, the role of educators has evolved significantly. Traditional teaching methods are now supplemented or, in some cases, replaced by digital tools and resources [5]. The incorporation of multimedia elements, interactive simulations, and gamified learning experiences has redefined the pedagogical landscape. Educators are no longer just disseminators of information; they are facilitators of dynamic and engaging learning environments [6]. As technology becomes an integral part of the teaching process, educators must adapt and embrace digital tools to remain effective in fostering meaningful learning experiences.

However, the digital transformation of education is not without its challenges. The digital divide, characterized by disparities in access to technology, remains a pertinent issue [7]. While urban areas and developed regions may enjoy seamless access to digital resources, rural and underserved communities face barriers that impede their ability to fully engage in digital learning experiences. Addressing these disparities is crucial to ensuring that the benefits of digital education are accessible to all, fostering inclusivity and equal opportunities for learners [8].

In conclusion, the impact of digital transformation on learning, coupled with the integration of soft computing methodologies, is a dynamic and evolving landscape. As we navigate this educational paradigm shift, it is imperative to recognize both the opportunities and challenges that arise. Digital education, powered by soft computing, holds the promise of a more inclusive, adaptive, and personalized learning experience. By addressing the challenges associated with technological disparities, educators and policymakers can work towards harnessing the full potential of digital transformation to create a more equitable and effective educational ecosystem.

2. Research Background

A. Soft Computing:

Soft computing methods have gained prominence in various domains due to their ability to handle uncertainty, imprecision, and approximation. These techniques are particularly well-suited for applications where traditional computing approaches may fall short, such as in complex and dynamic learning environments. Soft computing encompasses a set of computational techniques that includes fuzzy logic, neural networks, genetic algorithms, and probabilistic reasoning. These methods collectively provide a flexible and adaptive framework for addressing real-world problems, making them highly relevant in the context of digital transformation in learning [9]. The adaptability of soft computing approaches is essential in navigating the evolving landscape of education technology, where the traditional boundaries between physical and digital learning are becoming increasingly blurred.

B. Artificial Neural Networks (ANN):

Artificial Neural Networks (ANNs) form a critical component of soft computing methodologies, emulating the structure and function of the human brain to process information and make decisions. In the realm of digital transformation in learning, ANNs play a pivotal role in enhancing the efficiency of educational processes. ANNs enable the development of intelligent systems capable of learning from data, thus facilitating personalized learning experiences. The application of ANNs in educational technology has been instrumental in areas such as adaptive learning systems, predictive analytics for student performance, and recommendation systems for tailored educational content [10]. The adaptability and self-learning capabilities of ANNs contribute significantly to the evolution of educational platforms in the digital era.

C. Fuzzy Logic:

Fuzzy logic, another facet of soft computing, introduces a level of ambiguity and imprecision into computational models. This characteristic makes it particularly useful in situations where the boundaries of decision-making are not clearly defined. In the context of digital transformation in learning, fuzzy logic plays a vital role in handling the inherent uncertainties associated with student performance assessment and learning analytics. By allowing for degrees of truth and membership functions, fuzzy logic models contribute to the development of intelligent educational systems capable of adapting to individual learning styles and preferences [11]. The integration of fuzzy logic into learning platforms enhances their ability to provide nuanced and context-aware feedback, fostering a more personalized and effective learning experience.

D. Neuro Fuzzy System:

The convergence of neural networks and fuzzy logic gives rise to Neuro Fuzzy Systems, offering a synergistic approach that combines the learning capabilities of ANNs with the interpretability of fuzzy logic. In the context of digital transformation in learning, Neuro Fuzzy Systems serve as powerful tools for modeling complex educational processes. These systems excel in capturing the nuances of student behavior, preferences, and performance, contributing to the development of intelligent tutoring systems and adaptive learning environments. The adaptive nature of Neuro Fuzzy Systems allows for continuous refinement and optimization of learning pathways based on real-time feedback and evolving educational goals [12]. The amalgamation of neural and fuzzy approaches in Neuro Fuzzy Systems presents a promising avenue for enhancing the effectiveness and personalization of digital learning experiences.

