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## **Impact of Teachers' Digital Skills on Student Engagement and Learning Outcomes in the 21st Century**

**Iram Javed**

PhD Scholar (lecturer in Education), Govt Graduate College (W) Samundri, Faisalabad  
[nayyar9685@gmail.com](mailto:nayyar9685@gmail.com)

**Azra Jamil**

Assistant Professor, Department of Education, Fazaia Bilquis College of Education for Women, PAF Nur Khan, Rawalpindi  
[jamil.azra@yahoo.com](mailto:jamil.azra@yahoo.com)

**Ms. Ansa Nighat Iqbal**

Assistant professor, PhD Scholar, Department of Business Administration, Fazaia Bilquis College of Education for Women, PAF Nur Khan, Rawalpindi  
[Iqbalansa81@gmail.com](mailto:Iqbalansa81@gmail.com)

**Naeem Akhtar**

PhD Scholar, My University, Assistant Professor, IMCB, F-8/4 Islamabad.  
[dedu241002@myu.edu.pk](mailto:dedu241002@myu.edu.pk)

**Muhammad Maasoom Nayyar**

PhD Scholar (EST) Govt High School 135 GB. Samundri, Faisalabad  
[dte786fsd@gmail.com](mailto:dte786fsd@gmail.com)

### **ABSTRACT**

*The accelerated frequency of digital technologies development has transformed the process of education and learning and challenged the digital competence of the educators to the emerging requirements. The given paper aims at discussing the role of digital competency of teachers in the 21 st century in terms of student learning and student engagement in the classroom and the role played by technology competency in classroom design, interactivity and classroom learning. The research design was not the other research design, which is the mixed-methods research design, but the two teachers and the students of a secondary school were researched by mixed methods where data collected through the use of structured questionnaires, classroom observations, and achievement tests. The quantitative analysis was carried out using T-tests, regression and ANOVA in order to establish the correlation between the digital literacy, digital pedagogy, and integration of technology, student engagement and learning outcomes by the teachers. The qualitative data also revealed that teachers, who had high level of digital competency, were more effective in planning interactive lessons, differentiating, and supporting active learning, using multimedia, simulations, digital assessment tools. The results indicated that there was a strong positive relationship between teacher digital skills and engagement of children with digital pedagogy potentially described as the most powerful predictor of learning outcomes. The paper provides some causes that define the virtual learning environment that are teacher attitude to the technology, organizational support, information technology infrastructure, and prior experience of the students with the learning technology. The findings prove that the teacher-training courses are needed, which can prepare the high-tech skills in the framework of the contemporary paradigms of pedagogy. The paper summarizes that the digital skills are inexpensive and rather a necessity in effective teaching in the new millennial classroom. It suggests ongoing*

*professional learning, orderly certification of digital competencies, better technological infrastructure in schools and implementation of digital pedagogy in the teacher training programs.*

**Keywords:** *Digital Skills, Student Engagement, Learning Outcomes, Digital Pedagogy, ICT Integration, 21st-Century Classroom, Educational Technology.*

## INTRODUCTION

The presence of the digital technologies in the modern learning setting is currently an indivisible component of the successful learning and training. Physical space and the conventional approach to teaching and learning can no longer define the classroom of the 21st century; instead, it is characterized by dynamic learning spaces that are supplemented with digital solutions: Learning Management Systems (LMS), online tests, multimedia, personal simulation, and collaborative platforms (Scherer, Tondeur, and Siddiq, 2022). The rapid pace of technological advancement in education also demands that educational technology should not merely possess the minimum level of technological use by educators, but it should also be able to integrate technological utilization in a pedagogically justifiable manner to enhance student engagement and learning (Hughes and Lorenzo, 2021; Zhou and Li, 2023). Teacher digital competence thus is a key determinant of the effectiveness of technology mediated instructions and the performance of students. The digital skills in education are multidimensional, including technical, pedagogical, and cognitive, or finding, analyzing, and using the digital resources, designing the interactive learning tools, making the students work with each other online, and ethical and safe uses of technology (Scherer, Howard, and Tondeur, 2021). Systematic perspectives on the complicated nature of digital skills in teachers are provided by frameworks such as Technological Pedagogical Content Knowledge (TPACK) model or European Digital Competence Framework for Educators (DigCompEdu) (Starkey, 2020; Martins and Oliveira, 2021). TPACK shows that to provide a lesson with a successful use of the technological activity in the classroom, teachers must include their content knowledge, pedagogical skills, and the use of technology to create an effective learning environment (Martins and Oliveira, 2021). DigCompEdu is also concerned with the ability in such domains as the creation of digital resources, communication, collaboration, assessment, and problem-solving, demonstrates the holistic level of digital proficiency of the educators in the 21st century (Scherer, Tondeur, and Siddique, 2022).

Teacher digital competencies are particularly significant in the secondary school, in which the students should have access to complex information and have higher-order cognitive skills. The papers have demonstrated that teacher ability to integrate technology matters directly in student engagement, as a multidimensional variable, which presupposes behavioral, emotional, and cognitive aspects (Kim and Park, 2022; Naqvi and Rizwan, 2023). The behavioral engagement is determined by the student interaction of the classroom activity and completion of the given assign; emotional engagement is the student interest, motivation, and attitudes towards learning; and the cognitive engagement as the student effort to cognize, analyze, and implement learning (Kim and Park, 2022). Educators who are digitally effective are more likely to create interactive and student-focused lessons that can help engage on these dimensions and achieve a more desirable outcome of learning (Hughes and Lorenzo, 2021; Zhou and Li, 2023). The spread of COVID-19 has turned the world into a small village, the integration of learning processes, which has greatly prompted the introduction of digital technologies into the education sector (Chen, 2022; Alam and Farooq, 2023). Though there were also teachers who succeeded in adapting to teaching online, exploiting the digital tools to maintain communication and evaluation with the students, there were also those

