

Teachers' Competencies in Effective Technology-Enabled Assessment for Holistic Development of Students

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Abstract

The 21st century has witnessed a profound transformation in education with the integration of technology-enabled assessment. This study aims to identify the key competencies that teachers require for effective technology-enabled assessment for the holistic development of students at the secondary level of school education. A descriptive survey method was used for collecting data from 60 secondary school teachers in Suti, Murshidabad, West Bengal, through a self-constructed 5-point scale. The results highlight significant gaps in teachers' digital literacy, with a lack of formal training in educational software and applications and familiarity with learning management systems and online platforms for assessments. Teachers also face challenges in analyzing and interpreting assessment data, leading to difficulties in providing personalized feedback and adapting instructional methods. The study underscores the urgent need for teacher training and professional development programmes, specifically targeting digital literacy, data analysis, and the design of innovative assessments. Ethical considerations, including data privacy and the promotion of digital citizenship, are also identified as critical issues that require attention. By addressing these competencies, teachers can effectively implement the potential of technology-enabled assessments, foster vital skills in students and prepare them for success in the digital age. Ultimately, this study emphasizes the importance of empowering teachers to become agents of change through the development of their competencies, which can guide students towards becoming well-rounded and adaptable individuals in the ever-evolving digital world.

Keywords: Holistic Development, School Education, Secondary Level, Teachers' Competencies, Technology-Enabled Assessment

Introduction

The educational landscape of the 21st century has been profoundly reshaped by the integration of technology within teaching and learning practices. One of the most impactful advancements in this realm is technology-enabled assessment, which has emerged as a powerful tool that empowers educators to nurture the holistic development of students. In an era marked by rapid digital transformation, it is essential for teachers to develop the competencies required to effectively harness technology in the assessment process (Smith & Johnson, 2020).

Technology-enabled assessment provides educators with unparalleled opportunities to create personalized and engaging learning experiences. By leveraging interactive multimedia platforms, formative assessment tools, and sophisticated learning analytics, teachers can obtain real-time insights into students' progress and allow them to adapt their instruction to meet individual learning needs (Brown & Lee, 2021). This adaptability enhances the learning experience and fosters an environment where students can thrive academically and develop key skills. Beyond academic performance, the use

of technology in assessments supports the cultivation of critical life skills such as problem-solving, collaboration, critical thinking, and digital literacy (Garcia & Martinez, 2019). These competencies are crucial for students to succeed in an increasingly interconnected digital world. Furthermore, technology-enabled assessments empower students by encouraging self-directed learning and motivating them to take active ownership of their educational journeys. When teachers possess the skills needed to leverage these technological tools, they can act as agents of transformative change and guide students to become well-rounded, adaptable individuals prepared for future challenges.

Technology-enabled assessment is essential for the holistic development of students, as it goes beyond simply measuring academic performance and plays a critical role in nurturing social, emotional, and cognitive growth. Traditional assessment methods often focus solely on academic achievement, but technology-enhanced assessment methods allow for a more comprehensive approach, offering insights into a student's overall development. One of the primary advantages of technology-enhanced assessment is its ability to provide real-time feedback, which enables teachers to make timely instructional adjustments that meet the unique needs of each learner. By leveraging data-driven insights, educators can identify areas of improvement and celebrate achievements, thus fostering a continuous learning cycle that benefits students. Additionally, technology in assessments supports differentiated learning paths, allowing for personalized instruction that caters to the diverse learning needs of students. This adaptability ensures that each student is appropriately challenged, whether they need additional support or further

enrichment. As a result, technology helps create a more inclusive learning environment where every student, regardless of ability, has access to the resources and opportunities necessary for success. Another significant advantage of technology-enabled assessment is its role in promoting self-regulation and critical reflection—skills vital for lifelong learning. With access to immediate feedback, students can actively engage with their learning process, identify their strengths and weaknesses, and make adjustments to their approach. This self-awareness helps students become more independent and motivated learners, taking ownership of their educational journey. Moreover, technology-integrated assessment fosters the development of emotional intelligence and social skills. Through collaborative and project-based learning tools, students are encouraged to work together, solve complex problems, and communicate effectively. These experiences not only enhance their academic understanding but also teach valuable interpersonal skills, such as teamwork, empathy, and conflict resolution. These competencies are essential for students as they navigate real-world challenges in a rapidly changing and interconnected society. Ultimately, technology-enabled assessment serves as a powerful mechanism for developing well-rounded individuals who can navigate the complexities of the modern world (Albinson, Cetinkaya, & Orman, 2020). However, Effective implementation of technology-enabled assessment comes with its own set of challenges. Educators must address ethical considerations, including data privacy and security, and work to bridge the digital divide to ensure equitable access for all students (UNESCO, 2022). It is, therefore, essential for teacher training and professional development programmes to prioritize building digital competency, foster an understanding of ethical practices,

