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Building Educational Resilience through Education 4.0 in Africa

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ABSTRACT

This paper aims to describe the digitalization in Educative system in Côte d'Ivoire according to the Education 4.0 paradigm to promote digital appropriation and build social resilience in a challenging context. Through a multisite ethnography case study in Côte d'Ivoire, a West African country, observation, interviews, and focus groups were used to collect data from a convenience sample of 20 participants (students, educators, parents, administrators) settled in 3 cities of the country. Based on Education 4.0 lenses, findings underlined the benefits and challenges of techno-pedagogy and technology integration according to Educative institutions' capacities in terms of Competencies, Learning methods, Information and communication technologies (ICT) categories, and Infrastructure levels. Moreover, participants show the integration of 21st century learning as an approach to support digital as a tool of educative resilience. As recommendations, an educative system approach including techno-pedagogy and 21st century pedagogy is a strategic approach for an effective educative system in Côte d'Ivoire in this changing world, according to SDGs and internationalization of education trends.

INTRODUCTION

The digital revolution is transforming all domains of daily life worldwide (Allcoat et al., 2021; Asad, 2021; Bonfield et al., 2020; Strogetskaya et al., 2020). It highlights the importance of promoting equity in education, improving its quality, and enhancing governance through the digitalization of educational systems. This transformation is reshaping educational paradigms, generating new ideas, methods, and practices, and providing both robust support and a driving mechanism for educational resilience (Tarricon, 2021; Voronkova, 2023).

It means that significant shifts are occurring in educational models and environments (Strogetskaya et al., 2020; Voronkova, 2023), which directly impact the core objectives of the Sustainable Development Goals (SDGs). These shifts open up new avenues for applying technology in planning for the sustainability of economic, social, and environmental systems (Costan et al., 2021; Leite, 2022; Zunaidah, 2024). As a result, individuals increasingly rely on digital tools to balance human

development and well-being, integrating Information and Communication Technology (ICT) into all aspects of society.

According to many scholars, including Carayannis and Morawska (2023), Fentyrina & Mardi (2025), and Strogetskaya et al. (2020), the digital transformation of education management is a critical step toward achieving inclusive, adaptive, and sustainable education in the emerging era of Education 5.0. This evolution of education through digital innovation requires revising policies to empower learners with the skills necessary to address societal needs and ensure personal well-being, in alignment with 21st-century pedagogy.

This innovative pedagogy emphasizes digital literacy, communication skills, civic and environmental awareness, as well as critical thinking and problem-solving, which are integrated into modern curricula. Consequently, the digital revolution represents an unprecedented shift from traditional approaches to modern, skills-based education grounded in 21st-century learning models (Allcoat et al., 2021; Asad, 2021; Dodds et al.,

2021; Giesenbauer & Müller-Christ, 2020; Haleem et al., 2022; Strogetskaya et al., 2020). Specifically, in countries such as Indonesia, India, the USA, Japan, South Africa, and Côte d'Ivoire, the digital transformation of education requires new systemic capacities to respond to unprecedented crises (e.g., the COVID-19 outbreak). It includes supporting the ongoing pursuit of excellence and education for all, in line with the goals set by the United Nations (Koné, 2021; Voronkova et al., 2023; Yunus et al., 2023).

In both the Global North and South, the internationalization of educational trends in an interconnected world has driven a shift from traditional teaching tools to digital approaches, particularly within blended learning frameworks aiming to ensure sustainable education systems. As a result, traditional pedagogy is continuously shifting toward techno-pedagogy, calling for the integration of synchronous and asynchronous digital technologies to support the sustainability of education (Salman, 2021; Strogetskaya et al., 2020).

In the world and particularly in the Global South, the rise of digitalization intensified during the COVID-19 pandemic, which accelerated responses to lockdowns by offering accessible and scalable techno-pedagogical tools to ensure educational continuity (Koné, 2021; Mhlanga et al., 2020; Strogetskaya et al., 2020; Zeleza & Okanda). In this context, Africa, as a youthful continent, has gradually adopted technology, and digitalization has become a key lever for educational policy-makers, stakeholders, and governments.

However, over the past decades, this resource-rich continent has faced numerous challenges related to digitalization, including a lack of infrastructure, insufficient access to suitable materials and digital teaching resources, widespread poverty, and disparities in digital accessibility between countries and between urban and rural areas (Evans, 2021; Koné, 2021; Nermend, 2022). However, the strengthening of educational institutions through digital capacity-building has enabled the implementation of blended learning approaches to empower learners, despite the challenging context.

This transition from traditional, face-to-face classrooms to hybrid teaching models (both in-person and virtual) has also taken root in Côte d'Ivoire, a Francophone country in West Africa.