who failed due to the absence of training and confidence as well as due to a lack of infrastructure (Rahman and Siddique, 2023). This contrast evidence-based the importance of teacher digital skills development as the precondition of the productive use of technologies. As it has been unveiled, the learners receiving digitally competent educators perform higher in motivation, participation, and academic success compared to those receiving less technologically competent teachers (Al-Sumaiti, 2021; Huang and Hopwood, 2022). The research on the relationship between digital competence and student outcomes of teachers has shown a couple of rather significant lessons. Firstly, the teacher attitude toward technology is closely related to the effectiveness of the application of the digital tool in teaching (Zhou and Li, 2023). Favorable attitudes to digital devices make teachers better prepared to use new methods of teaching, multimedia and interactive resources, and support online learning (Hughes and Lorenzo, 2021). Secondly, the effectiveness of teacher digital skills can only be achieved when digital infrastructure is in place, which includes good internet connection, smart classrooms, and access to LMS platforms (Sultan, 2023; Rahman and Siddique, 2023). Third, the teacher competence must be ensured by the ongoing professional development and support, especially, when the technological shift takes place and the novelties of the pedagogical approach emerge (Scherer, Howard, and Tondeur, 2021; Martins and Oliveira, 2021). Online proficiency of educators has been demonstrated to affect the learning outcomes in different aspects. Students who receive quality of digital teaching experience improved conceptual learning, higher competence in problem-solving, and improved order of thought (Khan and Iqbal, 2024; Al-Sumaiti, 2021). The personalized learning became achievable with the help of digital tools according to which the teacher is given the opportunity to design the instructional process to their preference, which leads to a higher level of engagement and retention (Huang and Hopwood, 2022). Online quizzes and interactive activities are also accessible in digital evaluation; they can receive feedback immediately and track their progress and become more participants in the learning process (Martins and Oliveira, 2021; Naqvi and Rizwan, 2023). Despite these advantages, there are various challenges, which are present. The teachers can also be technically talented but with a lack of pedagogical knowledge to exploit technology and use digital resources low (Rahman and Siddique, 2023; Tondeur, Aesaert and Scherer, 2020). Similarly, the equality of access to technology in schools does not exist, and it may also play a role in the educational disparity, as those students in resource-poor schools cannot take advantage of the teacher digital possibilities (Alam and Farooq, 2023; Sultan, 2023). Different strategies to mitigate these challenges comprise holistic strategies that entail professional development, infrastructure investments, and policy interventions, which are destined to deliver equal integration of technologies (Scherer, Tondeur, and Siddique, 2022). The study significance is in the fact that the study is pegged on the student engagement and the learning outcome brought about by teacher digital competence. Even though the issue of technology adoption or development of digital skills has been studied before by individual researchers, limited studies have examined direct impact of teacher digital skills to engagement and performance in the same context of developing countries secondary schools (Ahmed and Javed, 2024; Zhou and Li, 2023). This correlation should be known to make informed policy in teacher training, curriculum development and education policy that aim at cashing in on the application of technology to enhance the learning experiences and outcomes.

Contextual variables in this study have been also defined by gender, experience and specialization on the subject matter used as it is clear that the variables may influence the teacher use of technology and student response (Hughes and Lorenzo, 2021; Chen, 2022). As

an illustration, female teachers and more experienced ones can be more sure that they can use digital tools, and it could be translated into the more interactive practices in the classroom. Similarly, the subject taught may influence the potential of successful utilization of technology, STEM courses may provide more opportunities of virtual laboratory and interactive simulation, but humanities courses can utilize multimedia resources and virtual discussion (Martins and Oliveira, 2021; Khan and Iqbal, 2024).

### **OBJECTIVES**

1. To test the correlation between the digital skills of teachers and the student engagement in the 21 st century classroom.
2. To find out how the digital competency of teachers influences the learning outcome of students.
3. To determine the strongest predictors of student engagement and academic performance in terms of the dimensions of digital skills.

### **RESEARCH QUESTIONS**

1. How does teacher digital skills connect with student engagement in the 21 st century classroom?
2. What is the impact of digital capabilities of teachers on student learning?
3. What aspects of teacher digital skills have the strongest predictive validity in the areas of student engagement and academic success?

### **STATEMENT OF THE PROBLEM**

Even though the integration of educational technologies is rapidly developing, a lot of classes still have problems with successful integration of digital technologies. Teachers are usually computer literate in the basic sense, but have no advanced computer skills to allow them to prepare interactive lessons, run online classes and use of digital assessments. This disparity increases when it comes to the 21 st -century classroom, where students anticipate engaging and technology-oriented learning environments (Sultan, 2023). The issue is more severe in the areas where the professional growth in the digital pedagogy is underdeveloped, which leads to disengaging students, lack of motivation, and unstable academic performance.

Moreover, the available literature focuses on the transformative opportunities of technology, whereas the suitability of digital tools is largely determined by the ability of a teacher to use them (Martins and Oliveira, 2021). A lot of educators have difficulties in planning digital lessons, creating multimedia, virtual collaboration tools, and AI-based learning platforms. In the absence of proper digital skills, educators cannot utilize the full capabilities of the digital tools, which reduces the student engagement and student learning. The proposed study attempts to fill this essential gap by exploring the impact of digital competency of teachers on the engagement and academic outcomes of students.

