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ORIGINAL

Educational Performance and the Role of E-Learning, Digital Leadership, and Digital Innovation: A Study of High Schools in Jordan in the Context of 5G

Rendimiento educativo y el papel del aprendizaje electrónico, el liderazgo digital y la innovación digital: Un estudio de los institutos en Jordania en el contexto de la 5G

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ABSTRACT

Introduction: this study examines the impact of e-learning, digital leadership, and digital innovation on educational performance in high schools, focusing on Jordan's transition to 5G technology. It explores how these factors enhance educational outcomes in a developing country facing technological and infrastructural challenges.
Method: a quantitative approach was used, collecting data from 385 high school teachers in Jordan through a cross-sectional survey. The study employed Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze the relationships between e-learning, digital leadership, digital innovation, and educational performance.
Results: the findings indicate that e-learning significantly improves educational performance by offering flexible and interactive learning environments. Digital leadership is crucial for guiding digital transformation and fostering innovation, while digital innovation, including AI, VR, and AR, enhances teaching methods and student engagement, leading to better educational outcomes.
Conclusions: the study concludes that integrating e-learning platforms, effective digital leadership, and digital innovation is essential for improving high school performance. Policymakers and school administrators should invest in digital infrastructure, provide teacher training, and promote a culture of innovation to prepare students for a technology-driven future. This research offers valuable insights for enhancing educational practices in developing countries like Jordan.

Keywords: E-Learning; Digital Leadership; Digital Innovation; Educational Performance; 5G Technology; High Schools; Jordan; PLS-SEM; Digital Transformation; Artificial Intelligence.

RESUMEN

Introducción: este estudio examina el impacto del aprendizaje electrónico, el liderazgo digital y la innovación digital en el rendimiento educativo en las escuelas secundarias, centrándose en la transición de Jordania a la tecnología 5G. Explora cómo estos factores mejoran los resultados educativos en un país en desarrollo que se enfrenta a desafíos tecnológicos y de infraestructura.
Método: se utilizó un enfoque cuantitativo, recopilando datos de 385 profesores de secundaria en Jordania a través de una encuesta transversal. El estudio empleó el modelo de ecuaciones estructurales por mínimos cuadrados parciales (PLS-SEM) para analizar las relaciones entre el aprendizaje electrónico, el liderazgo digital, la innovación digital y el rendimiento educativo.
Resultados: los resultados indican que el e-learning mejora significativamente el rendimiento educativo al ofrecer entornos de aprendizaje flexibles e interactivos. El liderazgo digital es crucial para guiar la transformación digital y fomentar la innovación, mientras que la innovación digital, incluida la IA, la RV y la RA, mejora los métodos de enseñanza y el compromiso de los estudiantes, lo que conduce a mejores resultados educativos.
Conclusiones: el estudio concluye que la integración de plataformas de aprendizaje electrónico, el liderazgo digital efectivo y la innovación digital son esenciales para mejorar el rendimiento de la escuela secundaria. Los responsables políticos y los administradores escolares deben invertir en infraestructura digital, proporcionar formación a los profesores y promover una cultura de innovación para preparar a los estudiantes para un futuro impulsado por la tecnología. Esta investigación ofrece valiosas ideas para mejorar las prácticas educativas en países en desarrollo como Jordania.

Palabras clave: E-Learning; Liderazgo Digital; Innovación Digital; Rendimiento Educativo; Tecnología 5G; Escuelas Secundarias; Jordania; PLS-SEM; Transformación Digital; Inteligencia Artificial.

INTRODUCTION

The quick changes in technology have drastically altered worldwide educational settings by putting more emphasis on digital platforms for teaching improvements. The educational sector alongside high schools needs these elements more strongly than before because of 5G technological advancement. The critical nature of understanding performance influencing factors in education has gained importance as countries work towards digital transformation and educational goal achievement. This research studies the connections between e-learning and digital leadership and digital innovation and their effect on high school performance in Jordan under the new 5G technological landscape.