According to Data Reportal (2024), there were 11.23 million internet users in Côte d'Ivoire at the beginning of the year, representing a 38.4% internet penetration rate. This widespread connectivity is fuelling the digitalization of the education system, as reflected in the increasing availability of internet access and a critical mass of digital devices, such as mobile phones, enabling more citizens to connect for various societal needs, including business, education, and communication.

Moreover, digital adoption now plays a crucial role in creating flexible, sustainable, and inclusive education for all citizens, regardless of their identity or social background (Koné, 2021). The proliferation of smartphones and social media, in particular, has given rise to a new generation of learners, Gen Y, Gen Z, and digital natives who incorporate digital technologies into nearly all aspects of their lives, from early childhood education to higher education.

However, in both the Global North and South, the shift to digital education remains an ongoing transformation. This raises important scientific questions about the social perceptions, representations, and outcomes of digitalization in education (González-Pérez et al., 2023; Mhlanga & Moloi, 2021; Miranda et al., 2021; Strogetskaya et al., 2020). In Côte d'Ivoire, as elsewhere, researchers are exploring this transformation by identifying its benefits, challenges, and recommendations especially regarding the use of digital tools such as smartphones, social media, Artificial Intelligence (AI) and virtual learning platforms in both urban and rural contexts (Adeoye et al., 2023; Bamba et al., 2022; Catalano, 2019; Khahro & Javed, 2022).

Consequently, the transition from traditional “brick-and-mortar” approaches to digital learning in Côte d'Ivoire has become significant. A growing number of digital tools and platforms now assist the learning process, making this transformation a critical topic of academic interest for strengthening educational sustainability in the country. Therefore, this paper seeks to examine how digital transformation is reshaping educational practices through blended learning and techno-pedagogy in Ivorian educational institutions.

This study aims to describe the digitalization of the educational system in Côte d'Ivoire through the lens of Education 4.0 paradigms, to promote

digital appropriation and fostering social resilience in a challenging context.

Various studies have examined this pedagogical shift and identified key components of Education 4.0 that serve as analytical lenses to better understand and evaluate the transformation. These core components offer a new perspective to explore the ongoing digital transition in education (González-Pérez et al., 2023; Mhlanga, 2022; Miranda et al., 2021). Based on these foundations, Education 4.0 integrates the principles of 21st-century pedagogy and provides educational leaders and policy-makers with methodologies for assessing the trajectory from Education 4.0 to Society 5.0 (Allcoat, 2021; González-Pérez et al., 2023; Sharma, 2019; Okunlola et al., 2024).

Similarly, the study by Stroetskaya et al. (2020) explores how Education 4.0 is being applied to secondary teacher training programs. The authors emphasize that the digitalization of education across various contexts has led to a reconfiguration of learning models, centered on creativity, cyber-physical systems, and ICT-based pedagogy. Accordingly, this current study adopts the four core dimensions of the Education 4.0 paradigm as a theoretical framework to analyze the digital shift in education in Côte d'Ivoire. These dimensions are: 1) Competencies; 2) Learning methods; 3) Information and communication technologies (ICT) categories, and 4) Infrastructure levels.

In brief, this paper in the context of Cote d'Ivoire is based on the 4 components of education 4.0 in order to describe the educative shift due to the integration of techno-pedagogical tools and 21st century skills in classrooms and the educative system (Salman 2021; Nermend 2022). To reach this goal, a reliable scientific method is detailed in the next section of our reflection.

METHODS

Research Design

This paper is a qualitative and descriptive ethnographic case study (Hine 2015) in order to describe how digital transformation and techno-pedagogy in Educative institutions in Côte d'Ivoire, according to Education 4.0 and 21st century learning lenses. Indeed, the choice of qualitative case studies allows for the identification of target participants' perceptions and views based on their own experiences of digital integration in education.

This qualitative descriptive study explores digital usage in Educative institutions in this country as a revolution to support and apply modern education lenses. For Cunningham et al. (2017), case studies provide the opportunity to place research into a certain context due to the selection of specific sectors, institutions, countries, and so on. Hence, according to the paper's scope, researchers focused on technology, organization, and environment as inclusion/exclusion criteria to select the participants, and the literature synthesis supported the research validity. It is a reliable design allowing to frame the study into 21st century learning approach and Education 4.0 related to this digital integration in education, following these 4 items: These dimensions are: 1) Competencies; 2) Learning methods; 3) Information and communication technologies (ICT) categories. and 4) Infrastructure levels. In sum, the inclusion/exclusion criteria were focused on the technology adoption in education, stakeholders of this transformation, and the environment (Infrastructures and organizations) in order to document the modern education facts with various sources of opinions as users and parents in Cote d'Ivoire.