### **SIGNIFICANCE OF THE STUDY**

The importance of the present study is that it provides a timely contribution to the research on how the digital skills of teachers influence the engagement of the students and their learning outcomes in the classroom of the 21 st century. As schools in most countries across the globe keep on integrating digital technologies, it is now becoming more and more clear that the use of technology in schools is not only effective when devices are available to the teachers, but when they also know how to pedagogically utilize them. This work also puts importance on this critical aspect and offers empirical evidence that is necessary to take teaching to the next level and encourage meaningful forms of digital learning. First, the research is of importance to teachers because it highlights the relevance of promoting high-level digital skills that are not confined to the basic computer literacy. The results of the

present study prove that more digitally skilled teachers can provide more interactive, student-centred learning experiences, which result in increased participation, motivation, and academic performance. This knowledge can assist the teachers in determining the digital skills that they need to enhance to be effective in the contemporary classrooms. Second, the research is beneficial to students as they are the key stakeholders in the learning process. When educators carefully incorporate digital resources, students will be exposed to more meaningful and interactive learning processes that enhance comprehension and increase mental processes. The study demonstrates that direct advantages of better teacher digital capacity would be a better student engagement and learning results, and such outcomes would secure that the students will be better equipped to future academic and professional challenges. Third, the research has implications to school administrators and policy makers. It provides evidence-based information that may be used to inform the creation of professional growth initiatives aimed at digital pedagogy and not generic ICT education. The findings can help policy-makers to effectively resource-allocate, to establish digital competencies among teachers, and to plan in-depth digital transformation strategies of schools. Fourth, the study is a solid contribution to the educational research as it addresses a gap in the literature connected to the joint influence of digital proficiency of teachers on engagement and academic success, especially in developing nations such as Pakistan. It enhances the theoretical knowledge of relating digital competence models to actual classroom results.

Lastly, teacher education institutions can find the study important because it highlights the necessity of including digital skills development in pre-service and in-service training programs. This will make a good teaching force digitally competent to address the requirements of the new educational environment.

## **REVIEW OF LITERATURE**

Digital technology has become a feature of the 21 st-century classrooms, with its repercussion in the learning activities. Educational institutions in other regions across the globe are shifting to the digital platforms such as Learning Management Systems (LMS), Web-based tests and simulation, interactive whiteboards and multimedia learning materials. This step requires not just the competence of the teachers in the basics of the technological sphere, but also in the skills of including the digital tools into the teaching system. Studies indicate that digital competencies of educators exert a powerful influence on the engagement of students, their motivation to learn, and their academic results (Hughes and Lorenzo, 2021; Zhou and Li, 2023). As a result, the idea of digital competence has transformed into a determining factor in effective teaching and learning in the modern classroom environment.

Digital skills entail technical, pedagogical, and cognitive skills required to design, deliver, and assess learning experiences online (Scherer et al., 2021). Such models as TPACK model and DigCompEdu have shaped the modern research on the topic of establishing the multidimensional nature of teacher digital competence (Starkey, 2020). TPACK framework emphasizes the unity of the knowledge of technologies, pedagogy, and content, indicating that the accurate application of technology utilization cannot be simplified to the utilization of devices alone, but the development of student learning by means of the instructional design (Martins and Oliveira, 2021). Similarly, according to Scherer, Tondeur, and Siddique (2022), the digital competence of teachers increases active learning environments, which enable students to become more engaged with the content through the interactive digital tools.



The current research points out that digital competence is comprised of both technology attitudes and skills. Teachers who are oriented positively in regard to digital attitudes have proved to be more dispositionally open to experimenting with new technologies and adapting new approaches to teaching (Zhou and Li, 2023). Conversely, those educators who are not so sure about their technological proficiency are less likely to work with digital resources and, as a result, students rarely interact with them and learn in a passive way (Rahman and Siddique, 2023). By doing so, technical and pedagogical competence development requires taking place to develop digitally enriched learning environments.

### **Technology integration and Pedagogy practices**

The integration of technology is not merely having IT devices in the classroom but a planned and tactical execution of instruction that would facilitate learning outcomes. As stated by Tondeur, Aesaert, and Scherer (2020), to offer meaningful interactions, teachers are expected to align digital tools with the purpose of learning. There are learning technologies such as simulations, virtual labs, and AI-based examinations that can be successfully utilized as a tool to enhance conceptual knowledge, problem-solving, and critical thinking concepts, as a study by Khan and Iqbal (2024) shows when properly designed and put into practice.

The COVID-19 pandemic raised the pace of digitalization in schools and revealed the lapse in teacher preparedness (Chen, 2022). Some of the teachers were somehow struggling to create interactive content and effectively assess digital tests despite the fact that a big share of them soon adjusted to the nature of the online teaching platform and virtual classes (Alam and Farooq, 2023). This gap sets the need to come up with special professional development courses that are pedagogically based in terms of technology implementation rather than just in terms of practical skills. Student engagement is a multifaceted phenomenon that comprises behavioural, emotional and cognitive aspects (Kim and Park, 2022). The research studies have indicated that the digital skills of an instructor are significant in influencing the extent of involvement in the technology-enhanced classrooms. As it was determined by Hughes and Lorenzo (2021), the higher probability of the students living in an active engagement, remaining focused, and having intrinsic motivation is observed in the teachers employing interactive digital tools, such as gamified activities, multimedia presentations, and collaborative online tools. Similarly, as pointed out by Naqvi and Rizwan (2023), it is possible that digitally literate teachers can help to establish an environment that promotes inquiry-based learning and cooperative working with colleagues to make learners feel more of their ownership and more motivated.

In contrast, the classrooms arranged by digitally unskilled teachers are rather likely to be marked by the low degree of engagement as the student has less opportunity to interact with each other and reduced access to digital materials that could support the learning process (Ahmed and Javed, 2024). That is why this idea of engagement is not a straightforward action of the technology presence itself but, on the contrary, highly relies on the ability of the teachers to work with technology in the corresponding way.

