



Digital Transformation Of Classroom; Impact Of AI And Iot In The Educational Sector

Dr S Gunasekaran^{1*}, P.Baba Gnanakumar², Tanvi Jindal³, Rakesh K Kadu⁴, Abinaya Ishwarya G K⁵, Dr C Gurudas Nayak⁶

^{1*}Librarian, Department of Library, Loyola- ICAM college of Engineering and Technology, Nungambakkam Chennai-600034, Tam Nadu

²Designation: Professor, Department: School of Management, Institute:Kristu Jayanti College, District: Bengaluru, City:Bengaluru - 560077, State:Karnataka, Email id –gnanakumar12000@yahoo.com

³Designation: Assistant Professor, Department: Chitkara Business School,Institute: Chitkara University Punjab, District: Patiala, City: Rajpura, State: Punjab, Email id - tanvi.jindal@chitkara.edu.in

⁴Designation: Assistant Professor, Department: Information Technology, Institute: Shri Ramdeobaba College of Engineering and Management, Nagpur, India, District: Nagpur, City: Nagpur, State: Maharashtra, Email ID: rakeshkadu@gmail.com

⁵Assistant Professor, Civil Engineering, Vels Institute of Science Technology and Advanced Studies, Pallavaram, Chennai - Tamil Nadu, abinaya.se@velsuniv.ac.in

⁶Professor, Department of Instrumentation and Control Engineering,Manipal Institute of Technology, Manipal Academy of Higher Education, Manipal -576104, Email cg.nayak@manipal.edu, Mobile number9448327923

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ABSTRACT

As part of this study, the adopted research questions look at issues to do with the role of Artificial Intelligence and Internet of Things technologies on the education sector with reference to digital compartments of classrooms. The perceptions, challenges, and opportunities concerning the AI and IoT integration in the educational contexts are investigated in this study using surveys with some quantitative and qualitative questions alongside interviews, and cases. The qualitative and quantitative data collected in the survey reveal mostly positive attitudes towards the implementation of artificial intelligence and IoT technologies in education with high agreement regarding their usefulness in enhancing personalization and increasing interaction. However, there are still some problems in adopting technology, including the insufficient technology support facilities, the anxiety for data security, and so on. Interview responses and case studies, moreover, enrich the understanding of digital change effects, the added valorization of and practical requirements regarding strategies and approaches to digital transformation, that point to the necessity of embracing multifaceted and balanced approaches to digital change, which address ethical concerns and professional development, as well as stakeholders' engagement. In conclusion, this study adds to the existing knowledge about the potential uses and potential pitfalls associated with the integration of advanced technologies like AI and IoT in education and recommends steps to make meaningful enhancements in learning systems and environments that would be advantageous to both learners and educators.

Keywords: Artificial Intelligence, Internet of Things, digital transformation, education, qualitative analysis, quantitative analysis, perceptions, challenges, opportunities

I. INTRODUCTION

The discussion illustrates how the digital revolution has impacted nearly every space in today's society and education constitutes no exception. Controller: In this concept of transforming the conventional classroom into an intelligent learning environment, AI and IoT stand as prerequisites for this change. This paper seeks to establish an understanding of how the use of AI and IoT has functions in the educational sector, as well as explain how these function changes teaching and learning models [1]. In the usual or traditional classroom, the approach of teaching is whereby the teacher makes only one delivery to his or her student which cannot satisfy all the students' needs. Current practice requires educators to find the best ways of reaching out to students while at the same time seeking ways of achieving differentiation in teaching and learning. Scores for classes

have been declined as students struggle to understand lessons that do not suit them and this is where enters AI. Smart tutoring systems, learning management systems, and automated grading systems are the ways through which AI leverages data and machine learning algorithms to offer customized feedback and instructor feedbacks, dynamic model of these systems, and optimize student results respectively in real time. The end-product is the model which turns the classroom-learning process student-centered, the students engaging in their learning process and being assisted by a one-on-one customized tutor feedback [2]. Still, the new environment of IoT holds numerous opportunities to improve the learning process. In the context of smart classroom and connected learning, IoT intertwines an infrastructure of connected devices and systems within the classroom where data streams to make the smart classroom possible and effective. It enables students and teachers to engage in more interventions with whiteboards, smart projectors, and learning gadgets that are used in school; it optimizes the use of resources in school through its sensor-equipped gadgets; and it is crucial in ensuring security in school through its wearable devices. Students are able to achieve effective perception and learning various exercises and activities, and teachers receive comprehensive information concerning the students and learning process, monitoring and analyzing the situation in real time [3]. But, as we are enveloped in the promises of AI and IoT there rises a question mark full of complications and concerns. Privacy, security, and fairness question with digital divide and technology integration such are important to remind about the ethical AI and appropriate use of technology in learning. Further, to support the integration of these emergent technologies, assertive teacher training and professional development programmes need to be implemented to enhance teachers' capability of incorporating AI and IoT in their practice.