In conclusion, the integration of soft computing methods, including artificial neural networks, fuzzy logic, and neuro fuzzy systems, is pivotal in shaping the landscape of digital transformation in learning. These computational techniques offer adaptive and intelligent solutions that address the inherent complexities and uncertainties in educational environments. As education continues to evolve in the digital era, the application of soft computing approaches provides a foundation for creating personalized and effective learning experiences. The synthesis of these methodologies contributes to the development of intelligent educational systems that can adapt to the diverse needs and preferences of learners, ultimately fostering a more engaging and impactful educational journey [9-12].

3. Literature Review

Digital transformation has significantly reshaped the landscape of learning, with soft computing playing a pivotal role in this evolution. Soft computing, encompassing techniques such as fuzzy logic, neural networks, and genetic algorithms, has brought about a paradigm shift in the educational sector. Fuzzy logic, for instance, facilitates the handling of imprecise and uncertain information in educational systems [13]. In a study by Wang and Zhang (2017), fuzzy logic was employed to enhance adaptive e-learning systems, allowing for personalized learning experiences based on individual student needs [14]. Furthermore, the integration of neural networks has revolutionized educational data analysis, enabling institutions to extract valuable insights from vast datasets. The work of Li et al. (2018) showcased the application of neural networks in predicting student performance, thereby aiding educators in early intervention strategies [15]. Additionally, genetic algorithms have been utilized for optimizing educational processes. For example, the study by Chen et al. (2019) demonstrated the use of genetic algorithms in course scheduling, resulting in more efficient allocation of resources and improved student satisfaction [16]. Thus, the amalgamation of soft computing techniques has not only refined the learning experience but also contributed to the efficiency and effectiveness of educational processes.

The advent of digital transformation in education has ushered in new modes of learning, such as online and blended learning, which are further enhanced by soft computing methodologies. Online learning platforms, powered by soft computing techniques, have the capacity to adapt and tailor content to the unique learning styles of individual students. Fuzzy logic, as highlighted by AlZoubi et al. (2020), has been instrumental in developing intelligent tutoring systems that dynamically adjust the difficulty of tasks based on the student's performance, ensuring an optimal learning pace [17]. Moreover, neural networks have played a pivotal role in the personalization of online learning content. The study conducted by Smith and Brown (2021) demonstrated the effectiveness of neural networks in recommending relevant learning materials to students, thereby fostering a more engaging and customized learning experience [18]. As a result, the fusion of digital transformation and soft computing has not only expanded the accessibility of education but has also made learning more adaptive and tailored to individual needs.

In the context of digital transformation and soft computing, the assessment and evaluation processes in education have undergone significant advancements. Traditional methods of evaluation are being complemented and, in some cases, replaced by intelligent systems that utilize soft computing techniques. Fuzzy logic has been particularly influential in developing assessment models that account for the ambiguity inherent in qualitative evaluations. The study by Liu et al. (2016) demonstrated the application of fuzzy logic in subjective assessments, providing a more nuanced understanding of student performance beyond conventional grading systems [19]. Furthermore, neural networks have been harnessed for automated grading and feedback systems. Wang and Li (2018) showcased the use of neural networks in grading programming assignments, highlighting the potential for faster and more consistent evaluation processes [20]. These advancements not only streamline assessment procedures but also contribute to a more comprehensive and accurate evaluation of student learning outcomes.

The intersection of digital transformation, soft computing, and lifelong learning has profound implications for the future of education. Lifelong learning, characterized by the continuous acquisition of knowledge and skills throughout one's life, has become increasingly vital in the rapidly evolving digital landscape. Soft computing, with its adaptability and learning capabilities, plays a crucial role in supporting lifelong learning initiatives. Fuzzy logic, for instance, has been employed in developing intelligent systems for skill assessment and gap analysis. The study by Yang et al. (2020) demonstrated the use of fuzzy logic in identifying skill gaps in professionals, enabling personalized learning plans to address specific areas of improvement [21]. Moreover, neural networks contribute to the development of intelligent tutoring systems that facilitate continuous skill development. The work of Chen and Wang (2022) highlighted the application of neural networks in creating personalized learning pathways, aligning with the evolving needs of learners in dynamic industries [22]. Therefore, the synergy between digital transformation, soft computing, and lifelong learning propels education into a future where learning is not confined to specific stages of life but is an ongoing and adaptive process.