Subjects

This paper includes an investigation into both educational institutions and communities in urban and rural areas in order to take the views of educative actors (Learners, teachers, administrators) and stakeholders (parents, policy-makers, etc.) on the shift to technology in Education. So, researchers selected a convenience sampling method (Golzar 2022) in order to reach respondents easily without the pressure of a statistic numbers of participants. This approach is appropriate in our context of qualitative study, as many authors found it remarkable to describe and analyze facts related to human views and social representation of transformation in their practices and daily habits (Gallagher & Savage, 2023). Therefore, researchers selected participants in Bouake and Abidjan, two important educative cities of the Country with many (Public and Private) educative institutions. Then, they discussed with parents in communities in order to take their point of view related to the digitalization of education outcomes and challenges. Finally, 20 participants were selected as follows: 12 students, 5 teachers and 3 administrators working

in some teaching institutions like UAO (Université Alassane Ouattara, Bouaké), Lycée Moderne 2 Bouaké, Collège Notre Famille Bouaké, Collège Kadissis (Private secondary school Bouaké), IUA (Institut Universitaire Abidjan), Collège Mère Elisa Akouedo (Private High school in Abidjan). Finally, the diversity of the point of view related to the research scope allowed us to build a sustainable reliability of this paper's data source. So, the choice of collection tools is presented in the next section.

Data Collection

This qualitative interpretative study explores modern education practices in Côte d'Ivoire based on the digital tools interaction in practices. So, 3 tools were used for the investigation: observation, interviews, and focus groups. Observations were conducted in both school and university classrooms. They were carried out by the research team composed of academics and education professionals, as well as by some participants themselves (teachers and learners), in order to capture concrete examples of digital practices within their teaching environments. The observation period extended from 2023 to 2024 and aimed to document the evolution of digitalization in education from the COVID-19 crisis to the present. It included both retrospective observations and current data, focusing on the transformation of educational practices across various sectors that increasingly rely on technology to support the education system in Côte d'Ivoire.

In addition to the observations, interviews were conducted with students, teachers, parents, and educational administrators between December 2024 and February 2025 to update and enrich the dataset. These interviews were conducted both in person and by phone. A total of 12 individuals participated in the interviews.

Finally, a focus group discussion was organized with four participants representing different stakeholder perspectives: one teacher, one student, one parent, and one administrator. The semi-structured, open-ended interviews and focus group aimed to explore participants' perspectives and practices related to the integration of digital technologies in education, particularly within the framework of Education 4.0: 1) Competencies; 2) Learning methods; 3) Information and communication technologies (ICT) categories, and 4) Infrastructure levels.

Data Analysis

Through a content analysis (Wu & Zhang, 2024; Lehtinen, 2021), findings revealed firstly that the digital adoption is the source of transformation related to the pedagogy. It means tis hilt from traditional brick and mortar classrooms to a blended approach, including more technology presence. So, the data were examined according to Education 4.0 dimensions to describe the evolution of the teaching practice based on the digital pedagogy integration in teaching and learning practices in Côte d'Ivoire. These analyses of observation interviews helped to organize the findings according to the 4 items of the Education 4.0 model in order to situate the modern education lens in Côte d'Ivoire according to scientific theory. This approach is similar to Miranda et al. (2021) and González-Pérez et al. (2023) studies, which focused on educational trends shift in regard to digital integration in teaching practices. As results of this data processing and analysis, after the method section, our investigated lead to the presentation of the findings in the next section.

RESULTS AND DISCUSSION

In this research, the observation, interviews, and various secondary sources allowed to process the findings in the 4 categories of education 4.0 applied in the context of Cote d'Ivoire. These findings are organized according to Competencies, Learning methods, Information and Communication Technologies (ICT) categories, and Infrastructure levels.

Competence's Dimension

The Education 4.0 or transformation of the educational system is underlined by the respondents through the statements below: "Using technology in our School requires a capacity building of the workers and new infrastructure with an IT dimension. There are opportunities and it represents a big challenge too due to the digital literacy gap" (Secondary School Teacher 2, Bouaké). "I am savvy in technology for my homework with the mobile and computer. But using it for pedagogical activities in our larger class is a big challenge. Our school lacks technology to teach" (Secondary school Teacher, Abidjan). "The COVID outbreak increased the usage of our digital competence in our practices as teachers and the students can benefit today. So, WhatsApp, telegram and zoom, Google

Meet are still useful for blended teaching activities”. (HEI professor, Bouaké).

Related to Transversal competencies in Education 4.0, according to the observation and interviews, it is clear that the shift to digital and 21st century pedagogy transforms the educative approach from a teacher-centered to a student-centric approach in classrooms. For this study participants, it was clear that more activities encourage critical thinking, collaboration, communication, and creativity. It is a real transformation of the learning process and offers more flexibility and opportunities of interaction to support educative system sustainability and learners’ wellbeing as a goal citizen aware of local trends and participate in problem-solving through project-based learning, case studies, and more introspection (Lim 2023). This fact is common in Asad (2021), González-Pérez & Ramírez-Montoya (2022), and Strogetskaia et al. (2020) studies mentioning that reinforcing the education in a context of change reveals the importance of technology and 21st century skills transfer to learners for whole society wellbeing through low-tech tools like projectors, smartphones, and virtual platform usages for teaching.

