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Digital Technologies and Generation Z: Shaping Future Education

Anil Khurana & Neha Girdhar *

Department of Management Studies, Deenbandhu Chhotu Ram University of Science and Technology, Murthal (Haryana), India.

anilkhurana.dcrust@gmail.com, nehagirdhar121@gmail.com
* Corresponding author

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Abstract

Digital technologies are crucial for achieving Sustainable Development Goals (SDGs), especially for ensuring fair and quality education. With the rapidly advancing technology, Generation Z (Gen-Z) are more attracted towards digital learning methods. This study aims to prepare students for a tech-driven job market by understanding how Gen-Z engages with online learning and digital tools. Employing the SPIDER framework, this research involved a qualitative study using Boolean operators and N-vivo qualitative analysis. The evaluation included word clouds related to digital educational technologies. This paper discusses the influence of digital technologies including digital learning platforms, gamification, smart campus learning, augmented reality, artificial intelligence, virtual reality, and the Internet of Things in shaping the future of education. The findings highlight the need for educational institutions to adapt to the preferences and learning styles of Gen-Z, emphasizing digital competence and preparing students for a technology-driven future job market.

Keywords: generation z, digital technologies, gamification, artificial intelligence

1. Introduction

Technology is rapidly advancing with artificial intelligence. Digital technologies are crucial for achieving Sustainable Development Goals (SDGs), particularly in providing quality education. It has evolved significantly owing to advancements in computer science and technology 4.0.

Digital pedagogies in higher education have been mapped by Casal and Lopez (2023), showcasing the constant evolution of digital trends across various sectors. Digital evolution related to the adaptation of new technologies concerns how learners use and combine these technologies to create something new. Generation Z (Gen-Z), born between 1995 and 2015, is a major focus of research because of its dominance in today's student population (Sanjeev et al., 2022). Gen-Z, being tech-savvy and born in the online era, relies heavily on digital tools for learning, and expects similar conditions offline. They consider technology as the primary tool for acquiring knowledge. They are not relying on memorization, but accessing information instantly online. This study emphasizes the need for Higher Education Institutions (HEIs) and governmental agencies to understand how Gen-Z engages with online learning, benefiting e-learning platforms and educational providers.

Gen-Z, the first digital native, is comfortable with technology in various aspects of life, including education, commerce, finance, and entertainment (table 1). Bulsara et al. (2023) indicated that Gen-Z desires to understand their progress and the requirements to reach the next level. Digital transformation facilitated by smartphones, laptops, and tablets has significantly changed the learning methods and tools. The critical question is whether Gen-Z effectively utilizes these digital tools for education and future professions. It can be decided by their digital competence and it was considered as vital 21st-century skill which involves various knowledge, skills, and attitudes, including communication, cooperation, creativity, critical thinking, and problem-solving (Tóth et al., 2022). A digitally competent person can perform multitasking activities using digital media for participation, work, and problem-solving. The ultimate goal was to prepare students, particularly Gen-Z, for a technology-driven job market. Digital competency is ensuring familiarity with the tools encountered in their careers.

2. Literature Review

2.1. Generation Z or digital natives

Generation Z are also known as digital natives. They are those individuals who born in a technology-rich era, including current students at Higher Education Institutions (HEIs). Digital natives have grown up surrounded by and using various digital technologies such as computers, video games, music players, and cell phones. They are considered "native speakers" of the digital language. They are always ready to display a high level of IT skills, experience, positive attitudes, and intuitive mastery of informatics and electronic devices. Digital natives are known for their adaptability to emerging technologies, short attention spans, multitasking abilities, and

preference for teamwork and collaboration. They expect immediate results, instant gratification, and frequent rewards, with a tendency towards a random-access and hypertext approach in accessing knowledge.