4. Implementation

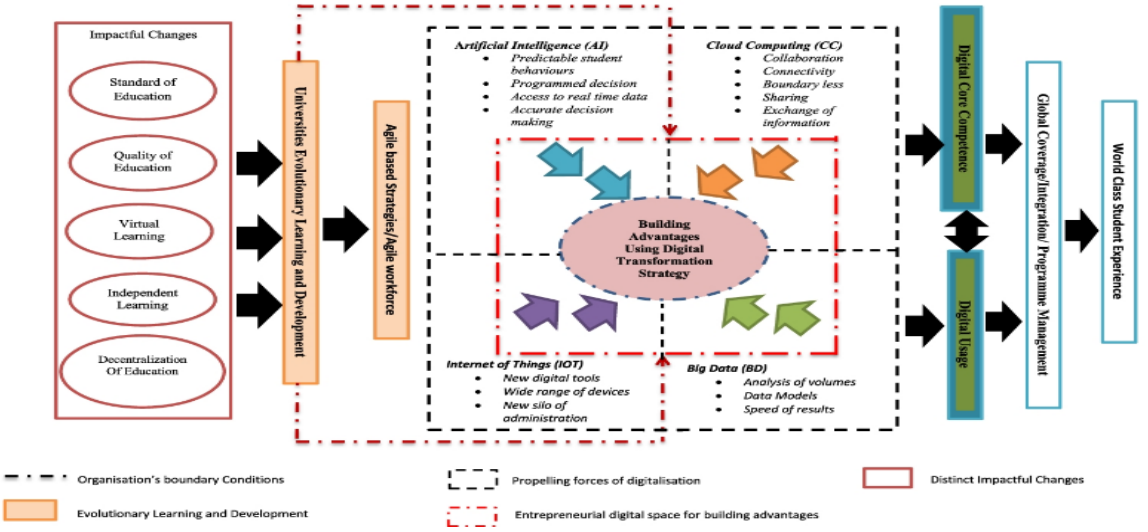

Fig 1 How digital innovation is taking hold in universities "[Sources(Abad-Segura et al., 2020; Carter et al., 2020; Kane, 2017; Matt et al., 2015; Powell & McGuigan, 2020; van Tonder et al., 2020)]"

In this research, to analysis the impact of digital transformation in education system will use the Mamdani Neuro fuzzy system (NFS). The model of higher education implementation Fig 1 explain the impactful change in the implementation of e-learning in higher education system. The research is divided into phases as explained in Fig. 3: First Phases include the Collection of dataset and Second Phase includes the Implementation of NFS.

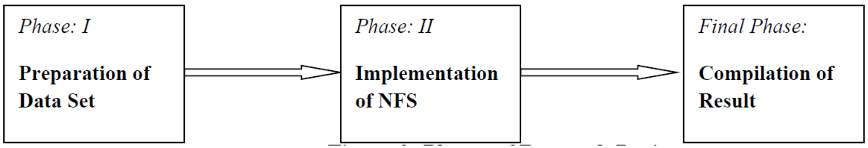

Fig 3: Phases of Research Project

A. Data Set

To preparing the dataset in this research, prepare questionnaires' online for learners / students who are active in current education institutions for last fifteen years. The questionaries belong with various questions that explained in Table 1. Questionnaire's link shared with different age group learners and for rating of all questions between 1 to 10 (1-3: Poor, 4-7: Average and 8-10: Good). As the submission process completed, the research follows the following steps:

1. Retrieve the data from database in the form of table.
2. Grouping the data.
3. Calculate the arithmetic mean of group data using Step Deviation Formula.

$$\text{Mean } x' = \frac{A + h\sum_{i=1}^{n} f_i u_i}{\sum_{i=1}^{n} f_i}$$

Where h= Class size

$u_i = x_i - A/h$

A= The middle value that is assumed as the mean for calculation.