Moreover, Disciplinary competencies, the usage of technology in a modern educational system, dynamically give more opportunities for learners’ empowerment and engagement in the learning process for successful job employment after the training. Therefore, for the respondents, it builds the capacity to do research, design, create, and implement new technologies. This disruption in the educational approach from traditional methods to a more centered one revealed the positive benefits of digital tools. Technology supports competence growth for both users and the whole of the educational stakeholders for more professional and resilient. For example, problem-solving training and technological knowledge contribute to successful workplace performance skills and intercultural communication abilities in order to be effective in various cultural environments (Voronkova, 2023).

Learning Methods Dimension

The integration of technology in education leads to the transformation of learning methods and that is clearly expressed in our respondent statements. “To use technology in teaching,

seminars, and more educational tasks, professional workshops are offered to teachers and administration. Each new software is integrated with the training support. For example, during the COVID outbreak, professors received training to use Moodle and Zoom to meet for academic education continuity online. The usage of blended learning pedagogy is a new innovation in our university context” (HEI teacher, Yamoussoukro).

In our secondary school, we continue to use the traditional teaching approach, even if the teacher can use technology if they want. For example, as an English teacher, I often use my own loudspeaker material and record it to engage learners in active listening activities. The student centered approaches is recommended by administrators and policy-makers too (Secondary School Teacher, Bouake).

The integration of smartphone and relation to social media like WhatsApp and telegram offers us to improve communication and collaboration after the course between the student during project-based learning pedagogy. It is a very important tool to support students’ immersion and research to share their knowledge in various problem-solving activities. The big risk now is the usage of AI like ChatGPT in the assessment (HEI Student, Abidjan).

With digital tools, the student learning autonomy grows and they can learn themselves various topic self-paces. For us as teachers also, it is the democratization of the knowledge and it calls to update our skills continuously (HEI Teacher, Bouaké).

The findings show a transformation of the learning place from brick and mortar to hybrid sites, including in-person and online activities in a blended learning perspective. It concerns learning delivery modalities that allow a more flexible approach to connecting teaching with learners from various places. In the context of COVID, this transformation from in-person to online hybrid approach helps to grow digital mastery and also. In the traditional teaching approach, Face-to-Face learning based mainly on Active Learning are replaced by blending approach, including technology in HEIs and the dissemination of knowledge through Open educational Resources (OER) to support educational resilience and performance. Therefore, the shift to online distance learning platforms supported by mobile terminals led to blended learning (Hybrid).

In particular, Strogetskaia et al. (2020) study discusses the integration of Education 4.0 approaches to secondary teacher education. For the authors, due to digitalization of education and learning in various contexts, this transformation led education 4.0 through 21st century pedagogy to increase the importance of creativity, employing cyber-physical systems in education, extensive use of ICT-mediated teaching and learning (Keshavarz & Ghoneim, 2021; Strogetskaia et al., 2020; Abendan et al., 2024). Therefore, the authors stated that hybrid formats are recognized as the most functional option for teaching students, especially senior courses of both levels of education. It means that, as stated by Asad (2021), Techno-pedagogical ability is a way and a reasonable value of education available to everyone. Through the digital adoption to support the modern educational system in Côte d'Ivoire, our findings reveal also a need to mention the participants' views on the new learning strategies. This aspect is derailed in the next section of our reflection.

Learning Strategies Dimension

The learning strategies shift from traditional theoretical approaches to more practices and community involvement, according to respondents, to apply critical thinking and project-based learning through technology opportunities: "In our teaching approach, the case studies and project-based learning play an important function in class. Thanks to technology integration, students have the possibility to do research in teamwork and come back to present their findings. It is a reversed pedagogy that continues to improve the student skills by doing" (HEI teacher, Abidjan).

As students, when we have to do research, technology and platforms are useful. But the digital culture is the digital literacy due to the lack of IT Skills and the competence in digital mastery. It is often a big challenge to follow (HEI Student, Bouaké).

Gamification based learning is something new for us and digital help to blend the learning with more collaborative activities based on Open Educational Resources, critical thinking, problem solving, and teamwork (HEI Teacher, Abidjan).

In the education 4.0 perspective, the integration of new learning strategies in Cote d'Ivoire plays an important role in supporting learners' wellbeing and education for all. It is the

case of the critical thinking and problem-solving calling to introduce activities related to problem-based learning. Indeed, face to society challenges and for an effective Knowledge and Technology transfer (KTT) in the educational environment, the integration of these innovative pedagogical approaches, such as challenge-based learning, problem-based learning, learning-by-doing, and gamification-based learning, empowers students and teachers by using technology to assess and solve communities' real problems in a skills application (Sharma et al. 2023).