and empower teachers to navigate the complexities of digital tools and data responsibly.

This article highlights the significance of teachers' competencies in effective technology-enabled assessment for the holistic development of students. By embracing technology, teachers have the potential to revolutionize the educational experience, cater to diverse learner needs and foster essential skills for the future. As we continue to embrace the digital revolution in education, empowering teachers with the necessary competencies will be instrumental in maximizing the potential of technology-enabled assessment to shape the next generation of lifelong learners.

Objective of the Study

1. To identify the key competencies that teachers require for effective technology-enabled assessment for the holistic development of students at the secondary level of school education.

Research Question of the Study

1. What specific competencies do secondary school teachers believe are critical for implementing technology-enabled assessment effectively?

Operational Definitions of the Key Concepts:

Competencies of Teachers: In the study, teachers' competencies refer to their proficiency in utilizing digital tools and technologies to enhance assessment practices. The present study focused on the following five competencies of teachers for technology-enabled assessment: 'Competencies of Teachers in Digital Literacy and Technology Skills', 'Competencies of Teachers in Data Analysis and Interpretation', 'Competencies of Teachers in

Personalization and Differentiation', 'Competencies of Teachers in Pedagogical Practices and Innovative Assessment Design', 'Competencies of Teachers in Ethical Use of Technology in Assessment'.

Technology-Enabled Assessment: It refers to the integration of digital tools and platforms in the assessment process to evaluate and enhance students' learning. This approach encompasses a variety of methods, including online quizzes, interactive assessments, and digital portfolios that facilitate real-time feedback and data collection. This approach not only streamlines the assessment process but also fosters engagement and collaboration among students and supports their holistic development by promoting critical thinking, problem-solving skills, and digital literacy. The present study focused on technology-enabled assessment competencies of teachers at a secondary level of school education.

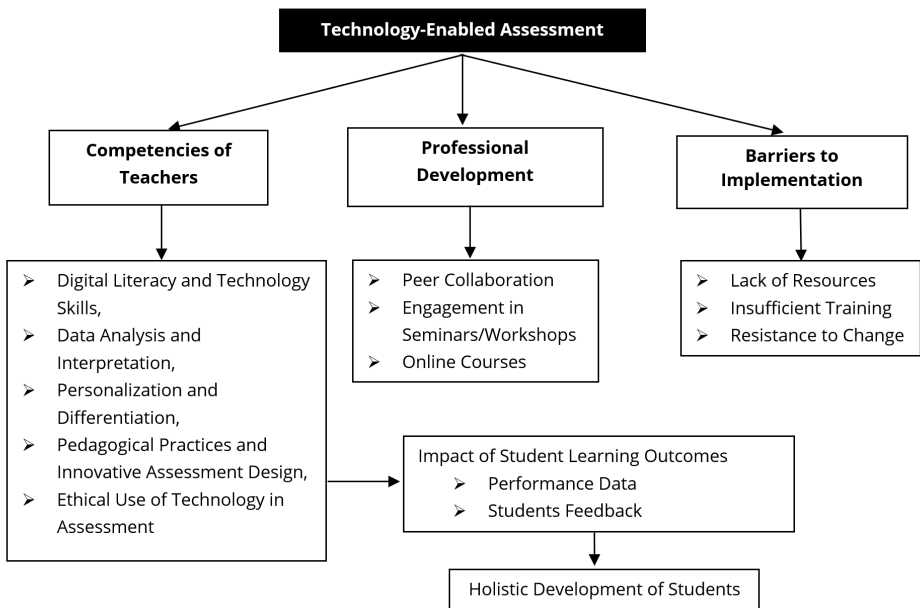
Holistic Development of Students: It refers to the comprehensive growth and maturation of learners across multiple dimensions, including cognitive, emotional, social, physical, and ethical aspects. This approach emphasizes the importance of nurturing the whole child rather than focusing solely on academic achievement. Holistic development promotes a balanced education that integrates various learning experiences, including collaborative projects, creative activities, and community engagement, allowing students to connect knowledge to real-world applications. By prioritizing holistic development, teachers aim to cultivate well-rounded individuals who are prepared to thrive in diverse environments and contribute positively to society. The present study highlighted on holistic development of secondary school students based on technology-enabled assessment.