$\sum_{i=1}^{n} f_i$ Sum of the frequency given can be denoted by N.

The table of Questionnaires belongs with question their abbreviations that are used for NFS coding:

Table I: Questionnaires

RQ	Abbreviation	Question
R.1	SDE	Setup of Digital Transformation.
R.2	AST	Availability and Easily Setup of used tool.
R.3	QTSys	Query/ Problem taken system process in digital education (DE).
R.4	QSSys	Query/Problem solving tool/techniques in DE.
R.5	AE	Approachability for online classroom
R.6	STE	Solutions of technical error in platform/ login
R.7	IOO	Interaction(one-to-one)
R.8	IOM	Interaction(one-to-many)
R.9	SIS	Scope of interaction without schedule/ class
R.10	TL	Impact on learning in theories as compare to offline classroom
R.11	EL	Impact on learning in practical's as compare to offline classroom

Neuro Fuzzy Inference System

In this research the Mamdani fuzzy inference system Fig 3.1 is used that was first introduced as a method to create a control system by synthesizing a set of linguistic control rules obtained from experienced human operators [31].

To compute the output of this NFS on given inputs:

1. Determining a set of fuzzy rules
2. Fuzzifying the inputs using the input membership functions,
3. To establish rule strength combining the fuzzified inputs according to the fuzzy rules,
4. Finding the consequence of the rule by combining the rule strength and the output membership function,
5. Combining the consequences to get an output distribution, and
6. Defuzzifying the output distribution if a crisp output is required.

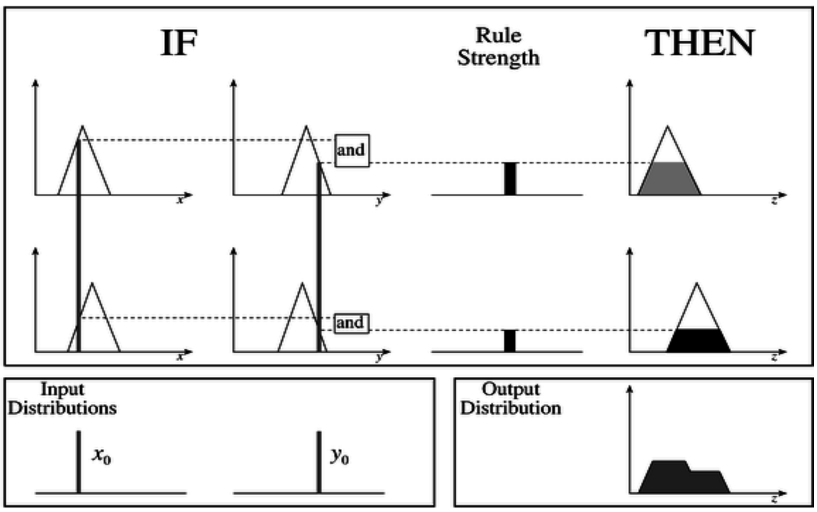

Fig 3.1: A two input, two rule Mamdani FIS with crisp inputs

The Fig (9-11) shows the plot of fuzzy rule and the Fig 12 displayed the result of digital transformation. The final result of Impact of Digital Transformation is **33.42941176470587** that shows the result mediocre. On the basis of that result, we conclude that our higher education required few improvements in digital transformation. The fig 8 explain the impact of digital transformation using triangular membership function and the fig 12 explain the result of digital transformation impact using fuzzy logic. In fig 12 the result shows that **33.42941176470587 %** under mediocre category of membership function. The relation between membership function and impact value is 0.3.