Table 1. *An integration of Digital technologies and Generation Z*

Digital Technologies	Gen Z's Utilization	Benefits for Gen Z	References
Digital Learning Platforms	Gen Z embraces platforms for self-paced learning, flexible access, and tailored experience. They use these to develop digital skills and navigate effectively.	It leads to individualized learning, convenient and accessible content, cognitive development, improved assessment, and efficient time management.	Costa et al., 2024; Bagdi et al., 2023; Díaz-Noguera et al., 2022
Gamification and Motivational Techniques	Gen Z engages with interactive methods, rewards, and motivational tools which help in enhancing competencies and sustaining engagement. This results in increased digital skills and sustained motivation through the game elements.	This results in increased digital skills and sustained motivation through game elements.	Sanjeev et al., 2022; Khulwa and Luthfia, 2023
Cloud Computing	Gen Z leverages cloud technology for easy access, collaboration, and improved productivity.	The benefits include effortless access to resources and enhanced collaborative work and productivity.	Gupta et al., 2023; Wang et al., 2023
Artificial Intelligence (AI)	Gen Z utilizes AI for personalized learning, efficient problem-solving, and timely feedback.	They experienced personalized learning, critical thinking support, and convenient problem-solving environments through AI applications.	Rouse, 2019; Cao et al., 2023; Chen et al., 2020
Social Media Platforms	Gen Z heavily relies on social media for communication, information sharing, and activism.	It helps in instant communication, networking, self-expression, and awareness of global issues.	Sanjeev et al., 2022; Kotula et al., 2021
Internet of Things (IoT)	Gen Z's surroundings are equipped with IoT devices, enhancing learning through real-time data.	This leads to efficient use of smart devices, improved connectivity, automation in daily life, and enhanced student assessment and learning resources.	Cao et al., 2023; Aldowah et al., 2017; Bogoviz et al., 2019
Smart Campus Technologies and BYOD	Gen Z utilize technology to improve campus experiences by using various smart devices and preferring their own devices.	These benefits include streamlined access to campus services, efficient learning and communication, and easy access to information and learning tools.	Awuzie et al., 2021; Issa and Isaias, 2016
Virtual Reality (VR)	Gen Z is attractive to virtual environments for immersive learning experiences.	This results in enhanced learning experience through simulations and practical skill development.	Tolstikova et al., 2021; Brereton, 2019
Online Learning Management Systems	Gen Z embraces online learning, utilizing 5G technology and digital platforms for smoother experiences.	It gives flexibility, accessibility to diverse courses, self-paced and mobile learning, reliable access to content, and collaborative problem-solving.	Ahammad, 2019; Ovchinnikova et al., 2020; Fisher and Baird, 2021; Hashim et al., 2022
Augmented Reality and mixed Reality	Gen Z utilize AR apps for interactive learning experiences.	This results in enhanced interactive learning, practical applications, and real-world experiences.	Bhuvaneswari et al., 2023; Fisher and Baird, 2021

In the context of online education, our research explored whether students used multiple devices simultaneously, such as using two screens to connect to online education while working on parallel tasks. The individualized nature of technology has made Generation Z comfortable with independent learning, and they express a desire for collaboration, interaction, and idea-sharing on social media platforms (Seemiller and Grace, 2017; Gentina, 2020).

2.2. Digital Learning Platforms

In our highly digitalized world, the use of ICT devices, including 3D platforms, gamification, and Bring Your Own Devices (BYOD), has become inevitable. In addition to traditional Learning Management Systems, various innovative learning practices such as Massive Open Online Courses (MOOCs), flipped classrooms, gamification, simulations, e-books, and collaborative distance learning environments promise enriched and lifelong learning experiences. Notably, problem solving and innovation skills are crucial for education. The emerging concept of the metaverse are combining advanced technologies. It holds significant potential for immersive learning and could revolutionize education (Al-Adwan et al., 2023). Digital-native students, particularly Generation Z exhibit distinct characteristics as they access information through various media; engage in simultaneous information processing or multitasking; prefer visuals, sound, and videos over texts; utilize non-linear elaboration; thrive on simultaneous interactions; require inner learning motivation; seek immediate feedback; and prioritize useful, immediately applicable information but the recent National Education Policy (2020) underscores the importance of Higher Education Institutions (HEIs) in allocating funds for advanced technological tools, such as augmented reality, artificial intelligence, robotics, and big data, to enhance technical assistance for effective teaching and learning. This policy encourages the maximal use of technology and integration of dedicated units to transition from traditional to digital education (Yenugu, 2022). Notably, the education sector has swiftly embraced technologies such as Zoom, Google Meet, and Google Classroom to ensure course delivery and facilitate interactions between students and teachers (Shahzad et al., 2020).