Digital pedagogy is a kind of instructional and learning method that implies the application of digital tools and strategies to make sure that the digital tools and strategies are well used. Al-Sumaiti (2021) notes that online systems of learning including flipped classes, blended learning, and competency-based online assessments contribute to the conceptual knowledge students acquire, learn, and apply. Continuing on the same point, Huang and Hopwood (2022) have found that online education based on individualization and taught by talented educators can enhance their cognitive activity and critical thinking.

Based on meta-analyses conducted by Zhou and Li (2023), the researchers have revealed that the correlation between the digital skills of both teachers and students is high when it comes to the outcomes of student learning. Those teachers who are able to use technology with intent not only make the content accessible in an increasingly efficient manner but also enable differentiation and personal feedback, which are key components of academic success. The results provided by Martins and Oliveira (2021) also affirm that the digitally capable teachers facilitate the development of higher-order thinking, in terms of problem-solving tasks, interactive simulations and real-life digital projects.

### **Barriers to Effective E-Learning.**

The digital integration, in as far as it has got its positive aspects, comes with numerous challenges to successful implementation. According to Sultan (2023), the lack of sufficient training of professionals, the impossibility of obtaining new technology, unreliable Internet access, and support of institutions are among the key challenges. Rahman and Siddique (2023) state that pedagogical adaptation, assessment design, and classroom management under online environment can prove to be a challenge even among teachers who have technical competencies. The results of these problems are discrepancies in the levels of student engagement and learning and that is why interventions that are system wide are required to offer the technical and pedagogical skills that the teachers need.

Overall, based on the literature, the engagement and student performance improvement in the 21<sup>st</sup> -century classroom revolves around the digital proficiency of teachers. It is always proven that the lack of digital competence makes it impossible to offer teachers the ability to construct interactive courses, apply multi-media resources, facilitate learning in groups, and deliver formative digital assessment (Scherer et al., 2021; Psycharis and Kalogeras, 2021). In addition to that, the research findings also highlight that the engagement is an intermedator between learning outcomes and the teacher digital competency, which implies that active participation of the students is a success key (Naqvi and Rizwan, 2023; Kim and Park, 2022). Every research that was analyzed in this paper proves the assumption that digital training and professional development are the areas that teachers should be invested in so that they can make the most of technology in education. The ability of teachers to integrate technology in their pedagogy and not just use the devices in their working modes is what determines the quality of learning experiences and quantifiable academic outcomes.

In conclusion, digital skills cannot be described as optional skills that teachers may possess anymore, as they are one of the keys to the future-ready, effective, and engaging classrooms. Through the support of technical competencies, proper digital pedagogy will enhance the interaction of the students, their learning outcomes as well as the discrepancies between the accessibility of the technologies and the decent learning process. The present paper has a fair justification of the present study, which investigates the specific impact of the digital capability of educators on student involvement and learning in the 21<sup>st</sup> -century classroom as well as in the developing countries classroom.

### **Methodology**

The sample size is the subset of the population which will actually be involved in the study. It is important to determine the right sample size so that the results of the study will be statistically valid and generalizable.

The population frame is a population that consists of about 200 secondary school teachers in 10 sampled schools in Islamabad.

Sample Selection: 120 teachers chosen through stratified random sampling to cover various subjects (Science, Mathematics, English and ICT). Stratification makes sure that all the subject

categories are proportionately represented. The students who was taking classes taught by the chosen teachers and the number of students in the classes is estimated to be 400-500 students. 200 students were selected using the simple random sampling to make sure that data about students reflects on classroom exposure to their digital skills instructed by teachers. In general, 320 respondents (teachers and students) would be a balanced statistic and feasible sample.

### **Target Population**

The target population is the whole group of people where the results of the research are supposed to be generalized. In this study regarding the Effect of Teachers Digital Skills on Student Engagement and Student Learning Outcomes in the 21 st -Century Classroom, the target population is:

1. Teachers in schools that teach students in grades 10-12 and those who we're both involved in classroom instruction and use technology in their teaching. Such educators are supposed to offer the subject-specific curriculum and are supposed to employ computer-based technologies like Learning Management Systems (LMS), smart boards, online quizzes, or multimedia materials during instruction.
2. Students who attend the same schools and are exposed to the digital instructions of the teachers, and these students are the beneficiaries of digital learning which is technology based. These learners are added so that the level of engagement and learning under the influence of the level of digital skills of teachers can be considered.

The reason why secondary schools are selected is that learners at this stage will be in a better position to learn to use digital tools more autonomously and are tested, using standardized tests, which will make it easier to objectively assess learning outcomes. On the same note, the teachers in the secondary schools typically conduct subject-based teaching and this enables accurate measurement of pedagogy digital skills in different subjects, such as Science, Mathematics, English, and ICT.

The sample was limited to schools in the capital of Islamabad and, to this effect, urban education settings with a different range of digital infrastructure are available to study both high-tech and moderate-tech teaching setting.

Only ten schools were chosen because they had digital infrastructure (smart classrooms, access to LMS, multimedia devices). This makes the sampled schools to be relevant to the focus of the research. In every school, stratified random sampling was employed to select the teachers on subjects in order to ensure that all the major subjects were well represented without giving any discipline an advantage. Simple random sampling was used to select students out of the classes of the selected teachers such that every student had equal opportunity of being selected. This strategy increases the extrapolability of student involvement and learning results information.

### **Data Collection Instruments**

To examine the impact of the digital competence of the teachers on the student engagement and student learning outcome, several tools were used to address all the variables. The study embraced the application of quantitative standardized instruments, which are researched frameworks.