In this dynamic, communication tools based on smartphones, relational commemoration platforms like WhatsApp and Telegram play an important function in learning and sharing according to 21st century pedagogy. However, due to the internet environment and imbalance between urban and rural areas, this approach is most effective with technology connected in Urban centers (Qureshi et al. 2021). It is evident that social media and LMS play an important role in the context of the accessibility of millions of documents online to enrich local problem solutions with globally adapted solutions. In HEIs particularly, this shift to digital. According to these findings, Education 4.0 learning strategies include collaborative learning, experiential learning, and personalized learning. These strategies are designed to help students develop skills like teamwork, communication, and problem-solving. Yet, challenges related to class size, digital mastery, and accessibility, traditional brick and mortar teaching continue to affect these new strategies integration (González-Pérez, 2022). This situation is similar in the studies of Koné (2021) related to the context of Higher Schools' digital transformation.

In sum, new strategies of teaching through technology integration in the learning process revealed a clear change in Cote d'Ivoire educative system. This is marked by the usage of new pedagogical approaches such as challenge-based learning, problem-based learning, learning-by-doing, and gamification-based learning (Miranda et al. 2021; González-Pérez et al. 2023). However, these strategies are new and need digital literacy and infrastructure to reach their goal of knowing that Côte d'Ivoire is a global south intercultural country with many local challenges. So, it is

important to describe the ICT categories in the education 4.0 perspective in Cote d'Ivoire.

Information and Communication Technologies (ICT) Categories

In a changing context of education, the digital growth in Côte d'Ivoire is an important factor to implement 21st century pedagogy. Thus, the benefits, there are also challenges underlined by the respondents in the statements below: "There is the internet, a computer room, and online platforms to connect teachers with students in the learning process. As an innovative university, our institution supports us by providing training to the employee on how to use digital tools. The integration of the 21st century skills is very important through communication, collaboration, critical thinking, and creativity activities" (HEI Administrator, Abidjan).

There is not enough training, few computers, a lack of electricity in classrooms, insufficient computer equipment in overcrowded classrooms to simulate complex concepts, lack of video projectors to show real-life examples of how theoretical knowledge is used in everyday life through digital tools (HEI Teacher, Bouaké).

Do a lot of training, make computers available to teachers Equipping schools with computer equipment, ICT training, basic ICT training for teachers, good training, and equipment (Secondary school teacher, Bouaké).

In this digital transformation, the accessibility to the internet and availability of various computers and smartphones increase the InTechnology integration according to education 4.0. Even if it is a new digitalization of education, this transformation is an important part of 21st century pedagogy adoption by the integration of tools requiring digital mastery in learners' skills. Moreover, according to participants, in HEIs, the usage of Artificial Intelligence in education is new and due to the presence of AI like ChatGPT online to support research (Hlongwane et al., 2024).

This last aspect requires ethical issues as teachers' educators are not often well equipped to identify students' work done by the generative artificial intelligence (AI) tools. However, this GenAI helped in constructing course materials and images, often to support teaching evidence through technology-based platforms. For example, it is for processing virtual and experiential environments, tools, and platforms like synchronous online

sessions to support student learning through web conference technologies use Zoom, Meets. Moodle is also applied as a Learning Management System. It means that the shift to education 4.0 is an ongoing movement that needs a digital transition in order to equip users with available technology for this dynamic (Abendan et al., 2024; González-Pérez et al., 2023; Strogetskaya et al., 2020). Particularly, these new facts in an education 4.0 in Cote d' Ivoire and other countries call for taking into consideration the digital infrastructure and capacity availability. This aspect is presented in the next section.

Infrastructure Levels

Digital revolution in education requires appropriate infrastructure as described in the statements below: "Facilitate Internet access, equip schools with computers, review the cost of computers Lots of resources. We need to train teachers in ICT both upstream, in initial training, and downstream, in initial training" (Secondary School Teacher, Bouaké).

We encounter many challenges with ICT integration for a perspective of Education 4.0. Equipment for schools and teachers, Internet connection, problems with computers and Internet connections at work and at home. Limited resources to equip all schools face to Shortage of ICT equipment, Poor implementation of ICT policies (Secondary School Administrator, Abidjan).

In this dimension, classroom size and equipment often constitute a big challenge to providing technology access in public institutions. Education 4.0 requires innovative furniture like connected tools, access to Digital Resources for blended learning, and E-learning platforms: Implementing e-learning systems can bridge the gap between rural and urban schools. Platforms like Moodle, Google Classroom, or locally developed ones can be used for online lessons, assignments, and exams. Moreover, according to the respondent and the observation, digital textbooks and resources: Replacing traditional textbooks with digital versions can reduce costs and ensure that students have up-to-date content at their fingertips. Digital resources like Khan Academy, Coursera, and local content could support a wide range of subjects. This transformation in the educational system is supported by the integration of full online teaching to students as the case of UVCI (Virtual University of Côte d'Ivoire). These online courses

could be made accessible to students and teachers to improve skills and support continuous learning (Giesenbauer & Müller-Christ, 2020).