2.3. Gamification

Generation Z adopted distinctive methods for motivation and learning with a notable rise in the popularity of motivational techniques such as gamification. Gamification is integrated into the learning process which enhances digital competencies of students by incorporating game elements. It boosts student engagement and commitment to learning. It becomes a valuable component of the overall motivational strategy which is necessary for enriching the teaching

and learning experience. Additionally, the use of Digital Exam Assessment Tools aids in the creation and evaluation of digital exams. These exams can take various forms, including multiple-choice tests and problem-solving, presented as games and simulations. In this approach, players begin with limited knowledge and skills and gradually gain experience and proficiency as the game unfolds. Game-based learning, which is particularly effective in interdisciplinary subjects requiring the simultaneous application of critical thinking, communication, and decision-making skills, holds promise for success in the educational landscape.

2.4. Smart Campus Learning

Digital technologies are evolving rapidly, prompting Higher Education Institutions (HEIs) to transition to a new model known as a digital university. This shift goes beyond adopting new technologies and involves a comprehensive organizational transformation encompassing information, processes, and human aspects. The aim is to establish anytime, anywhere learning within a Smart Campus environment these campuses are focusing on real-time space utilization measurement, context-aware smart classrooms, and the use of digital platforms.

The existing ICT infrastructure such as e-learning platforms and the institution's knowledge capabilities, play a crucial role in this transformation (Awuzie et al., 2021). Successful e-learning relies on key tools, such as online courses, Learning Management Systems (LMS), social networks for education, and advanced technologies (Ovchinnikova et al., 2020). Mobile-friendly courses and LMS platforms that support consumption on mobile browsers are emphasized. It encourages the design of activities and assignments for completion in mobile apps utilizing smartphone and tablet features. The Internet has facilitated the adoption of communication technology by academic institutions (Santosa et al., 2019). The integration of 5G networks enhances the efficiency of online courses. It enables quicker downloads and near-immediate information transfers.

Leveraging mobile tools, such as laptops, tablets, and mobile phones in the educational process provides learners with diverse and exciting opportunities to access the latest and authentic information. Common practices, such as Bring Your Own Device (BYOD), involve students using their devices in the classroom for educational purposes. Smart computer programs, guided by AI-based predictive analytics (Ciolacu et al., 2018; Hamadneh et al., 2022), assist institutions in efficient planning for the future by forecasting student enrolment trends and budget needs. The vision of a digital campus extends beyond education. It aims to reduce crime

rates, enhance infrastructure with real-time connections through sensors, improve working conditions, and reduce costs. Real-time monitoring of student performance contributes to higher education completion rates (Bogoviz et al., 2017; Bogoviz et al., 2019).