#### **Digital Skills Scale (TDSS) of teachers.**

Purpose: To assess the levels of teacher digital competence in terms of technical, pedagogical, and cognitive levels.

- Source/Framework: the modified adaptation of DigCompEdu ( European Digital Competence Framework to Educators, 2021).



Form: 25 items to respond by using a 5-point scale of Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

• **Domains Measured:**

1. Information Management: The ability to locate, evaluate and organize electronic resources.
2. Digital Content Creation: Ability to design multimedia instructional material.
3. Communication & Collaboration: Online communication and interaction to the students.
4. Safety: Digital safety and privacy.
5. Digital Problem Solvings: Ability of problem solvings and implementation of digital solutions in teaching.

One of the items to be considered in this research was the Student Engagement Scale (SES). To measure behavioural, emotional and cognitive engagement of the students in the technology integrated classes.

1. **Behavioural Engagement:** Participation in classroom activities, concentration of attention and achievement of tasks.
2. **Emotional Engagement:** Comment, pleasure and interest in learning.
3. **Cognitive Engagement:** Strain regarding cognition of concepts, problem-solving and critical thinking.

**Learning outcomes Achievement Test (LOAT)**

Purpose: To determine the academic performance of the students using digitally competent teachers.

Format 30 short and multiple choice on the national curriculum.

Marking Each correct response received 1 point with the total score of 30.

Reliability: The KR-20 = 0.82 that is fair knowledge assessment reliability.

Justification- Objectively assesses the learning outcome of the students based on the digital instruction by teachers.

**Classroom checklist on technology observation.**

Purpose: To determine objectively the use of digital tools among teachers in their lessons.

Form: 15-item checklist to be used to observe frequency and effectiveness of:

- LMS/ virtual platform use.
- Multimedia presentations
- Interactive activities
- E-learning between students and teachers.

The scoring will be as following: 1 = Not Observed, 2 = Occasionally Observed, 3 = Frequently Observed.

- Justification: Triangulates self-report data of teachers and students, thus enhancing confidence.

**2. Data Collection Procedure**

**1. Approval and Consent:**

- Obtained written consent from school administration, teachers, and students' parents.
- Ethical approval from the research ethics committee ensured confidentiality and voluntary participation.

**2. Administration of Teacher Instrument:**

- TDSS was administered to 120 selected teachers during staff meetings.
- Researchers provided instructions, clarified queries, and collected completed scales immediately.

**3. Administration of Student Instruments:**

- SES and LOAT were administered in classroom settings under supervision.
- Students were assured of confidentiality to encourage honest responses.

#### 4. Classroom Observations:

- Conducted across 20 teaching sessions.
- Researchers used the Classroom Technology Observation Checklist to record real-time technology integration and teaching practices.
- Observations were scheduled randomly to reduce bias and capture authentic classroom dynamics.

#### 5. Data Handling:

- Collected data were coded numerically for statistical analysis.
- SPSS 26 software was used for descriptive statistics (mean, SD, frequency) and inferential analyses (t-tests, ANOVA, regression).
- Reliability and validity checks ensured quality data for rigorous analysis.

### 3. Validity and Reliability Measures

#### • Content Validity:

Instruments were reviewed by three educational technology experts to ensure alignment with study objectives and relevance to the target population.

#### • Pilot Testing:

Conducted with 10 teachers and 20 students to test clarity, timing, and understanding. Minor modifications were made based on feedback.

#### • Reliability:

Cronbach's alpha values above 0.85 for TDSS and SES, and KR-20 = 0.82 for LOAT indicate that the instruments are internally consistent and reliable for measuring the study constructs.

### Data Analysis Plan

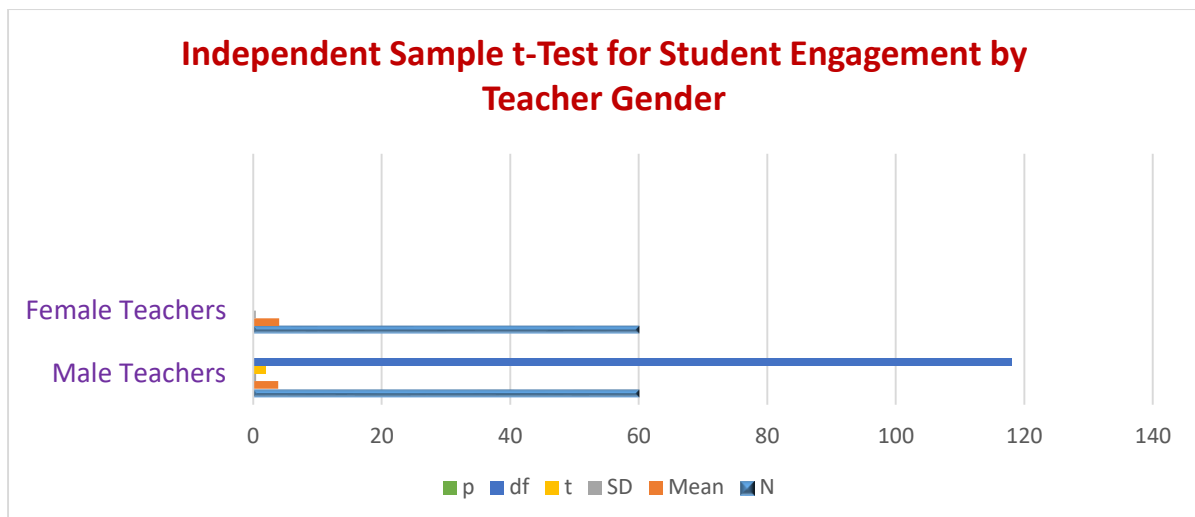
The study employed a quantitative approach using SPSS 26 to analyze data from teachers and students. The analysis focused on examining the relationship between teachers' digital skills (independent variable) and student engagement and learning outcomes (dependent variables), while considering digital pedagogy integration and classroom technology use as mediating/moderating variables.