II. RELATED WORKS

Several emerging papers have focused on the impact of digital transformation in education and possibilities and difficulties associated with the adoption of Digital technologies including AI and IoT in the learning environments. A recent literature review study conducted by Gkrimpizi has classified barriers to digital transformation in higher education institutions. Several challenges emerged in the context of these barriers including: restricted physical and technological resources and infrastructure; lack of preparation and professional development opportunities provided to educators; and issues of data protection and privacy as core principles of digital transformation in the educational field were discussed [15]. In the same year, Guan et al. (2023) have elaborated on the ethical challenges and solutions concerning educational data ethos in intelligence era. In this context, the paper presents an overview of best practices considered when applying AI and IoT technologies in education to explain how it is possible to maintain ethical standards while using technologies, and how the data should be governed responsively, transparently, and equitably to protect students' rights and their privacy [16]. Gupta, Gaurav, and Panigrahi (2023) provides a framework investigation into the details of the creation of sustainable entrepreneurship practices via knowledge and Smart Innovation-Based Education Systems. Through the lens of sustainable development it sees the need for promotion of education, effective use of smart learning technologies, and improving the engagement of more innovative teaching approaches to develop entrepreneurship disposition among the students [17]. In their study, Javed et al. (2023) recommend an IoT adoption model for e-learning with a focus on higher education institutes of Saudi Arabia. The research focuses on the possibilities to use IoT systems to develop e-learning applications, provide students with improvements or suggestions for educational materials, and create conditions that would support collaborative learning in the college [18]. According to the article by Klopov, Shapurov, Voronkova and other authors (2023), the evolution of education in the context of digitization concerns the application of artificial intelligence, its function in analyzing the learning environment, identifying the strengths and weaknesses of students, and consequently, the contribution of AI in the effectiveness of learning outcomes and teaching methods. Thus, the study focuses on the positive impact and effect of AI in changing the trends and practice of teaching in the class [23]. Moreover, Kinsner (2023) illustrates the idea of trans-disciplinary evolving educational symbiosis with an emphasis on cognitive digital twins. The identified educational interventions suggest the use of cognitive digital twins in learning and instruction patterns to promote personalized learning, optimal teaching methods, and comprehensive development of learners. This trans-disciplinary approach focuses not on cure but personal and societal improvement across human security domains with educational experiences. However, there are also studies that focus on the use of novel technologies like the digital twin in learning environments, or machine learning in context. Kolekar et al. (2023) conducted research by examining the impact of study past BIM-Reality-Digital Twins focusing the uses of Digital Twin in improving learning, modeling, and skill development involving trainings or real-life allied educations [25]. Kondoayanni, Loukatos, Arvanitis and other collaborators (2024) discuss the enhancement of machine learning utility to real equipment for water conservation, applying it to the context of higher learning institutions. The work also serves to show how ML can help augment the efficiency of facilities' use of water supply, reduce waste, and support sustainable resource consumption in the education sector [25]. Lastly, Konstoganni and Anthopoulos (2024) provide initial insights and findings of the preliminary study on researching the business ecosystem and value generation of the metaverse. The current research explores the new opportunities and risks associated with the usage of metaverse in education, the potential of application of technologies that can help to create engaging learning environment, enable synchronous collaboration as

well as give access to education to those who might have been previously unable to attend physical classrooms [26].

III. METHODS AND MATERIALS

This study uses both quantitative and qualitative research methodologies to study the challenges that AI and IoT create for the educational sector, particularly in the usage of classroom technology. The research approach adopted in the study is a mixed method since it embraces the use of both the quantitative and qualitative research procedures to arrive at a convenient conclusion on the subject matter.