Secondly, the growth of mobile phone accessibility and internet calls is shifting to Mobile Learning in HEIs in Côte d'Ivoire. It is the case of social media platforms like WhatsApp used to disseminate knowledge and continue to work together on the education needs. These mobile apps can be an opportunity due to the high mobile phone penetration in Côte d'Ivoire. So, developing mobile apps tailored to education can offer a convenient and accessible way for students to learn. Apps could cover various subjects, from math to language arts, and be designed for both primary and secondary education levels. It was shown during the COVID outbreak that low-cost technology platforms and smartphones play an important function in modern education continuity, supported by technology to reach the aims of education for all. This fact is also seen through SMS-based learning: For areas with limited internet access, SMS-based learning tools can be used to send educational content, quizzes, or even homework assignments to students. It is also the question of Internet Connectivity and Infrastructure, calling for improving the Internet bandwidth infrastructure. In order for these technologies to be effective, internet connectivity across the country, especially in rural areas, needs to be improved. Expanding broadband infrastructure and ensuring affordable access to internet services for schools and students would be key to success (Asad 2021; Strogetskaya et al. 2020; Vargo et al. 2021).

In addition, at the Institutional level, management of 21st century pedagogy in an education 4.0 perspective calls to empower both administrators, decision makers, and strategies according to new approaches for sustainability, and accessibility of new services such as online libraries, instant messaging systems, remote laboratories enabled and widely used, and access to internet services. It calls for organizational disruption for modern education in Côte d'Ivoire and a digital Educative system environment through techno-pedagogy. This concerns the Government, educational partners and Policy Support according to a National digital strategy for education. Even though it is ongoing according to government policy instruction. The Ivorian government could

develop a comprehensive national strategy for integrating technology into education and in favour of digital equity. So, Policies should focus on ensuring equitable access to digital tools, especially for students in rural or underprivileged areas. This includes providing subsidies or free access to digital devices and ensuring internet coverage is extended to all regions. For many educational stakeholders, this dimension of the digital integration is not sufficient. It means that more Technology integration for Modern education in Cote d'Ivoire requires the availability of the infrastructure, empowerment of users in education and also continued improvement regarding international trends and norms.

In brief, the findings revealed that technology integration in educative system in Côte d' Ivoire is a recent development with many benefits and challenges. As in the world, this digital integration requires a transition from tradition system to a digital one requiring specific infrastructure, knowledge, skill, and various capacities buildings. From the perspective of education 4.0, this analysis revealed the application of Industry 4.0 trends. So, this question of digital transformation in the educational system remains a continuous concerns face to the new orientation of digital technology and integration of Artificial Intelligence (AI) in many North and South countries (Crompton et al., 2023; Howard & Ulferts, 2025; Ibrahim et al., 2023). It shows the need of making strategic investments in technology and addressing these challenges, Côte d'Ivoire can significantly enhance its educational system, providing students with the tools and skills they need for success in the modern world.

CONCLUSION

This paper aims to describe how digital transformation and techno - pedagogy in Educative institutions in Cote d' Ivoire through the Education 4.0 paradigm and 21st century learning theory, describe the integration of technology in Educative system of Côte d'Ivoire, a West African francophone Country. This qualitative ethnography study's findings show that digitalization for modern education in Côte d'Ivoire is an ongoing useful shift despite the low digital capacity infrastructure. Therefore, the Educative Institutions stakeholders encounter a positive transformation from tradition to techno-pedagogical teaching tool integration in

urban and rural areas of this country to provide education for all and 21st century skills to learners. Similarly, the environmental dimension due to the accessibility of mobiles, the internet, and digital platforms offers a positive perspective on the 21st century pedagogy's effectiveness in the classroom through the support of digital tools. As limitations, this qualitative study could not investigate in all the entire country and got data from a convenience sample for a short period. The future reflection could be focused on Continuous Professional development to support educative resilience based on MOOCs and OER in Africa.