The educational experience experienced a revolution when e-learning introduced alternative learning opportunities outside traditional classrooms for both students and teachers. Through e-learning systems students can engage in three types of educational activities including material access and peer interaction with additional collaborative learning capabilities. Teachers can achieve flexibility through e-learning systems because these platforms enable multiple lesson delivery methods including recorded instruction and interactive tests. The advantages of e-learning are clear yet Jordan and other developing nations especially face ongoing barriers from technological constraints alongside instructor reluctance to adopt new methods and insufficient education involving digital tools.[1,2]

The successful deployment of technology in educational settings depends mainly on digital leadership as a fundamental driver. Versions of digital leadership in high schools require guidance for teachers and students in new technology adoption alongside the promotion of innovation and creation of adaptable educational environments. Educational institutions require their leaders to build a digital culture while leading the implementation process of technology tools which improve educational delivery. Digital leadership expands through its ability to lead digital transformation complexities together with establishing an education framework that matches modern technological advancements.[3]

Digital education innovation describes the strategic deployment of future technologies to construct better teaching methods and improve student learning processes along with education institution measurement standards. A combination of advanced technologies like cloud computing with artificial intelligence and Internet of Things (IoT) brings novel educational approaches which create better and interactive learning experiences for students.[4] Digital innovation strengthens school performance by implementing active learning techniques while enhancing both communication methods and administrative operations. The implementation of digital innovation in Jordan faces obstacles like poor infrastructure coupled with insufficient funds and weak educational training programs for teachers according to.[5]

The implementation of 5G technology will advance educational transformation because it enables users to

enjoy automatic peak internet speeds alongside improved networking capabilities. Improved availability of 5G networks can sustain the increasing requirements of e-learning infrastructure together with virtual education software and collaborative applications which need fast data transfer combined with minimal delays. 5G technology introduces powerful opportunities to classroom learning through interactive tutorials and enables real-time work collaborations while bringing emerging technologies such as virtual and augmented reality into education spaces. 5G technology brings enormous potential for educational enhancement that enables teachers and students to achieve connectivity for tasks which were unthinkably challenging before.[6]

Various initiatives enable Jordan to achieve major progress in its educational system acceptance of digital technologies by integrating e-learning and digital tools across elementary schools. Jordan and other nations in the region encounter obstacles when implementing digital education through problems with infrastructure together with issues of technology accessibility and digital disparities. The Jordanian government together with educational institutions understand how crucial digital transformation remains for education because digital skills become foundational for students entering the future job market.[7]

This research aims to study the connection that exists among e-learning practice and digital leadership and digital innovation as they affect high school performance in Jordan. The study investigates variable interactions to reveal their educational outcome influence on technology-enhanced educational experiences. This study generates insights that will assist Jordanian policymakers and school administrators and educators to use e-learning platforms and develop strong digital leadership and cultivate digital innovation for improved school performance particularly during the transition into the 5G era.

The continuous educational digital transformation that combines e-learning with digital leadership and innovation creates dual benefits and obstacles for schools in developing nations such as Jordan. The educational potential from 5G technology continues to rise beyond all previous levels. The study investigates the impact these technological elements have on educational outcomes to help schools develop better combinations of digital resources with leadership strategies which enhance student and educator success.

Literature Review

E-learning

Education in the modern era depends heavily on e-learning which provides students digital platforms to access flexible learning opportunities in a system that is accessible anytime. Educational software provides students with multiple learning tools including online classes and videos as well as webinars together with interactive modules which operate in real-time and delayed sessions. Research evidence supports e-learning because it improves student learning by giving them adaptable schedules for private study together with digital resource access throughout any place and time.[8] The combination of videos and interactive quizzes with multimedia elements enables customize learning experiences that support diverse learning types thus making education more accessible to all students.[4]

Challenges to implementing e-learning exist predominantly in developing countries when aiming for successful execution. The effective use of e-learning systems faces significant obstacles in various areas such as Jordan due to insufficient infrastructure standards and minimal internet availability together with teacher training deficiencies according to.[1] The successful implementation of e-learning requires both educational institutions and teachers to show readiness and have access to required resources according to.[5] E-learning demonstrates ongoing potential for success because governments along with educational institutions support digital infrastructure growth while providing educator training programs.[7]