2.5. Social media platforms

According to Benali et al. (2018), educational technology applications extend beyond test preparation. It is fostering a range of skills, such as knowledge literacy, communication, global awareness, imagination, and teamwork. The profound impact of technology on communication processes and daily experiences is evident (Cao et al. 2023). Respondents are characterized by traits such as independence in decision making, rational thinking, critical discussion, and interaction with real and virtual spaces. It highlights the transformative potential of social capital as it transitions from the physical to the virtual world. In this virtual realm, social media platforms have emerged as powerful media platforms for communication, influence, and response. The dimensions of online learning readiness, including self-directed learning, self-efficacy, digital engagement, and motivation, are crucial for the first generation with the highest Internet penetration (Generation Z). Within the social sphere, interactive Internet websites, services, tools, and practices are supporting collaboration, constructivism, community development, information sharing, and the exchange of ideas with masses (Al-Rahmi et al., 2020). Generation Z relies on the Internet as a primary source of information, accessing multiple channels for learning, socialization, and entertainment. Their daily use of digital communication and technology, particularly in social media interactions and personal chatrooms, contributes to their well-developed skills (Khulwa & Luthfia, 2023).

2.6. Augmented Reality and Mixed Reality

Augmented Reality (AR) is transforming education by immersing students in interactive environments and providing hands-on experiences with various phenomena and scenarios, as highlighted by Bogoviz et al. (2019). This technology plays a crucial role in training highly specialized professionals, reducing the negative consequences associated with practice-oriented training, and ensuring safety. Students now expect more experiential content, including virtual laboratories and digital simulations. In particular, VR immerses students in their studies, sparks curiosity, and enhances engagement. AR and Mixed Reality (MR) offer various benefits for learners, such as reinforcing previous learning, providing reminders, and revisiting content resources. Students learn to leverage technology for deeper thinking and academic development by sharing personal stories of growth, feedback, support, and inspiration.

Current technology provides greater access to up-to-date information and learning activities that foster the achievement of instructional use. MR simulations facilitate challenging conversations such as end-of-life discussions using interactive avatars. Additionally, virtualized laboratories, tools for active learning, and Adaptive Learning systems adjust documents to alternative formats based on learners' preferences. Multimodal content, including e-books with reading activities and 3D experiential content, enhances user-focused experience. Apps for course content, video experiences capturing full-screen events. It contributes to a dynamic and engaging educational landscape. It aligns with the principles of crowdsourcing ideas within course learning communities and incorporating data visualization for computer-assisted creativity. Chen et al. (2020) highlight key AI applications in education, including intelligent tutoring systems for special education and natural language processing. Technologies such as deep learning, machine learning, natural language processing, expert tutoring systems, and virtual classrooms are transforming education, with notable effects on students (Sharma et al., 2021).

2.7. Online learning management systems

Generation Z (Gen Z) embraces the significance of collaboration in both local and distributed environments from an early age. Staying consistently connected with digital technologies, Gen Z desires 24/7 access to course content, fellow students, and faculty. It leads to many educational institutions to venture into virtual environments with online or distance courses (Girish et al., 2022). Online learning has become the norm for Gen Z, who prioritize relevance in their education. They are seeking personal and practical connections in the material, and apply a trial-and-error problem-solving approach to learning. They actively participate using Google to follow subject matter experts for supplemental learning (Yenugu, 2022).

The initiatives by the Indian government, such as SWAYAM, EDUSAT, DIKSHA platform, NPTEL, and DIKSHA, indicate a push toward the future of online education (Singh et al., 2021). Gen Z students relied on Google and AI assistants such as Alexa, Google, and Siri for information, demonstrating a shift away from traditional library use. They are multitaskers as they fluidly moving between platforms, and accustomed to concise knowledge snippets rather than lengthy lectures. Database tools play a significant role in centrally storing electronic media, providing accessibility via the Internet or intranet, and platforms such as Project Gutenberg and Google Books serve as notable electronic libraries (Goldin et al., 2022). Recent trends show a growing market for online classes delivered through MOOC platforms, particularly among

students in professional studies and working executives who seek to enhance their skill sets for better job opportunities in specialized industries. It also highlights the increasing popularity of MOOC-based personalized learning (Haleem et al., 2022).