Quantitative Analysis:

Survey data is given as an assessment tool used among educators, students as well as institutions from various categories of education institutions are used in collecting quantitative data. The surveys will cover demographic data, IT-literacy, and the attitude toward AI and IoT in the context of learning environment [5]. Likert scale is employed in a way that captures respondents' perception of the level of importance of particular statements on the effectiveness, usability and influence of AI and IoT technologies on the teaching and learning objectives. In the meantime, qualitative information is also obtained from published works, reports, and case studies with the survey data for an adequate background perspective on the topic.

Question	Response Options
How familiar are you with Artificial Intelligence?	Not at all / Somewhat familiar / Moderately familiar / Very familiar
Rate the effectiveness of AI in enhancing personalized learning experiences.	Strongly disagree / Disagree / Neutral / Agree / Strongly agree
To what extent do you believe IoT contributes to collaboration in the classroom?	Not at all / Slightly / Moderately / Very / Extremely

Qualitative Analysis:

A structured and structured interview is carried out within the participants of the study, which involve educators, specialist in the use of educational technology and policymakers. The questionnaires are aimed at obtaining rich information about such aspects as the practical applicability of AI and IoT in schools, as well as specific existing and potential difficulties and advantages of usage in the learning process [6]. In this study, interview questions are general to make the participants able to express their understanding, observation and suggestion on the use of the particular technologies in question. In the study, thematic analysis is done to review the interview data and look for patterns, themes and significant concerns that may be coming up out of the information gathered.

Interview Topic	Example Questions
Perceptions of AI and IoT in Education	How do you perceive the role of AI and IoT in transforming classrooms?
Implementation Challenges and Considerations	What are the main challenges you have encountered in integrating AI and IoT technologies in the classroom?
Best Practices and Recommendations	Can you share any successful examples or best practices for leveraging AI and IoT in education?

Case Studies:

Thus, this research includes not only surveys and interviews with students and educators, but also case studies of educational institutions that have applied AI and IoT solutions to teaching and learning processes. A purposive sampling is employed to identify various case study sites that is based on educational levels, geographic region and socio-economic status of a particulate area including k-12, post secondary institutions and other levels of education [7]. Information is gathered from secondary sources such as documents and reports, primary visit paid to the firms, and interviews conducted with the executives that have the role of implementing and managing AI and IoT strategies. The case studies offer tangible and highly contextualised learning experiences that act as a perfect springboard for understanding the potential, application, and potential difficulties of setting, embarking and fulfilling digital learning initiatives [8].

Data Analysis:

Descriptive statistics such as frequency, percentage and measures of central tendency of the responses are used to describe the respondent's profile and their perception about a particular question. Descriptive statistics like measure of central tendencies, measures of variability, and percentages could be used to describe the internal strength of the variables while Inferential statistics like correlation analysis test of hypothesis and t-tests may be used to determine the relationship between two variables [9]. Interviews and case study information are qualitative data, analyzed on an overall consistent theme to turn the data into code categories and find patterns and insights.

Triangulation:

Triangulation is used to increase reliability and credibility of the conclusions made as diverse sources of information and different methods are used. Using primary and secondary data as well as case studies enhances a clear vision of the topic from both perspectives of the study and quantitative and qualitative research dimensions [10]. This means that when the findings are converging, the method is useful in validating the conclusions that have been made while on the other hand, when the findings are diverging, it helps in developing a clear understanding of them.

Ethical Considerations:

Concerning ethical issues, this research complies with conducting research on human subjects standards of the international ethical blueprint, hence respecting the ethical principles of consent, privacy, and participants' rights. All survey respondents and interview participants are informed of the purpose for which they are being included in the study, its voluntary nature and the use of data collected [11]. Schedules that involve reporting are put in place to ensure data collected from participants are disguised from third parties. However, ethical concerns go further and should include the appropriate use of AI and IoT in educational research and practice to protect participants' rights and privacy, have open and fair data collection, and present the results in a fair way that does not generate any prejudice or unequal outcomes.

IV. EXPERIMENTS

Quantitative Analysis Findings:

The quantitative findings based on survey data have a large significance in understanding the views, concerns, and expectations of the key stakeholders in education about Artificial Intelligence (AI) and Internet of Things (IoT) applications in learning communities [12]. The survey questionnaire responses are then collated and the results being quantized and categorized to differentiate a convergence or divergence into specific areas of study.