Digital Leadership

Educational leaders who demonstrate digital leadership know how to guide teaching staff in the integration of digital technologies in educational practice. Educational institutions that implement new technological tools require digital leadership to accomplish effective utilization of technology for better educational results. Educational leaders need to develop digital transformation visions and direct teacher technology adoption and establish student learning skills needed for digital success.[3] Digital leadership depends on both technical competence in new technologies together with encouraging an innovative workplace that promotes team-based activities and sustained educational growth.[9]

Studies show that excellent digital leadership practices boost the integration between e-learning systems and classroom digital tools. Digital leaders facilitate teaching practices transformation through educational goal alignment by offering teachers diagnostic help and educational material along with support. Digital leaders assist teachers through training sessions together with collaborative frameworks and they maintain accessible digital platforms which function effectively for students.[3] Digital leaders take a crucial role in developing positive perspectives towards technology implementation because it is vital to succeed against educators who resist new educational technological practices.[7,10,11]

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Digital innovation

The application of novel technologies through creative methods produces digital innovation in education which enhances classroom instruction along with educational management systems. The innovation incorporates various modern technological tools such as artificial intelligence (AI) as well as virtual reality (VR) and augmented reality (AR) and cloud computing to boost educational outcomes. Digital innovation enables educational establishments to establish personalized learning spaces which promote student engagement through interactive educational content that connects with diverse student requirements.[6] Education outcomes show significant improvement through modern technology because it allows better dynamic teaching methods which support student collaboration and enhances educator delivery of content that is both engaging and interactive.[12,13,14]

Digital innovation adoption in educational institutions encounters various obstacles which impede its widespread implementation. Educational organizations struggle to merge new technological tools into their systems because they need better physical setups and budget allowances together with staff training. The widespread implementation of AI and IoT systems in educational methods needs mature technological frameworks combined with permanent innovating capabilities according to.[4] The existing barriers to technology integration require educational institutions to increase their infrastructural investments and train their staff while developing an innovative mindset throughout the school.[9]

The relationship between e-learning and performance

Extensive studies focus on the connection between e-learning and educational performance because digital educational tools steadily grow across educational systems. E-learning delivers flexible interactive content that leads to multiple academic improvements which makes it the key focus to enhance educational performance outcomes. Various academic studies demonstrate that e-learning creates substantial impacts on student academic results through enhanced material engagement time combined with adaptive learning speed which leads to superior scholarly achievements.[1,7]

Students benefit from personalized education through e-learning since they can find learning materials that align with their individual learning styles and speed. A tailored educational strategy through e-learning realizes increased knowledge comprehension alongside better retention behavior and application skills which drives better academic outcomes.[4] E-learning platforms with their interactive features including quizzes and video tutorials and discussion tools enable students to engage actively which promotes more profound understanding and effective learning.[8]The immediate feedback system provided by e-learning proves essential for performance enhancement in studies because learners can discover their weak points and correct errors swiftly.[5]

The potential effect of e-learning on performance development is considerable yet its success depends on three main elements which include above-average platform quality and student-instructor connection quality as well as teacher and student readiness to use technology. The combination of appropriate instructional design with digital leadership creates stronger learning outcomes for e-learning programs according to.[3,7] Teacher skill in implementing e-learning within their instructional methods functions as a key condition which affects how teaching performance changes due to e-learning integration. The research provides grounds to establish the following prediction: H1: E-learning has a positive and significant relationship with performance.[15,16,17,18]

The research hypothesis demonstrates how educated students obtain better results from e-learning systems when their implementation receives proper support and integration. Academic results benefit from e-learning because it delivers customizable and adaptable educational encounters as well as interactive resources that enable valuable progress in education.[19]

The relationship between digital leadership and performance

Educational performance improvement depends on digital leadership which provides guidance for schools to successfully implement and exploit digital tools and technologies. Educational institutions need effective digital leadership to maximize the potential of their technology implementations through their teaching-learning processes. Research confirms digital technology leadership together with innovation-based culture development results in substantial performance improvement across educators and their students.[3]