REFERENCES

- Abendan, C. F., Kilag, O. K., Uy, F., & Vestal, P. (2024). Transforming Learning in the Digital Age: The Confluence of Innovation and Education. *International Multidisciplinary Journal of Research for Innovation, Sustainability, and Excellence (IMJRISE)*, 1(9), 211-218.
- Adeoye, M. A., Akinnubi, O. P., & Yahaya, A. K. (2023). Unlocking the Potential of Education in Nigeria's Industry 4.0 Era: Overcoming Challenges of Digital Transformation. *Indonesian Journal of Educational Research and Review*, 6(3), 608-617.
- Allcoat, D., Hatchard, T., Azmat, F., Stansfield, K., Watson, D., & von Mühlenen, A. (2021). Education in the digital age: Learning experience in virtual and mixed realities. *Journal of Educational Computing Research*, 59(5), 795-816.
- Asad, M. M., Aftab, K., Sherwani, F., Churi, P., Moreno-Guerrero, A. J., & Pourshahian, B. (2021). Techno-Pedagogical Skills for 21st Century Digital Classrooms: An Extensive Literature Review. *Education Research International*, 2021(1), 8160084.
- Bamba, A., Kamagaté, A., Koivogui, M., & Koné, D. (2022). Analysis of Social Networks among Students in Abidjan City. *Open Journal of Applied Sciences*, 12, 1339-1351.
- Bonfield, C. A., Salter, M., Longmuir, A., Benson, M., & Adachi, C. (2020). Transformation or evolution?: Education 4.0, teaching and learning in the digital age. *Higher education pedagogies*, 5(1), 223-246.
- Carayannis, E. G., & Morawska, J. (2023). University and education 5.0 for emerging trends, policies and practices in the concept of industry 5.0 and society 5.0. In *Industry 5.0: Creative and Innovative Organizations*, 1-25. Cham: Springer International Publishing.
- Catalano, H. (2019). Opportunities and challenges of education in the digital age. *Astra Salvensis-revista de istorie si cultura*, 7(14), 25-30.
- Costan, E., Gonzales, G., Gonzales, R., Enriquez, L., Costan, F., Suladay, D., Atibing, N. M., Aro, J. L., Evangelista, S. S., Maturan, F., Selerio, E., Jr., & Ocampo, L. (2021). Education 4.0 in Developing Economies: A Systematic Literature Review of Implementation Barriers and Future Research Agenda. *Sustainability*, 13(22), 12763.
- Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: The state of the field. *International Journal of Educational Technology in Higher Education*, 20, 22.
- Cunningham, J., Menter, M., & Young, C. (2017). A Review of Qualitative Case Methods Trends and Themes Used in Technology Transfer Research. *Journal of Technology Transfer*, 42, 923-956.
- Dodds, F., Chopitea, C. D., & Ruffins, R. (2021). *Tomorrow's People and New Technology: Changing how We Live Our Lives*. Routledge.
- Evans, D. K., & Mendez Acosta, A. (2021). Education in Africa: What are we learning?. *Journal of African Economies*, 30(1), 13-54.
- Fentyrina, A., & Mardi, M. (2025). Transformasi Digital dalam Manajemen Pendidikan: Tantangan dan Peluang di Era Pendidikan 5.0. *Journal Scientific of Mandalika (JSM)*, 6(3), 494-501.
- Gallagher, S. E., & Savage, T. (2023). Challenge-based learning in higher education: an exploratory literature review. *Teaching in Higher Education*, 28(6), 1135-1157.
- Giesenbauer, B., & Müller-Christ, G. (2020). University 4.0: Promoting the transformation of higher education institutions toward sustainable development. *Sustainability*, 12 (8).