2.8. Artificial intelligence

Artificial intelligence (AI) is an innovative technology capable of performing cognitive functions, such as thinking, learning, problem-solving, and decision-making. NEP 2020 emphasizes integrating AI into subjects to cultivate an AI mindset among students (Popenici et al. 2017). AI is a key player in transforming higher education by making it adaptive, personalized, and globally accessible (Peng et al. 2023). AI in education employs intelligent software systems that continuously learn and improve, utilizing various technologies, such as multi-agent systems, machine learning, ontology, semantic and knowledge grids, autonomic computing, cognitive informatics, and neural computing (Owoc et al., 2019). This technology enhances education through interactive training with holograms and intelligent systems, offering 24/7 support to students.

In this way, AI is improving enrollment and retention rates (McKenzie et al., 2018). AI assists in accessing resources, fostering effective teacher-student interactions, and providing counselling services based on academic performance. It aids in administrative decision-making and program customization for employer needs, potentially replacing routine administrative tasks with robots and leading to cost savings. AI teaching assistants intervene quickly, supporting at-risk students with customized information, alerts, and reminders (Crompton & Burke, 2023). It plays a significant role in upskilling faculty and students in data-driven capabilities which includes data visualization, web scraping, and machine learning (Nabwire et al., 2021). AI can predict student behavior, assist with tasks, and enhance the learning experience through emerging technologies, such as VR, AR, MR, and 5G networks. It ensures reliable access to streaming media for immersive learning experiences (Fisher and Baird, 2021). However, it is crucial to address concerns such as biases and data security to maintain AI in ethical and secure education (Roumate, 2023; Kelly, 2021).

2.9. Virtual reality

The incorporation of virtual reality (VR) in educational settings has gained popularity in recent years. This technology is utilized to create immersive and engaging learning experiences. It enables students to develop practical skills and preparing them for future careers involving VR technology (Radianti, 2020). Virtual reality campus tours, for instance, attract prospective

students by providing an immersive and interactive experience of the campus. Additionally, VR offers visual tools for mobile devices, such as 360-degree videos and VR activities. It also facilitates active and meaningful processing of learning materials. Communication and information exchange between instructors and students can be enhanced through platforms like Collaborate Webinars, Zoom, and Skype. Moreover, VR storytelling and augmented reality (AR). 360 imaging provide immersive workspace orientations, incorporating multiple senses to improve the understanding of topics. Video tutorials are essential for the digital native Generation Z, who prefer dynamic and engaging learning experiences. The use of VR in education aligns with contemporary learners' preferences by making educational content more accessible and enjoyable while developing practical skills.

2.10. Internet of Things (IoT)

The incorporation of Internet of Things (IoT) technology in education involves creating a digital campus that utilizes real-time data collection for monitoring, decision-making, and process optimization, as emphasized by Aldowah et al. (2017); Bogoviz et al. (2019). This approach allows for advanced student assessment methods and seamless integration with existing learning platforms. The implementation of digital campuses offers numerous benefits. It includes the development of an integrated infrastructure with real-time connectivity, improved data accessibility through sensor technology, cost savings and enhanced working conditions. Real-time monitoring of student performance made possible by IoT technology contributes to increased completion rates, providing educators and institutions with valuable data to support student success. This innovative use of technology in education represents a significant shift toward more interconnected and data-driven learning environments which ultimately leading to improved overall educational experiences for students.

3. Methodology

The research has followed SPIDER framework which provides a structured approach for research design. The "Sample" (S) specifies the target population (Generation Z) recognized for its prominence in the current student demographic. The "Phenomenon of Interest" (PI) outlines the research goal, focusing on preparing students for the technology-driven job market by ensuring familiarity with relevant tools. The "Design" (D) details the methodology, proposing a qualitative study incorporating meta-synthesis using Boolean Operators and N-vivo for qualitative analysis. The "Evaluation" (E) method involves creating a word to assess educational digital technologies and resources. Lastly, the "Research" (R) strategy

encompasses both qualitative research and a generation study. Overall, the SPIDER framework (table 2) serves as a systematic guide for designing and conducting research, addressing key aspects from sample selection to research methodology and evaluation methods.