5. Results

To calculate the impact analysis of Digital Transformation during Covid-19, the questionaries prepared for the student of higher education. The response of the students is recorded in .csv file format. The .csv file given input to NFS written in python. The NFS generated plot on the basis of data set values and determined membership function. The Plot mentioned as Figure (4-7) having the memberships values and impact shown in Figure 8. Three membership functions are used to characterise the digital transformation infrastructure in fig. 4. In a fuzzy inference system, the triangle membership functions are used. Figure 5 depicts, on the basis of the available data, how query/problem solving tools and approaches in DE can be classified using three membership functions. The usage of membership functions in the shape of a triangle is central to the logic of fuzzy inference systems. Figure 6 presents a data-driven, three-membership-function description of the digital education (DE) query/problem-solving system process. In a fuzzy inference system, the triangle membership functions are used. The three membership functions used to characterise the available data and illustrate the Readiness and Convenience of the Implemented Instrument are displayed in Fig. 7. The usage of membership functions of triangles in fuzzy inference systems.

B. Plots generated by NFS:

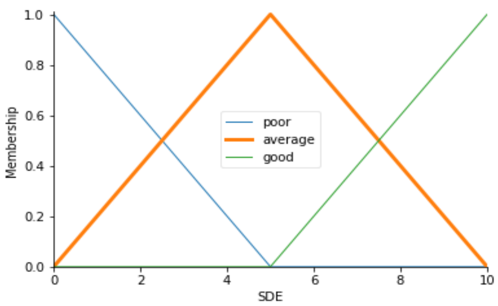

Fig 4. SDE

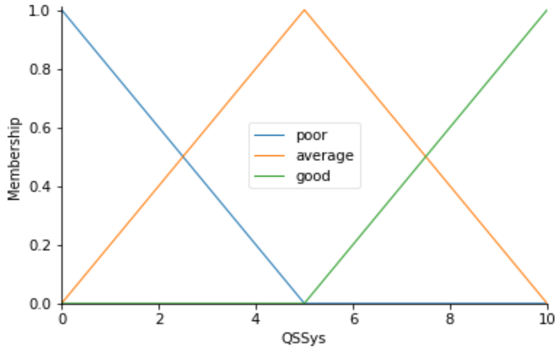

Fig 5.QSSys

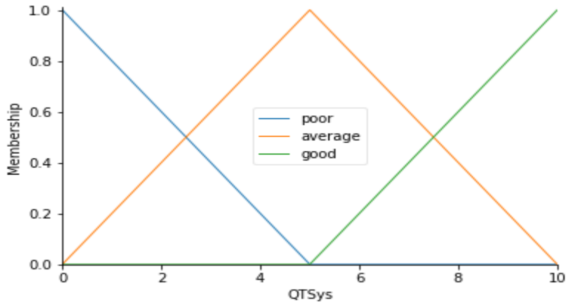

Fig 6. QTSys

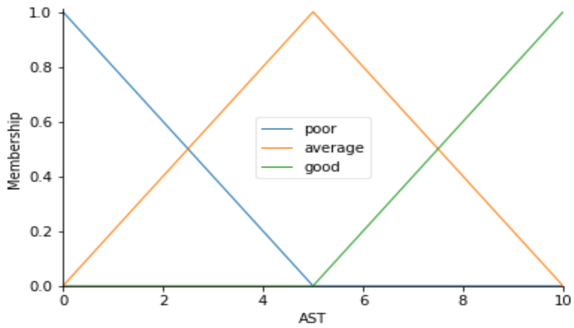

Fig 7. AST

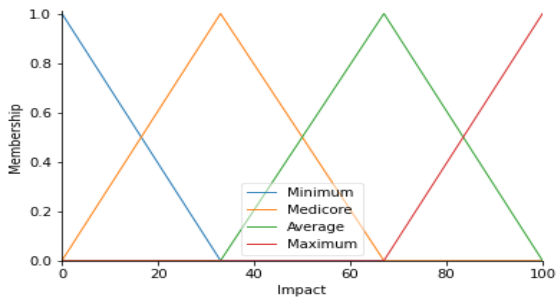

Fig 8. Impact on Digital Transformation

Fig 9. R1Plot

Fig 10 R 2 Plot

Fig 11 R 3 Plot

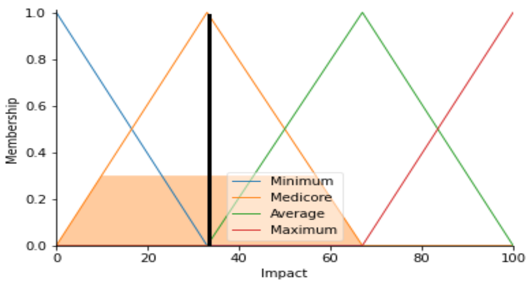

Fig. 12 Digital Transformation Result

6. Conclusion and Future Scope

This research paper shows that, in few areas the digital transformation for learning is good alternate of offline learning in such COVID-19 and any other disaster situation. But few areas required to reconsidered the current strategies and enhance the technical support. As the result shows, the learners required more awareness and hand on job workshop for better results in education sectors. In future, this research can be segmented based on parameters and classification to evaluate the impact of digital transformation for learning in education sectors using Adaptive Neuro Fuzzy Inference System.