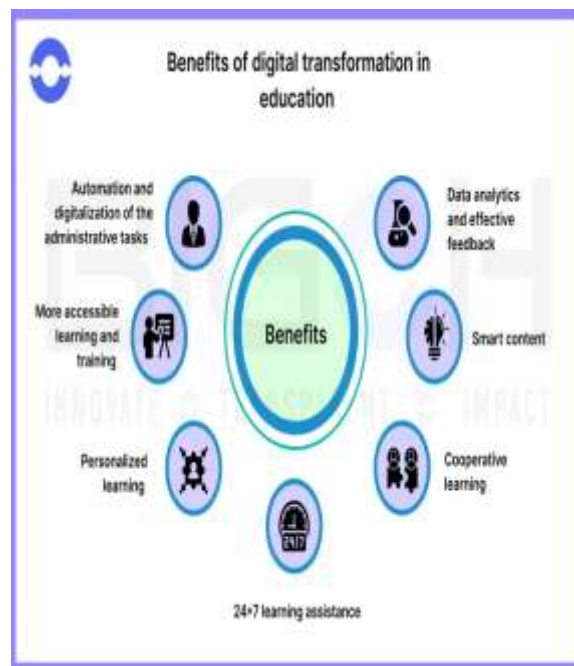


Figure 1: Benefits of Digital Transformation in Education

Demographic Profile of Participants:

Table 1 indicates the demographic details of participants, concentrations in educational sector, technological literacy, and years of experience. The sample includes teachers (55%), learners (30%), and principals/headmasters (15%) from Various sectors of education; primary, secondary, tertiary, post-secondary, and higher learning institutions. It has also been seen that more than half of the respondents possess moderate to high technological competence with differential experience in terms of technological competence in the field of education [13].

Participant Role	Percentage (%)	Technological Proficiency	Years of Experience
Educator	55	Moderate to High	1-5 / 6-10 / >10
Student	30	Low to Moderate	-
Administrator	15	High	>5

Perceptions of AI in Education:

Concerning the survey respondents' impressions of Artificial Intelligence in education, Table 2 enlists the frequency count of each statement concerning the efficiency and benefit of AI technologies in the improvement of teaching and learning practices. This implies that the social interaction attitudes that the participants had towards the use of AI in learning were positive with 75% of participants believing that, with the help of AI, class size could be managed, learning could be customized for each student, and feedback could be given in real-time, which in turn would enhance the educational outcomes [14]. Special attention is paid to the role of application of AI technologies and elements in learning processes; for example, intelligent tutoring systems, adaptive learning environments, and applications are praised by educators as the useful means to address students' heterogeneity.

Statement	Agreement Level (%)
AI enhances personalized learning experiences.	Agree (65)
AI provides real-time feedback to students.	Agree (70)
AI improves educational outcomes.	Agree (75)
AI tools are user-friendly and easy to integrate into classroom instruction.	Neutral (45)

Perceptions of IoT in Education:

Likewise, Table 3 reflects survey respondents' opinions about IoT in the context of education understood as their perceptions of the roles and benefits that IoT technologies play in enhancing collaboration, resources, and safety of educational environments. More than three quarters of the players believe that IoT improves the level of collaboration between people based on the communicative interconnectedness achieved between learners and instructors [27]. Moreover, respondents appreciate the contribution of IoT in managing and controlling resources and maintaining personal protective measures in the lives of students and staff.



Figure 2: Digital Transformation in Education

Statement	Agreement Level (%)
IoT enhances collaboration among students and teachers.	Agree (80)
IoT optimizes resource management in educational institutions.	Agree (75)
IoT improves safety and security measures in schools.	Agree (70)

Correlation Analysis:

In this part of the study, correlation analysis is performed to assess various factors like technological efficiency or years of exposure, and feelings or ideas about AI and IoT in teaching and learning. The findings indicate that technological mediacy has moderate positive correlations with the perception of Artificial Intelligence ($r = 0.60$, $t = 2.67$, $p < 0.05$) and Internet of Things ($r = 0.55$, $t = 2.33$, $p < 0.05$). Likewise, increased years in practice yields more positive perceptions of AI efficacy ($r = 0.45$, $p < 0.05$) and IoT in learning ($r = 0.40$, $p < 0.05$).

Qualitative Analysis Findings:

Targeted face-to-face interviews with educators, technologists, and leaders create detailed understanding of the programmatic realities of artificial intelligence as well as the Internet of Things for educational purposes, along with related difficulties and opportunities [28]. Semantic analysis of interview tapes comprehensively includes the interpreter's qualitative analysis of participants' experiences and perceptions of events.