Digital leadership drives better academic results by creating technology adoption visions and delivering educational training to staff members and optimizing resource distributions.[7] The implementation of digital leadership results in the proper combination of technology use with educational objectives so that teaching and learning resources integrate as essential tools instead of standalone components. Through their effort to promote collaboration and backing of teacher techno-professional development and by instilling innovative thinking Digital leaders enable institutions to achieve superior outcomes. The research shows schools operated by strong digital leaders typically carry out digital tool implementation successfully which leads to positive student results and enhanced organizational effectiveness.[9] Digital leadership helps educational institutions achieve better outcomes through effective implementation of e-learning platforms as they align digital

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technology with institutional targets.[20,21]

H2: Digital leadership has a positive and significant relationship with performance.

The relationship between digital innovation and performance

Digital innovation means implementing new digital technologies along with unique approaches which enhance educational procedures and results. The use of digital innovation in education has grown more vital in recent times because schools are embracing modern tools such as artificial intelligence virtual reality and data analytics to improve their teaching and learning methods. Education transforms through modern innovations through interface-driven learning systems that build interactive personal student environments thus strengthening academic results. Studies by [6] and [4] found that digital technological innovations boost student engagement along with solving problems successfully and improving academic results. The combination of digital innovation enhances school management while improving communication systems in addition to administrative operational efficiency which results in better institutional outcomes. The implementation of digital tools throughout learning activities combined with operational procedures enables educational institutions to build facilities which boost academic results alongside developing perpetual enhancement and innovative practices. Research by [9] proves that schools focusing on digital innovation outperform traditional schools since innovation lets them serve evolving needs in students and teaching staff and educational stakeholders. Electronic institutions that successfully integrate digital technology attain improved educational results based on their level of innovation.[22,23,24]

H3: Digital innovation has a positive and significant relationship with performance.

METHOD

The study examines high school teaching practitioners from Jordan who have worked with e-learning systems and digital innovation tools by studying a group of 385 experienced teachers. Using a cross-sectional survey the research analyzes e-learning and its relationship with digital leadership and digital innovation and its effects on educational performance through quantitative data. A web-based tool will be used to collect data on e-learning as well as digital leadership and digital innovation practices and teacher-student performance at four different levels using a Likert rating system. A PLS-SEM analysis will be performed on the gathered data using Smart PLS 3.0 software for determining direct as well as indirect links between the variables. The methodology allows researchers to obtain a deep comprehension of digital transformation effects on educational performance metrics.[25]