Table 2. *SPIDER Framework for qualitative research design*

SPIDER Framework	
S- Sample	Gen-Z has been designated for the research because of its representation as the greatest segment of today's student body.
PI- Phenomenon of Interest	The goal is to prepare students for the tech-driven job market, ensuring they are familiar with the tools they will encounter in their careers.
D- Design	A Qualitative study including meta-synthesis of condition by applying Bollean Operators and N-vivo qualitative results.
E- Evaluation	Evaluation based on word cloud and weighted word count related to the educational digital technologies and resources.
R- Research	Qualitative research and Generation study

Boolean operators, such as AND and OR, are essential tools in information retrieval and search query formulation. In table 3, the AND operator is employed to narrow down search results by requiring the presence of multiple specified terms. For instance, queries like "Digital Transformation" AND "Enablers" or "Generation Z" AND "Digital" AND "Technology" are taken in consideration.

Table 3. *Bollean Operaters of different terminologies*

Bollean Operaters	Conditions	Results
AND	"Digital Transformation" AND "Enablers"	421
	"Generation Z" AND "Digital" AND "Technology"	242
	"Digital" AND "Transformation" AND "Generation Z"	84
	"Digital Transformation" AND "Gen Z" AND "Higher Education"	34
	"Digital Transformation" AND "Generation Z"	21
OR	"Dt" AND "Inhibitors" OR "Barriers"	703
	"Gen Z" OR "Generation Z" AND "Digital Technology"	281
	"Digital Technology"	61
	"Higher Education"	51

During the evaluation process, Researchers ensure that records must contain all the listed terms to be included in the results, leading to a more focused and specific outcome. On the other hand, the OR operator broadens the search by including records that have any of the specified terms. For example, in the query "Dt" AND "Inhibitors" OR "Barriers," records are retrieved if they

contain "Dt" and either "Inhibitors" or "Barriers." These Boolean operations enable researchers to tailor their searches, refining or expanding the scope of information retrieval based on the relationships between different search terms.

The word cloud in the text features prominently the words "online" emphasizing the prevalence of digital learning (figure 1). "Accessibility" highlighting the importance of easy access to educational resources. "Learning" underscoring the central focus on acquiring knowledge. "Reality" possibly indicating the integration of virtual or augmented reality technologies However "Management" suggesting efficient organization and administration. Words like "courses", "augmented" "educational", "virtual", "digital", "flexibility", "information" and "progress" hold medium prominence which are representing various facets of modern education. Less highlighted terms including "metaverse", "blockchain", "collaboration" and "MOOCs" etc. signify emerging concepts and collaborative approaches in education. The word cloud visually communicates the thematic emphasis with the most prominent words capturing key aspects of online, accessible, and technologically advanced learning.

Figure 3. *Word Clouds on different terminologies*

4. Conclusion

Digital transformation makes it evident that the evolution of higher education is characterized by a profound transformation driven by a variety of advanced tools and technologies. It collectively contributes to the reconfiguration of the learning experience and the nurturing of lifelong learning. The incorporation of ICT devices, including 3D platforms, gamification, and BYOD, has become indispensable in our digitalized world. In addition to traditional Learning Management Systems, innovative approaches such as Massive Open Online Courses (MOOCs), flipped classrooms, gamification, simulation, e-books, and collaborative distance learning environments have the potential to enrich higher education and facilitate lifelong learning. In this changing educational landscape, the development of problem-solving and innovation skills remains essential. The emergence of the metaverse, grounded in technologies including IoT, AI, Blockchain, and machine learning, represents the next-generation internet. It can revolutionize human interactions with the world. The metaverse offers the potential for enhanced virtual and augmented reality experiences. By this transformation, Generation Z students are fostering creativity and customization with the use of digital technologies in the realm of education.

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