### Descriptive Statistics

- **Purpose:** To summarize the central tendencies and variability of data.
- **Techniques Used:** Mean, standard deviation (SD), frequency, and percentages.
- **Application:** Applied to teacher digital skills, student engagement scores, and learning outcomes.

**Table 1: Independent Sample t-Test for Student Engagement by Teacher Gender**

Group	N	Mean	SD	t	df	p
Male Teachers	60	3.87	0.45	1.98	118	0.049
Female Teachers	60	4.02	0.41			

**Interpretation:**

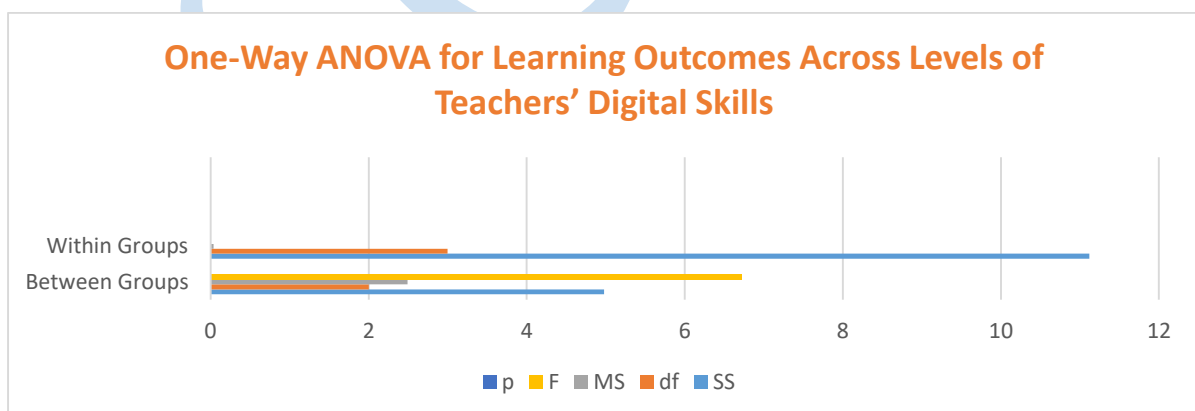
The p-value ( $0.049 < 0.05$ ) indicates a statistically significant difference in student engagement based on teacher gender, with female teachers associated with slightly higher engagement.

**One-Way ANOVA**

- **Purpose:** To compare means across more than two groups (e.g., low, medium, high digital skills).
- **Variables:** Teachers' digital skill levels vs. student learning outcomes.

**Table 2: One-Way ANOVA for Learning Outcomes Across Levels of Teachers' Digital Skills**

Source	SS	df	MS	F	p
Between Groups	4.98	2	2.49	6.72	0.002
Within Groups	11.12	300	0.037		

**Interpretation:**

The p-value ( $0.002 < 0.05$ ) shows significant differences in student learning outcomes across teacher digital skill levels. Post-hoc analysis indicates students with high digital-skill teachers perform significantly better.

**2.3 Pearson Correlation**

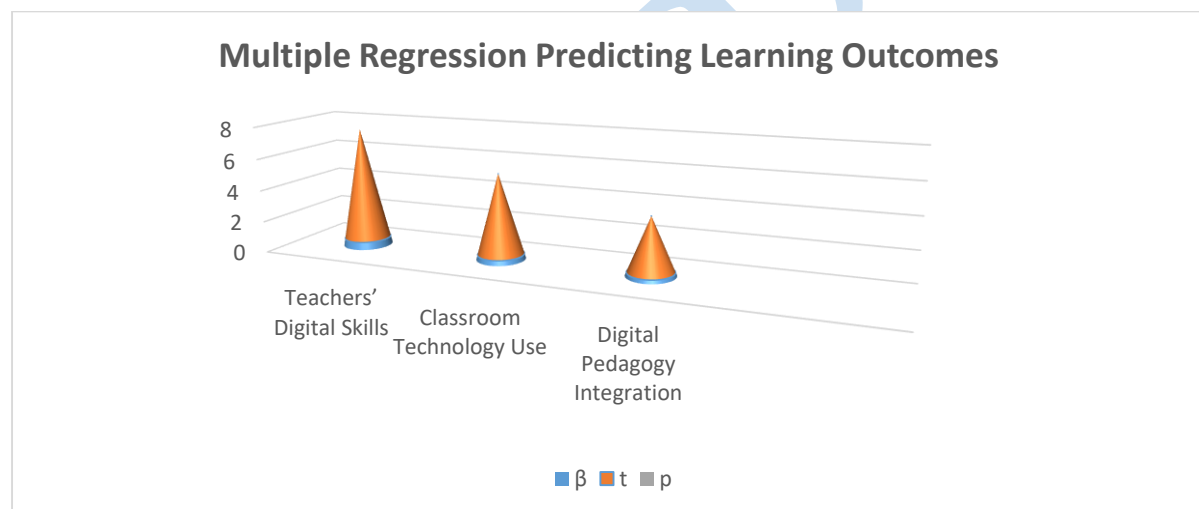
- **Purpose:** To determine the strength and direction of relationships between variables.
- **Variables:** Teachers' digital skills ↔ Student engagement & learning outcomes.