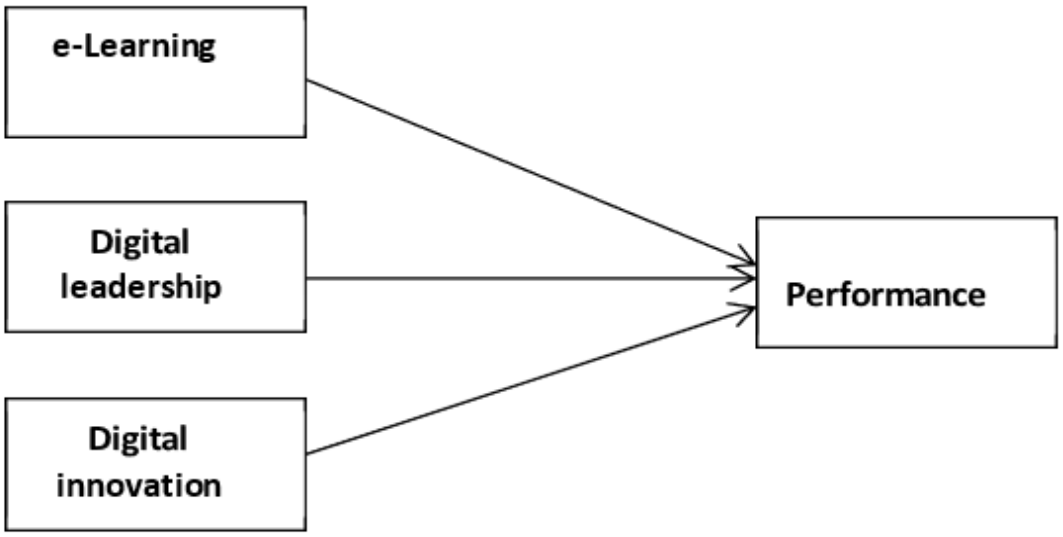

Figure 1. Research Model

RESULT AND DISCUSSION

Measurement Model

This section evaluates the measurement model using Partial Least Squares Structural Equation Modeling (PLS-SEM) with Smart PLS 3.0 software as the analytical tool. The model analyzes the associations which exist between the unmeasurable variables (e-learning, digital leadership, digital innovation and performance together with their linked indicators. To ensure validity and reliability, several criteria are examined: indicator reliability, where loadings above 0,7 indicate strong representation of constructs; internal consistency reliability, measured

through Composite Reliability (CR), with values above 0,7 indicating consistency; convergent validity, assessed using Average Variance Extracted (AVE), with values above 0,5 indicating adequate variance explanation; and discriminant validity, verified using the Fornell-Larcker criterion and HTMT ratio, where values below 0,85 confirm that constructs are distinct. The model qualifies as valid due to proper assessments against the set criteria allowing researchers to proceed by testing hypotheses regarding constructs in the structural model stage.[26,27]