Conceptual Framework

The conceptual framework presented here outlines the role of technology-enabled assessment in advancing educational outcomes through a structured, multi-dimensional approach. At the centre of this framework is the focus on 'Technology-Enabled Assessment', which acts as a bridge between teacher competencies, professional development, and the barriers associated with implementing technology in assessment. Each element in the framework supports the holistic development of students. Teacher competencies in 'Digital Literacy and Technology Skills', 'Data Analysis and Interpretation', 'Personalization and Differentiation', 'Pedagogical Practices and Innovative Assessment Design', and 'Ethical Use of Technology in Assessment'

are essential for creating effective learning environments. Professional development opportunities such as workshops, online courses, and peer collaboration equip educators with the necessary skills to adopt and integrate technology meaningfully. However, successful implementation often faces barriers, including a lack of resources, insufficient training, and resistance to change within educational institutions. Together, these components contribute to enhanced student learning outcomes, as technology-enabled assessment provides performance data and enables gathering of student feedback. This framework, therefore, emphasizes a collaborative approach to leveraging technology in assessment to drive holistic development and improve learning outcomes.

Figure-1: Conceptual Framework



Review of Related Literature

The integration of technology in assessment practices has increasingly gained attention as educators and

researchers recognize its potential to enhance student learning and support holistic development. Technology-enabled assessment not only facilitates real-time data collection but also

enables personalized feedback, aligning with the evolving educational needs of the 21st century (Hartnett, Brown, & Anderson, 2014). This shift towards technology is increasingly being seen as a way to promote more interactive and learner-centered approaches that emphasize the development of a broad range of student skills, including cognitive, social, emotional, and digital competencies (Gulikers, Bastiaens, & Kirschner, 2004).

Research emphasizes the need for teachers to develop digital competencies to navigate technology-enabled assessments effectively. Shute and Rahimi (2017) provide an overview of how formative assessments can be enhanced through digital tools, discussing platforms that support personalized feedback and adaptive learning paths. Their findings suggest that formative digital assessments help in identifying individual student needs, making real-time intervention possible, which is essential for promoting holistic development. Ertmer and Ottenbreit-Leftwich (2010) highlight that digital literacy and proficiency with educational tools are crucial for teachers to create engaging and adaptive assessments. Teachers' competencies in using technology for formative assessment tools and learning management systems can lead to enhanced student outcomes (Pawar & Yoon, 2021). However, studies indicate a general lack of training in these areas, as educators often lack the skills to analyze and interpret data, hindering personalized feedback and intervention (Fletcher, Iannucci & Scanlon, 2024). A study by Cifuentes, Maxwell, and Bulu (2011) points to the gap in teacher training programmes related to digital assessment tools. Their findings reveal that teachers often feel unprepared to integrate technology-based assessment methods due to limited exposure and training. Innovative assessment design facilitated by technology allows

teachers to move beyond traditional testing methods. According to William (2006), incorporating interactive and gamified assessments fosters critical thinking, problem-solving, and student engagement. These methods, when supported by technology, encourage students to actively participate in their learning journeys, which is essential for holistic development (Looney, 2019). Furthermore, technology-enabled assessment supports collaborative learning through peer reviews and group projects, enhancing skills necessary for success in the digital age. Collaborative assessments, when designed properly, offer opportunities for students to engage in meaningful interactions with peers, providing constructive feedback and developing skills in teamwork, communication, and conflict resolution. This collaborative aspect is particularly beneficial in developing social and emotional intelligence (Youngren, 2021). Despite its benefits, technology-enabled assessment presents challenges, including ethical considerations around data privacy and digital equity. UNESCO (2024) stresses the importance of teachers' awareness in navigating data privacy and promoting responsible digital citizenship among students. In regions with limited access to digital resources, a digital divide persists, creating inequalities in assessment experiences (Anderson & Kumar, 2019). Teachers must be equipped not only with technical skills but also with the ethical frameworks necessary to safeguard student data and ensure that all students have equal access to digital learning resources. Teachers' competencies in handling these ethical and logistical challenges are critical to ensuring that technology-enhanced assessment methods benefit all students equitably (Yadav, 2024). Professional development programmes are essential to bridging gaps in teachers' digital skills and enhancing their competencies in using educational