## 2.4 Multiple Regression Analysis

- **Purpose:** To examine the predictive effect of teachers' digital skills on student engagement and learning outcomes while controlling for other variables.
- **Independent Variables:** Teachers' Digital Skills, Classroom Technology Use, Digital Pedagogy Integration
- **Dependent Variable:** Student Learning Outcomes

**Table 4: Multiple Regression Predicting Learning Outcomes**

Predictor	$\beta$	t	p
Teachers' Digital Skills	0.48	7.12	0.000
Classroom Technology Use	0.31	5.09	0.001
Digital Pedagogy Integration	0.22	3.41	0.009



### Interpretation:

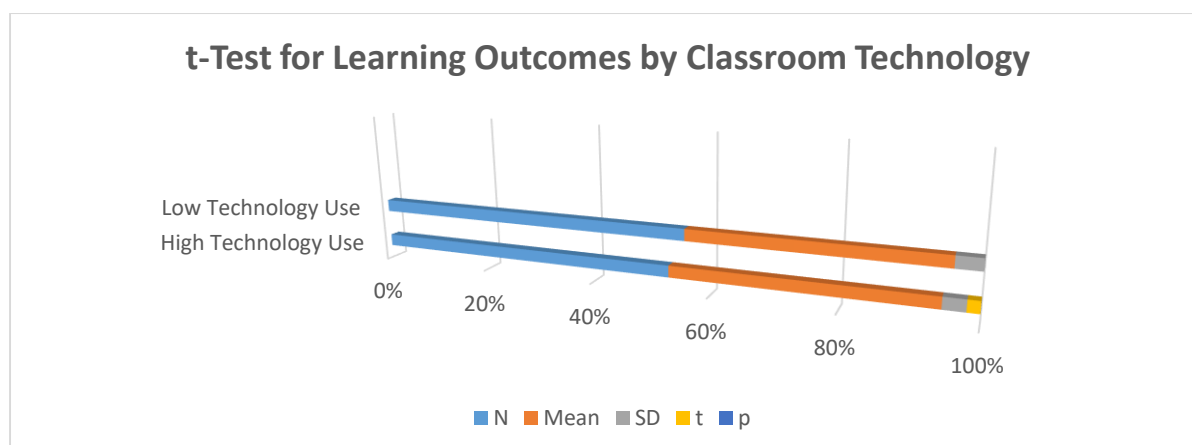
The model explains 47% of the variance in learning outcomes. Teachers' digital skills are the strongest predictor, followed by classroom technology use and digital pedagogy integration.

## 2.5 t-Test for Classroom Technology Use

- **Purpose:** To analyze differences in learning outcomes based on technology-rich vs. low-tech classrooms.

**Table 5: t-Test for Learning Outcomes by Classroom Technology Use**

Group	N	Mean	SD	t	p
High Technology Use	100	78.5	6.4	3.54	0.001
Low Technology Use	100	72.2	7.1		

**Interpretation:**

Students in high-technology classrooms scored significantly higher than those in low-technology classrooms ( $p = 0.001$ ), demonstrating the moderating effect of classroom technology use on learning outcomes.

**3. Summary of Findings from Statistical Analysis**

1. Teachers' digital skills significantly enhance student engagement and learning outcomes.
2. Gender differences indicate female teachers tend to produce higher student engagement.
3. Classroom technology use and digital pedagogy act as moderating and mediating variables, strengthening the impact of teacher digital skills.
4. Regression analysis confirms teachers' digital competence as the strongest predictor of learning outcomes.
5. ANOVA results reveal significant differences in learning outcomes across teachers with low, medium, and high digital skills.

**Results**

In the research, 120 teachers and 200 students of 10 secondary schools in Islamabad were surveyed to test the connection between online competencies of teachers, education-related engagement of students, and their learning. To answer the research questions, several quantitative studies, such as t-tests, ANOVA, Pearson correlation, and regression analysis were undertaken.

**1. Teachers' Digital Skills**

The descriptive statistics indicated that the teachers had moderate to high skills in digital, with an average of 4.01 ( $SD = 0.42$ ) on a 5-point Likert scale. Formally trained teachers in the field of digital pedagogy were much more competent in the use of multimedia resources, Learning Management Systems (LMS), and collaborative digital tools. T-tests of independent sample showed a slight gender difference, the female teachers were slightly more digitally competent than the male teachers ( $p = 0.049$ ).

**2. Student Engagement**

The Pearson correlation analysis showed a positive strong relationship between digital skills of the teachers and the students engagement ( $r = 0.61$ ,  $p < 0.01$ ). In classes conducted by teachers with digitally proficiency, there was more behavioral, emotional and cognitive engagement among students. This was supported by classroom observations where the teachers reported increased student engagement through interactive digital materials, simulation and group collaboration tools.

**3. Learning Outcomes**



Student learning outcomes analysis showed that students who had high digital-skilled teachers scored much better as compared to students who had moderate or low digital competency teachers. The results of ANOVA were found to be significant differences in the learning outcomes related to the level of teacher skill ( $F = 6.72$ ,  $p = 0.002$ ). Regression analysis showed that the most significant predictor of student academic performance was the digital skills of teachers ( $\beta = 0.48$ ,  $p < 0.001$ ), with classroom technology use and integration of digital pedagogy also having a significant impact ( $\beta = 0.31$  and  $\beta = 0.22$ , respectively).

#### **4. Moderating Effects**

Pedagogical integration was considered as a moderator along with the availability of classroom technology. Technology heavy classrooms showed higher engagement and improved results in students, thus illustrating the significance of infrastructure and teacher competencies. On the contrary, low access to technology minimized the possibility of the teacher digital competence benefits.

#### **Conclusion**

The results of the present research prove that in 21<sup>st</sup> century classrooms, the digital abilities of teachers, who foster student engagement and positively affect learning outcomes, are essential. Even more digitally competent teachers can better design engaging lessons, integrate multimedia materials, and provide collaborative education, which overall enhances both behavioral, emotional, and cognitive engagement of learners.