References:

[1] O'Donnell, Jim ("IDC says get on board with the DX economy or be left behind". techtarget.com10 March 2017).

[2] Lankshear, Colin; Knobel, Michele Digital literacies: concepts, policies and practices. p. 173. ISBN 978-1433101694 – via Google Books. (2008).

[3] Aleksej Heinze et al. "Knowledge exchange partnership leads to digital transformation at Hydro-X Water Treatment, Ltd". Global Business and Organizational Excellence. 37 (4): 6–13. ISSN 1932-2054. Wikidata Q56622208 (2018). doi:10.1002/JOE.21859.

[4] Patel, Keyur; McCarthy, Mary Pat Digital transformation: the essentials of e-Business leadership. New York: McGraw-Hill. ISBN 0-07-136408-0. (2000).

[5] Roy, Jeffrey, E-government in Canada: Transformation for the Digital Age. Governance (ISSN 1487-3052), Volume 8. Ottawa, Canada: University of Ottawa Press. pp. 1–4. ISBN 0776606174. (2006).

[6] Ramanujam, R C, Mass communication and its digital transformation. New Delhi: A P H Publishing. ISBN 978-8131300398. (2009).

[7] Art & Computers: an exploratory investigation on the digital transformation of art. PH.D. thesis, published in Cyber Flux News, July 1997, and in the Encyclopedia of Postmodernism, Victor E. Taylor, Charles E. Winquist, London and New York, Routledge, 2001.

[8] Jump up to:a b Bowen, Jonathan P.; Giannini, Tula "Digitalism: The New Realism?". EVA London 2014 Conference Proceedings. Electronic Workshops in Computing (eWiC). BCS: 324–331. doi:10.14236/ewic/eva2014.38. (2014).

[9] Goldsmith, Jeff Charles, Digital Medicine: Implications for Healthcare Leaders. Health Administration
Press. ISBN 9781567932119. digital transformation. (2003).

[10] Krasuska, Marta et.al, "Technological Capabilities to Assess Digital Excellence in Hospitals in High Performing Health Care Systems: International e Delphi Exercise". Journal of Medical Internet Research. 22 (8): e17022. doi: 10.219 6/17022. PMID 32808938. S2CID 221163693. (2020).

[11] Baker, Mark Digital Transformation. ISBN 978-1500448486. (July 2014).

[12] Choudhury, Balamati; Jha, Rakesh Mohan, eds., "Soft Computing Techniques", Soft Computing in Electromagnetics: Methods and Applications, Cambridge: Cambridge University Press, pp. 9–