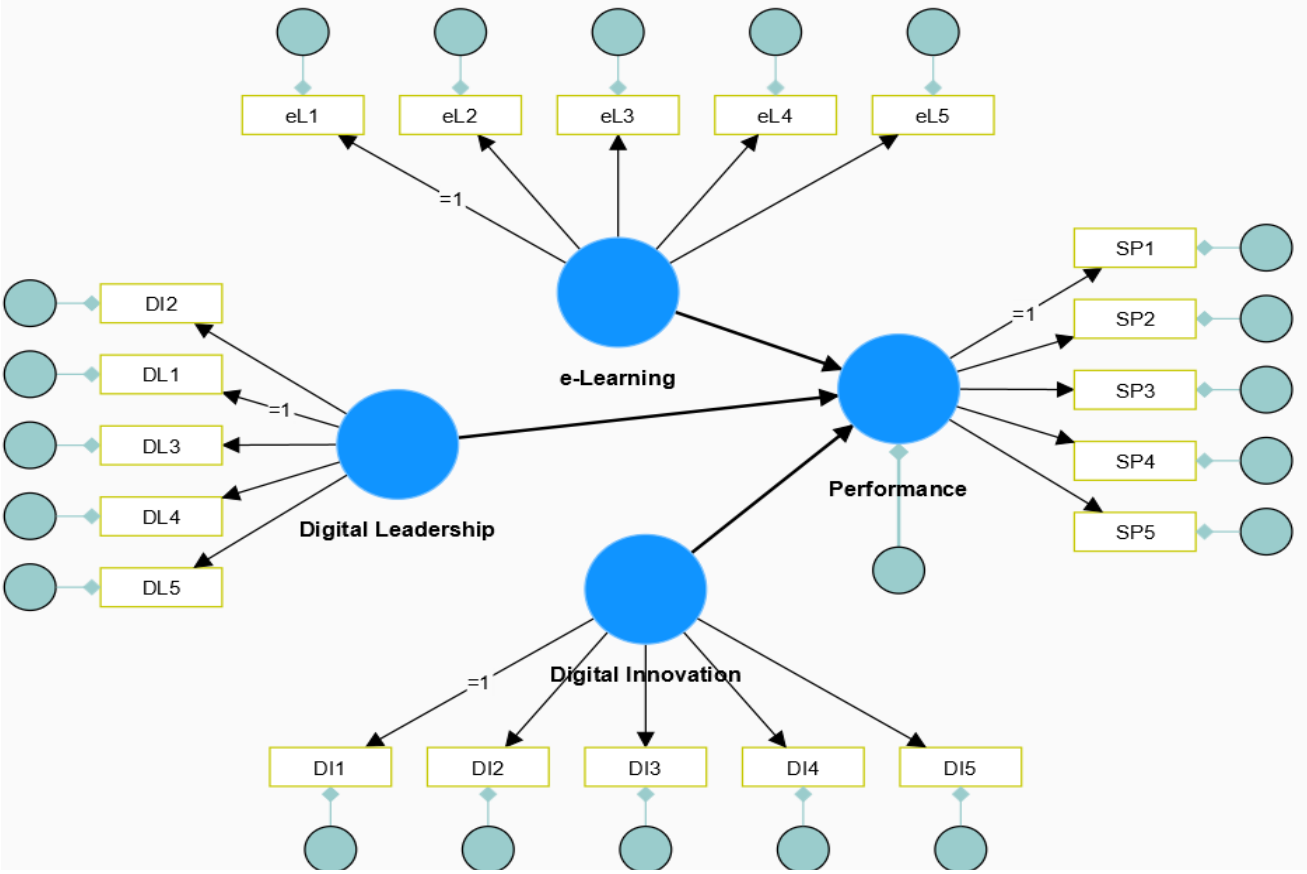

Figure 2. Measurement Model

Validity and Reliability

A validation process for the measurement model utilized Composite Reliability (CR) together with Cronbach's Alpha and Average Variance Extracted (AVE). The examination results appear in table 1.

Table 1. Composite Reliability (CR), Cronbach Alpha and Average Variance Extracted (AVE)

Variables	Cronbach's Alpha	CR	AVE
e-Learning	0,856	0,855	0,688
Digital Leadership	0,843	0,812	0,654
Digital Innovation	0,888	0,843	0,673
Performance	0,876	0,851	0,633

The Cronbach's Alpha values for all constructs demonstrate solid internal consistency since they exceed 0,7. The Composite Reliability (CR) results exceed 0,7 for every variable and further confirms the constructs' reliability standards. Each construct achieves good convergent validity because its Average Variance Extracted value surpasses the 0,5 benchmark thus accounting for greater than 50 % of its indicator variance. The measurement model shows both strong validity and reliability which creates an ideal basis to evaluate the structural model and testing hypotheses.

Discriminant Validity (HTMT)

The Heterotrait-Monotrait ratio (HTMT) served as the tool to evaluate the distinctiveness between constructs in the model for assessing discriminant validity. A value under 0,85 demonstrates that the constructs maintain appropriate separation between each other. The results presented in table 2 indicate that all HTMT values

remain below 0,85 which proves the model constructs have satisfactory discriminant validity.

Table 2. Discriminant Validity (HTMT)

	e-Learning	Digital Leadership	Digital Innovation	Performance
e-Learning	0,844			
Digital Leadership	0,778	0,845		
Digital Innovation	0,721	0,770	0,855	
Performance	0,612	0,690	0,711	0,855

The examined constructs demonstrate strong discriminant validity because HTMT values for every pair-wise comparison remain below 0,85 threshold.

Structural Equation Modeling

The Structural Equation Modeling results are presented to demonstrate direct associations between e-learning, digital leadership, digital innovation variables as independent factors and performance measures as the dependent variable. The study results confirm all research hypotheses because all path coefficients maintain statistical significance at the 5 % level.

Table 3. Direct Relation

		T Statistics	P Values	Decision
Hypothesis 1	El→P	6,543	0,000	Supported
Hypothesis 2	DL→P	7,765	0,000	Supported
Hypothesis 3	DI→P	6765	0,000	Supported

- Hypothesis 1 (e-learning → performance) is supported, as the T-statistic is 6,543 and the p-value is 0,000, which is less than the 0,05 significance level.
- Hypothesis 2 (digital leadership → performance) is supported, with a T-statistic of 7,765 and a p-value of 0,000.
- Hypothesis 3 (digital innovation → performance) is also supported, as the T-statistic is 6,765 and the p-value is 0,000.

The research findings demonstrate that all three variables including e-learning, digital leadership, and digital innovation generate substantial beneficial effects on high school performance.