software and platforms. Darling-Hammond et al. (2017) suggest that continuous training enables teachers to adapt their instructional methods to accommodate technology-enabled assessment, ultimately supporting student growth. Effective teacher training should prioritize data analysis, personalized feedback strategies, and digital literacy, equipping teachers to manage and utilize technology-enhanced tools in a meaningful way (Guskey & Yoon, 2009). Selwyn (2016) examines the ethical dimensions of technology in education, emphasizing issues of student data privacy, consent, and the implications of data tracking. This study encourages schools to adopt clear policies and educate both students and teachers on responsible data practices to safeguard privacy.

The literature suggests that while technology-enabled assessment holds significant potential for holistic development of students, the effectiveness of these assessments hinges on teachers' digital competencies, innovative assessment strategies, and a strong understanding of ethical considerations. Addressing these competencies through targeted professional development can empower teachers to harness technology in ways that foster student success in a rapidly evolving digital world.

Significance of the Study

The significance of the study lies in its comprehensive exploration of five crucial categories that play a pivotal role in leveraging technology for the holistic development of students.

The study recognizes the importance of equipping teachers with digital literacy and technology skills. As technology becomes an integral part of education, teachers must possess the knowledge and confidence to navigate digital tools, platforms, and resources effectively. Understanding how to use technology for instructional purposes empowers

educators to create engaging and interactive learning experiences, enhancing student motivation and fostering a deeper understanding of concepts. Technology-enabled assessment generates a wealth of data that can inform instructional decisions. This study emphasizes the significance of teachers' competencies in analyzing and interpreting data derived from various assessment tools and platforms. By interpreting data insights, teachers can identify students' strengths and areas for improvement, providing personalized feedback and targeted interventions to cater to individual learning needs. Technology allows for personalized and differentiated learning experiences. The study highlights the importance of teachers' competencies in tailoring instruction to meet the unique needs and preferences of each student. By leveraging technology, teachers can adapt content, pace, and assessments to align with individual learning styles, fostering a more inclusive and effective learning environment. Effective technology-enabled assessment goes beyond traditional methods. This study emphasizes the significance of teachers' competencies in employing innovative assessment designs that align with pedagogical practices. By integrating technology into assessment, educators can move beyond conventional approaches, embracing formative assessments, interactive quizzes, and multimedia projects that facilitate active learning and deeper engagement. As technology integration in education expands, ethical considerations become critical. The study underscores the importance of teachers' competencies in adhering to ethical principles when using technology for assessment. Respecting student privacy and data security and promoting equitable access to technology are essential aspects that teachers must prioritize while employing technology-enabled assessment methods.