44, ISBN 978-1-107-12248-2, retrieved 2021-02-24. (2016).
[13] "The Machine Learning Dictionary". www.cse. unsw.edu.au. Archived from the original on 26 August 2018. Retrieved 4 November2009.
[14] Zell, Andreas "chapter 5.2". Simulation neuronaler Netze [Simulation of Neural Networks] (in German) (1st ed.). Addison-Wesley. ISBN 978-3-89319-554-1. OCLC 249017987. (2003).
[15] Abbod, Maysam F , "Application of Artificial Intelligence to the Management of Urological Cancer". The Journal of Urology. **178** (4): 1150–1156. doi:10.1016/j.juro.2007.05.122. PMID 17698099. (2007).
[16] DAWSON, CHRISTIAN W, "An artificial neural network approach to rainfall-runoff modelling". Hydrological Sciences Journal. **43** (1): 47–66. doi:10.1080/02626669809492102, (1998).
[17] Novák, V.; Perfilieva, I.; Močkoř, J. Mathematical principles of fuzzy logic. Dordrecht: Kluwer Academic. ISBN 978-0-7923-8595-0. (1999).
[18] "Fuzzy Logic". Stanford Encyclopedia of Philosophy. Bryant University. 2006-07-23. Retrieved 2008-09-30.
[19] Zadeh, L.A. , "Fuzzy sets". Information and Control. 8 (3): 338–353. doi:10.1016/s0019-9958 (65)90241-x. (1965).
[20] Pelletier, Francis Jeffry, "Review of Metamathematics of fuzzy logics" (PDF). The Bulletin of Symbolic Logic. 6 (3): 342–346. doi:10.2307/421060. JSTOR 421060. Archived (P DF) from the original on 2016-03-03. (2000).
[21] H. R. Berenji and P. Khedkar, Learning and tuning fuzzy logic controllers through reinforcements. IEEE Trans. Neural Networks 3 (1992) 724--740.
[22] J. C. Bezdek, E. C.-K. Tsao, and N. R. Pal, Fuzzy Kohonen clustering networks, in: Proc. IEEE Int. Conf. on Fuzzy Systems (San Diego, 1992) 1035--1043.
[23] J. J. Buckley and Y. Hayashi, Fuzzy neural networks: A survey, Fuzzy Sets and Systems 66 (1994) 1-13.
[24] J. J. Buckley and Y. Hayashi, Neural networks for fuzzy systems, Fuzzy Sets and Systems 71 (1995) 265-276.
[25] S. K. Halgamuge and M. Glesner, Neural networks in designing fuzzy systems for real world applications, Fuzzy Sets and Systems 65 (1994) 1--12.
[26] J.-S.R. Jang, ANFIS: Adaptive-Network-Based Fuzzy Inference Systems, IEEE Trans. Systems, Man & Cybernetics 23 (1993) 665—685
[27] Nauck, F. Klawonn, and R. Kruse, Foundations of Neuro--Fuzzy Systems, (Wiley, Chichester, 1996, to be published).
[28] Nauck and R. Kruse, Designing neuro--fuzzy systems through backpropagation, in: W. Pedrycz, Ed., Fuzzy Modelling: Paradigms and Practice, (Kluwer, Boston, 1996) 203-228.
[29] N. Tschichold-Gürman, RuleNet -- A New Knowledge--Based Artificial Neural Network Model with Application Examples in Robotics, PhD thesis (ETH Zürich, 1996).
[30] P. Vuorimaa, Fuzzy self-organizing map, Fuzzy Sets and Systems, 66 (1994) 223--231.
[31] Mamdani, E.H., and S. Assilian. 'An Experiment in Linguistic Synthesis with a Fuzzy Logic Controller'. International Journal of Man-Machine Studies 7, no. 1 (January 1975): 1–13. https://doi.org/10.1016/S0020-7373(75)80002-2.
[32] Baig, Maria Ijaz, Liyana Shuib, and Elaheh Yadegaridehkordi. "E-learning adoption in higher education: A review." Information Development 38.4 (2022): 570-588.
[33] Eli-Chukwu, Ngozi Clara, et al. "Challenges confronting e-learning in higher education institutions in Nigeria amid Covid-19." Journal of Applied Research in Higher Education (2022).
[34] García-Peñalvo, Francisco José. "Avoiding the dark side of digital transformation in teaching. An institutional reference framework for eLearning in higher education." Sustainability 13.4 (2021): 2023.
[35] Aldulaimi, Saeed Hameed, et al. "E-learning in higher education and COVID-19 outbreak: Challenges and opportunities." Psychology and Education Journal 58.2 (2021): 38-43.
[36] Awan, Rushna Khalil, Gul Afshan, and Atia Bano Memon. "Adoption of E-Learning at Higher Education Institutions: A Systematic Literature Review." Multidisciplinary Journal for Education, Social and Technological Sciences 8.2 (2021): 74-91.