The relationship of e-learning to performance

SEM revealed that e-learning produces positive relationships with performance outcomes. The study produced significant positive results between e-learning and performance which were confirmed through the T-statistic of 6,543 and a p-value of 0,000 beyond the 0,05 significance threshold. The analysis supports Hypothesis 1 because it demonstrates that e-learning stands as a positive significant factor in performance measurement. Research outcomes demonstrate that teacher employment of e-learning systems creates performance improvements for both instructors and their students.

Research work by [7] together with [1] validates that e-learning improves academic results and facilitates efficient teaching practices. E-learning generates positive effects because it gives learners adaptable learning pathways while increasing student involvement and providing resources for different learning approaches.

The Relationship of Digital Leadership to Performance

Structural Equation Modeling (SEM) revealed that digital leadership and performance have a strong positive link which was confirmed through the results. This relationship received a T-statistic value of 7,765 and generated a p-value of 0,000 thus confirming Hypothesis 2 because it shows strong significance. Digital leadership creates favorable impacts on the performance levels of both teaching staff and their student members in high schools.

Educational leaders who carry out digital leadership focus on encouraging digital technology adoption and developing digital learning environments through their practices and behaviors. The outcomes prove high school administrators can boost teaching faculty together with student academic outcomes by executing digital transformation successfully with adequate technology innovation support. Previous studies by [3] and [6] support this discovery which reveals how accomplished digital leadership produces better student and teacher learning outcomes.

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The Relationship Between Digital Innovation and Performance

Testing managed by Structural Equation Modeling revealed an essential positive connection between digital innovation and performance. Six-point-seven six five was the T-statistic value for this connection and its p-value reached zero point zero zero zero thus validating Hypothesis three. Digital innovation enhances the academic achievements of both teachers along with students attending high schools.

The integration of digital technologies and teaching methods that improve student education represents the definition of digital innovation in education. High educational results and enhanced teaching practices along with improved student involvement become possible after schools accept digital innovation. The research findings agree with multiple previous investigations which show that implementing innovative digital teaching methods brings about important educational results for students.[8,9]

Managerial Implications

This research finds multiple vital approaches which could increase high school educational outcomes in the digital age. The first priority for improving e-learning infrastructure requires school managers to enhance digital tool functionalities while focusing on their accessibility and quality as well as integration. Educational institutions can develop better academic results by giving teachers training to use e-learning systems which creates active learning spaces with adaptable frameworks.

Strong digital leadership needs to be actively developed. The implementation of digital transformation needs school leaders to develop an inclusive vision which will support teachers to become leaders of digital educational initiatives in their classrooms. The changes will directly influence teacher performance and student academic achievement and will lead to successful digital implementation throughout the entire school institution.

The process of digital innovation should be encouraged by schools by enabling teachers to embrace new teaching methods alongside modern technological tools. The continuous development of professional skills related to digital tools combined with leadership and teaching methods helps teachers deal with emerging challenges. The evaluation process of digital strategies should continue as a regular practice to support ongoing development resulting in schools maintaining their effectiveness within technology-dependent learning spaces.[28]

CONCLUSION

This study explored the role of e-learning, digital leadership, and digital innovation in enhancing educational performance in high schools, particularly in the context of digital transformation. The findings provide strong evidence that all three independent variables—e-learning, digital leadership, and digital innovation—positively and significantly impact performance.

The analysis demonstrated that e-learning platforms significantly enhance both teacher and student performance by offering flexible, engaging, and resource-rich learning environments. Moreover, the role of digital leadership was shown to be critical in guiding schools through digital transformation, fostering an environment that supports technological adoption and innovation. Digital innovation, including the implementation of new technologies and innovative teaching methods, also proved to be a key factor in improving educational outcomes.

In light of these findings, school administrators and policymakers should prioritize the integration of digital tools, cultivate effective leadership in digital transformation, and encourage a culture of innovation. By investing in these areas, schools can adapt to the challenges and opportunities of the digital age, ultimately enhancing educational performance and preparing students for a future shaped by technology.

Overall, this study highlights the importance of embracing digital technologies in education and provides valuable insights for improving educational practices, leadership strategies, and performance outcomes in high schools.

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