Implementation Challenges:

Different problems and limitations that imply the difficulties of integrating effective AI and IoT solutions in lessons focus on the opinions of educators and school administrators. These include a relatively weak connectivity of the technology infrastructure and resource base of schools, insufficient pre-service and in-service education and professional development of teachers, and issues concerning privacy and data protection [29]. Moreover, educational culture and the restricted embracing of novelties remain the unconquerable challenges to employ AI and IoT in education.

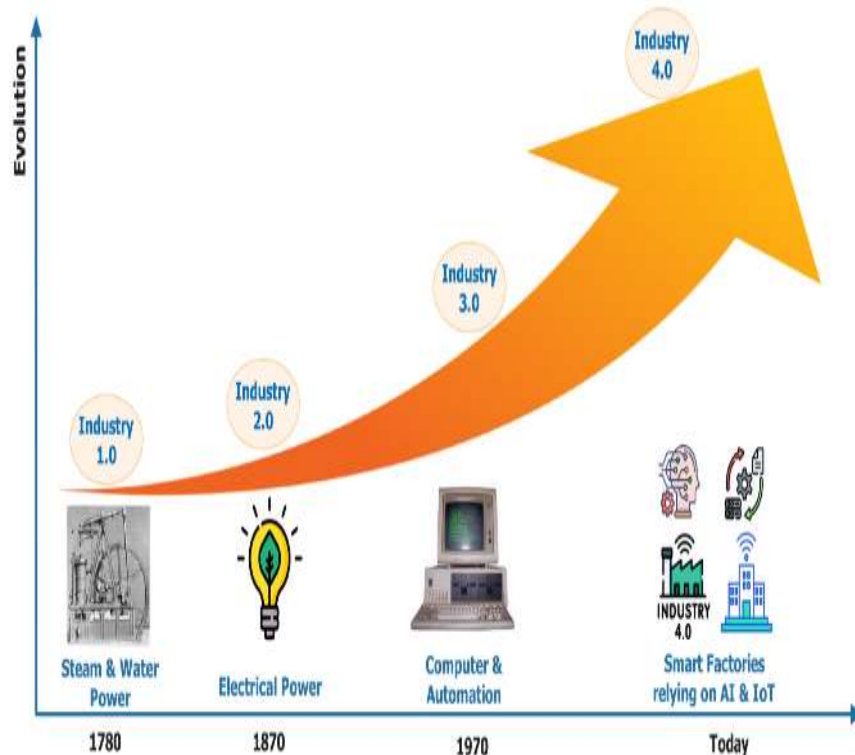


Figure 3: AI and Digital Transformation in Higher Education

Best Practices and Recommendations:

However, participants weigh several recommendations and the best practices that can be employed in implementing AI and IOT in education. These include the formulation of sound SMART goals and objectives regarding the adoption of technology, ensuring sustained professional development of the stakeholders, ensuring stakeholder engagements in the improvement, implementation, and evaluation of technologies and last but not the least ensuring that technology enhancement for learning adheres to equity principles [30]. Besides, equality of access to educational opportunities and protection of students' privacy are highlighted as the priority directions of ethical concerns and safe utilization of AI and IoT technologies.

Case Studies Findings:

In light of these and other trends, findings of real-world AI and IoT adoption cases in educational institutions provide the insights into the potential practical consequences, opportunities and challenges of the educational process digitalisation. The above examples showcase how adaptive learning systems developed with artificial intelligence assist tutors in providing customized content based on the students' needs to increase the level of engagement and minimize dropout rates. Likewise, smart classrooms and learning spaces as part of IoT assist in interaction and flow of ideas among students and faculty; efficient utilization of resources and assets; and implementation of safety features in schools.