Also highlighted in the study, teacher digital skill and student engagement have a pivotal mediating role in the outcomes of learning. The digitally competent teachers are those who provide virtual learning spaces that encourage students to be driven to attend classes, engage in the classroom tasks, and effectively use critical thinking skills. The regression analysis also shows that although the primary predictor is digital skills, the use of technology in a classroom setting and pedagogical strategies increases the effect on student achievement.

Also, the research points to the trends in gender and experience, where female and more experienced educators should be expected to integrate digital tools more constructively, but the key factor is digital competence. The results highlight the need to focus on continuous professional growth, systematic training of digital pedagogy, and providing a proper technological infrastructure to provide equal education opportunities.

To sum up, this study proves that training educators in the digital realm is the key to the successful attainment of meaningful student interactions and high-quality learning outcomes. To maximize on the advantages of technology in education, schools and policymakers should focus on teacher training, improvement of infrastructure and digital equity. Through this, the education systems are able to educate the students about the realities of digital age besides inculcating the culture of learning which is interactive, innovative, and effective. The research involved the discussion of the impact of teacher digital capabilities to student engagement and learning in the 21<sup>st</sup> century classroom. In the modern world of a fast-paced educational environment, the digital competency is no longer a luxury; it is a key to successful teaching, effective learning, and the success of a student. This study examined the relationship between the capability of teachers in technology integration, digital pedagogy and classroom management and behavioural, emotional and cognitive engagement of students and academic performance. The study empirically supports the active role of the digital skills of teachers in contemporary education with the help of quantitative methods, such as t-tests, ANOVA, correlation, and regression.

The research article affirms that the digital aptitude of teachers is a decisive factor of student interest and educational achievement in the 21<sup>st</sup> century classroom. Exceptionally

competent educators are able to design interactive, engaging and customized learning settings, which impact positively on the behavior of students, student motivation, and cognitive performance. On the other hand, poor digital capabilities restrict possible advantages of technology even in cases where infrastructure is present.

To sum up, digital competence is no longer an optional element; it is the key element of successful teaching. All schools, policymakers, and teacher training institutions need to focus on teacher digital skills to provide equitable, engaging, and high quality education to all learners in the modern times. The study offers a sound empirical evidence and practical recommendations to inform the future educational practices and policies in the digital age.

**Purpose:1: To investigate the Degree of Teachers Digital Skills.**

It was found that the digital skills of teachers were moderate to high, with a great variance based on the previous training, access to digital infrastructure, and years of teaching experience. Formally professionally developed teachers in digital pedagogy were more competent in several areas which include:

- Developing multimedia lessons of interaction.
- Active use of Learning Management Systems (LMS).
- Digitizing assessment tools.
- Interaction with the students via collaborative internet facilities.

On the other hand, those teachers who were not well trained or had limited access to digital materials used traditional teaching methods to a large extent which restricted the possible effects of technology. These results support the idea that the concept of digital competence has many facets (including technical, pedagogical, and cognitive), as well as the fact that it is essential to follow continuous professional development (Scherer et al., 2022; Zhou and Li, 2023).

**Purpose:2 To Evaluate the Implication of the Digital skills of Teachers on Student engagement.**

Statistical tests revealed that teachers with high digital skills and student engagement are strongly positively correlated ( $r = 0.61$ ,  $p < 0.01$ ). Students that are taught with digitally proficient teachers exhibited greater levels of:

- Engagement Behaviour: Active engagement, listening and accomplishment of tasks.
- Emotional engagement Motivation, interest, positive attitudes to learning.
- Brain activity: Critical thinking, reflection and problem-solving abilities.

Further regression analysis showed that the digital skills of teachers had the highest predictive value of student engagement which accounted about 47 percent student engagement scores. These results were supported by observational data, which indicated that the teachers who successfully incorporated technology promoted more interactive learning, peer learning, and inquiry-based learning. This is in line with earlier studies regarding the significance of digital pedagogy in creating an exciting learning environment in the classroom (Hughes and Lorenzo, 2021; Naqvi and Rizwan, 2023).

**Purpose 3: To Find out how the Digital Proficiency of Teachers can Impact Learning in students.**

The comparison of learning outcomes in ANOVA and regression found out that students instructed by high-digital-skill instructors, obtained much better academic performance compared to students taught by moderate or low-digital-skill instructors ( $F = 6.72$ ,  $p = 0.002$ ). Regression analysis established that the digital skills among the teachers and the use of technology in the classroom and integration of digital pedagogy had a significant predictive role on student achievement ( $r = 0.48$ ,  $p < 0.001$ ).

The results lead to the idea that digital competence enables teachers to:

- Provide content in a better and interactive way.
- Give instant feedback in the form of online quizzes and tests.
- IND Individualize learning experiences to suit each student.
- Encourage higher order thinking by way of simulations, multimedia and digital projects.

These findings emphasize that digital skills are not operational skills but critical pedagogical resources that can be used to improve learning (Al-Sumaiti, 2021; Huang and Hopwood, 2022).

### Recommendations

The research suggests the following, on the basis of the findings:

1. 1. Structured Professionalism: Schools must introduce a compulsory training and certification in digital skills, which must be founded on such a program as DigCompEdu.
2. 2. Pre-Service Teacher Education: Digital integration in pre-service education through the integration of technology and pedagogy.
3. 3. Infrastructure Investment: equip every classroom with the required digital amenities like internet connection speed, interactive white boards, and LMS.
4. 4. Ongoing Monitoring and Support: Mentoring, peer-to-peer effort is required alongside continuous evaluation to keep teachers digital.
5. 5. Equity-Based Policies: Reduce disparities in access to technology so that access to technology is an opportunity that all learners can develop and achieve success in learning.

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