- Golzar, J., Noor, S., & Tajik, O. (2022). Convenience sampling. *International Journal of Education & Language Studies*, 1(2), 72-77.
- González-Pérez, L. I., & Ramírez-Montoya, M. S. (2022). Components of Education 4.0 in 21st century skills frameworks: systematic review. *Sustainability*, 14(3), 1493.
- Haleem, A., Javaid, M., Qadri, M. A., & Suman, R. (2022). Understanding the role of digital technologies in education: A review. *Sustainable operations and computers*, 3, 275-285.
- Hine, C. (2015). *Ethnography for the internet: embedded, embodied and everyday*, Berg Publishers.
- Hlongwane, J., Shava, G. N., Mangena, A., & Muzari, T. (2024). Towards the integration of artificial intelligence in higher education, challenges and opportunities: The African context, a case of Zimbabwe. *Int J Res Innov Soc Sci*, 8(3S), 417-435.
- Howard, T. L., & Ulferts, G. W. (2025). Artificial Intelligence and the Redefinition of Higher Education. *Research in Higher Education Journal*, 46.
- Ibrahim, A., Idris, A. H., & Haruna, S. S. (2024). Artificial Intelligence in Digital Literacy: Ethical Concerns of Cultural Sensitivity in Katsina State, Nigeria. In *International Conference on recent advances in science, Engineering and management*, Pune, India.
- Keshavarz, M., & Ghoneim, A. (2021). Preparing educators to teach in a digital age. *The International Review of Research in Open and Distributed Learning*, 22(1), 221-242.
- Khahro, S. H., & Javed, Y. (2022). Key Challenges in 21st Century Learning: A Way Forward towards Sustainable Higher Educational Institutions. *Sustainability*, 14(23), 16080.
- Koné, M. (2021). Media Education as a Resilience Factor of Ivory Coast's Education System in COVID-19 Pandemic. *Open Journal of Social Sciences*, 9, 145-160.
- Lehtinen, E. (2021). Conversation analysis. In S. Engler & M. Stausberg (Eds), *The Routledge Handbook of Research Methods in the Study of Religion*, 194-204. Routledge.
- Leite, S. (2022). Using the SDGs for global citizenship education: definitions, challenges, and opportunities. *Globalisation, Societies and Education*, 20(3), 401-413.
- Lim, T. (2023). Problem-based learning: Benefits, challenges, and the way forward. In *Innovations and challenges in Cambodian education: Youth's perspectives*. *Cambodian Education Forum*, 21-36.
- Mhlanga, D. (2022). Rethinking education in the industry 4.0 in Africa, the effective management and leadership of education post-COVID-19 pandemic towards digital transformation. Mhlanga, David, Rethinking Education in the Industry 4.0 in Africa, the Effective Management and Leadership of Education Post-COVID-19 Pandemic Towards Digital Transformation (October 12, 2022). Available at SSRN: <https://ssrn.com/abstract=4245885> or <http://dx.doi.org/10.2139/ssrn.4245885>
- Mhlanga, D., & Moloi, T. (2020). COVID-19 and the digital transformation of education: What are we learning on 4IR in South Africa?. *Education Sciences*, 10(7), 180.
- Miranda, J., Navarrete, C., Noguez, J., Molina-Espinosa, J. M., Ramírez-Montoya, M. S., Navarro-Tuch, S. A., & Molina, A. (2021). The core components of education 4.0 in higher education: Three case studies in engineering education. *Computers & Electrical Engineering*, 93.
- Nermend, M., Singh, S., & Singh, U. S. (2022). An evaluation of decision on paradigm shift in higher education by digital transformation. *Procedia Computer Science*, 207, 1959-1969.
- Okunlola, J. O., Naicker, S. R., & Uleanya, C. (2024). Digital leadership in the fourth industrial revolution enacted during the COVID-19 pandemic: A systematic review. *Cogent education*, 11(1).
- Qureshi, M. I., Khan, N., Raza, H., Imran, A., & ismail, F. (2021). Digital Technologies in Education 4.0. Does it Enhance the Effectiveness of Learning? A Systematic Literature Review. *International Journal of Interactive Mobile Technologies (iJIM)*, 15 (04), 31-47.
- Salman , E., Sharif-Rasslan, A., Mussa, J., & Fattum, A. (2022). The Contribution of Techno-Pedagogy Courses to Teachers's

- classrooms-Efficacy in Providing Social, Emotional and Learning Support to Students Through Distance Learning Processes during Covid-19 and Beyond. In *EDULEARN22 Proceedings* (2219-2222). IATED.
- Sharma, P. (2019). Digital revolution of education 4.0. *International Journal of Engineering and Advanced Technology*, 9(2), 3558-3564.
- Sharma, Y., Suri, A., Sijariya, R., & Jindal, L. (2023). Role of education 4.0 in innovative curriculum practices and digital literacy– A bibliometric approach. *E-Learning and Digital Media*, 22(1), 1-32.
- Strogetskaya, E. V., Betiger, I. B., Timofeev, A. V., & Zamotin, M. P. (2020, May). Digitalization of Modern High School in the Perspective of the Paradigm of Smart Education. In *International Scientific Conference “Digitalization of Education: History, Trends and Prospects” (DETP 2020)* (pp. 605-613). Atlantis Press.
- Tarricon, P., Mestan, K., & Teo, I. (2021). Building resilient education systems: A rapid review of the education in emergencies literature. Australian Council for Educational Research. <https://doi.org/10.37517/978-1-74286-639-0>
- Vargo, D., Zhu, L., Benwell, B., & Yan, Z. (2021). Digital technology use during COVID-19 pandemic: A rapid review. *Human Behavior and Emerging Technologies*, 3(1), 13-24.
- Voronkova, V., Vasył’chuk, G., Nikitenko, V., Kaganov, Y., & Metelenko, N. (2023). Transformation of digital education in the era of the fourth industrial revolution and globalization. *TEM Journal*, 12 (2) 732-742.
- Wu, Y., & Zhang, X. (2024). Examining conversation analysis in palliative care: A systematic review. *Health Communication*, 39(13), 3072–3083.
- Yunus, U., Rizkiansyah, M., Ariestyani, A., & Sukandar, R. (2023). Analysis of YouTube Content about Konjac as an Education of Indonesian Farmers in the Disruption Era. *Journal of Communication and Public Relations*, 2(2), 36–57.
- Zezeza, P. T., & Okanda, P. M. (2021). Enhancing the Digital Transformation of African Universities: Covid-19 as Accelerator. *Journal of Higher Education in Africa/Revue de l’enseignement Supérieur En Afrique*, 19(1), 1–28.
- Zunaidah, A. (2024). Meaningful synergy in E-learning integrating environmental awareness and project based learning in EFL. *Academy of Education Journal*, 15(1), 816–825.