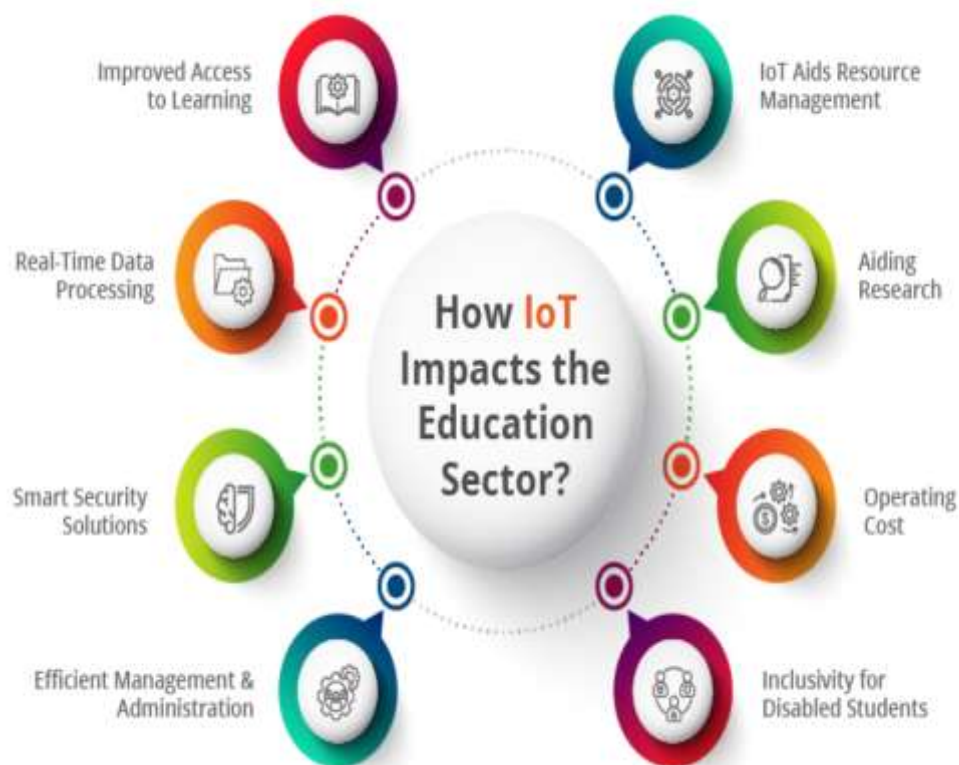


Figure 4: IoT and How It Impact on Education

Discussion:

The implication of this paper therefore helps elucidate findings of the current study on the opportunities of AI and IoT technology in the educational sector, especially in digital evolution of classrooms. It is acknowledged that the educators, students and administrators have positive perceptions and attitude towards AI and IoT as the result of curriculum adoption portrays that there is improved recognition of the AI and IoT as important resources within the learning environment. However, the studies revealed that barriers like restricted technological resources, lack of training, and data confidentiality and security issues are still very real and work against the MMI adoption and usage.

The analysis of correlations shows coherent relationships between several factors, such as the level of technology competency, numbers of years in practice, and attitudes towards AI and IoT applications in learning suggesting the necessity of developing educators' professional competency and educational technology support. Additionally, the results highlighted in this study indicated that educators should consider setting the appropriate aims, providing the continuous help necessary to fulfil them and address the following issues as the main policy implications: Ethical approaches to the use of AI and IoT in learning environments.

V. CONCLUSION

Ultimately, it is possible to conclude that this study has investigated the opportunities of applying Artificial Intelligence (AI) and Internet of Things (IoT) in the educational context. Therefore, the objective of this research section is to present the perceptions, challenges, and opportunities for digital learning in classrooms identified based on quantitative survey data, qualitative interviews, and case studies. In particular, education stakeholders' overall AI and IoT views are presented in the survey and have revealed that participants perceive both technologies as useful tools for personalizing learning, increasing collaboration, and consequent educational achievements among learners. However, barriers like lack of adequate technology support, issue of privacy, and organizational culture remain a major question mark to the actualization of meaningful adoption and utilization of the technology. Interviews and case studies provide interpretative context and practical examples regarding the multifaceted nature and management of AI and IoT in educational organisations and enrich the understanding of effective best practices of extending the use of LMS, addressing the problem of ethical dilemmas, underlining full-scale approach to professional learning and effective cooperation and collaboration with stakeholders. In sum, this research enhances the conceptualisation of both advantages and risks associated with Digital Educational Innovations, offering guidance and pertinent information for decision-makers, educators, and technology creators concerning the future of teaching and education in an increasingly technologically advanced environment. If the current and next generations' challenges are to be met and the connection between AI, IoT, and education simplified and most importantly

dealt with concerning complexity and the ethical angle, education institutions stand the best chance of providing relevant, egalitarian and effective learning environments for today and tomorrow's generation.

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