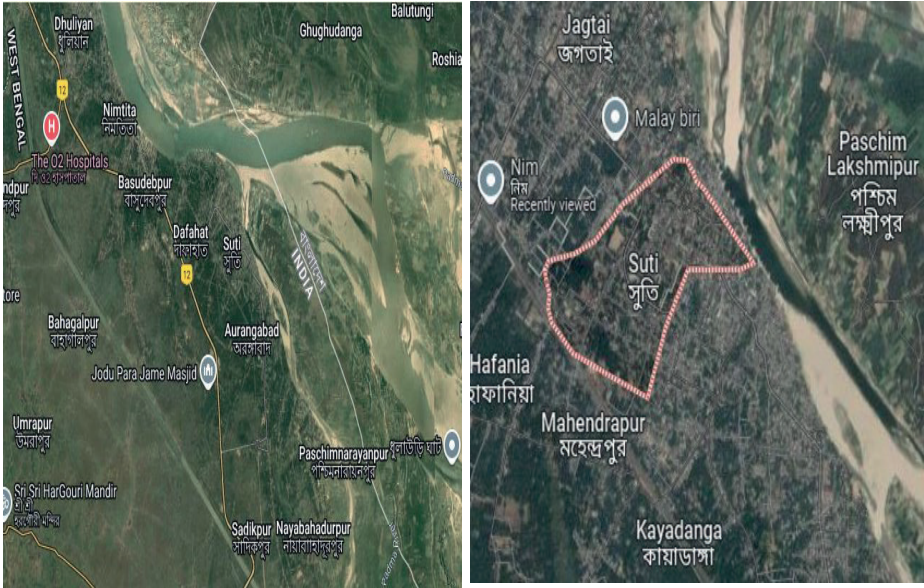
The significance of this study lies in its comprehensive focus on five key points that shape the successful implementation of technology-enabled assessment for the holistic development of students. By addressing digital literacy, data analysis, personalization, innovative assessment design, and ethical considerations, the research provides valuable insights and recommendations for educators, policymakers, and stakeholders. Embracing these competencies empowers teachers to leverage technology as a powerful tool for enhancing student learning experiences, fostering comprehensive growth, and preparing the next generation of learners for the challenges of the digital age.

Context of the Educational Setting

Suti, located in the Murshidabad district of West Bengal, is a rural area where 'Beedi Industry' plays a dominant role in

the economy. Here, secondary education faces challenges such as limited access to digital infrastructure, including internet connectivity and modern devices. Teachers often lack formal training in educational technology, hindering their ability to implement technology-enabled assessments effectively. Despite these obstacles, government initiatives like Digital India are gradually improving access to technology in the region. However, the rural setting also presents opportunities for collaborative learning, where teachers and students can support each other in overcoming technological challenges. With targeted professional development, teachers in Suti can enhance their digital competencies and effectively use technology to foster holistic student development. Addressing these challenges will be crucial in preparing students for success in the digital era.

Figure-2: Location Map of Study Area



Source: <http://www.maplandia.com/india/west-bengal/murshidabad/suti/> & Google Image

Methodology

Research Method: The present study was followed by the descriptive survey method. Investigator had collected data through a 5-Point Scale (by using Google Form) from teachers at secondary level of school education.

Population and Sample: The investigation was carried out among 60 teachers of secondary level of school education at Suti, Murshidabad, West Bengal. The study's sample was selected using the convenience sampling method. The study's target population was teachers of secondary level of school education residing in the Murshidabad district of West Bengal.

Tool: The researcher utilized a self-constructed 5-point scale to measure the competencies of teachers in effective

technology-enabled assessment for the holistic development of students at the secondary level of school education. The investigator utilized an internal reliability test to evaluate the reliability of the research tool. The reliability of the self-constructed tool was 0.82 (Cronbach's Alpha). The content validity of the self-constructed 5-point scale was assessed by the researcher by taking experts' views.

Analysis and Interpretation

The objective of the study was to identify the key competencies that teachers require for effective technology-enabled assessment for the holistic development of students at the secondary level of school education. The study explores five crucial categories that are required among teachers for effective technology-

enabled assessment for the holistic development of students. Responses of teachers were scored on spread sheet (Excel) and tabulated. Frequency and percentage were calculated with the help of spread sheet (Excel) software and presented in the following tables.

Table-1: Competencies of Teachers in Digital Literacy and Technology Skills

Proficiency in using digital devices (e.g., computers, tablets, smart phones) for educational purposes.	Very proficient	Proficient	Moderately proficient	Somewhat proficient	Not proficient
	01 (1.67%)	02 (3.33%)	03 (5.00%)	04 (6.67%)	50 (83.33%)
Received formal training in utilizing educational software and applications for instructional activities and assessments.	Yes, extensively	Yes, to some extent	No, but I have some experience	No, I have not received any training	Not applicable
	00 (0.00%)	00 (0.00%)	02 (3.33%)	58 (96.67%)	00 (0.00%)

Familiarity with learning management systems (LMS) and online platforms for managing and delivering assessments.	Highly familiar	Familiar	Moderately familiar	Somewhat familiar	Not familiar
	00 (0.00%)	00 (0.00%)	00 (0.00%)	00 (0.00%)	60 (100%)
Comfortable in troubleshooting basic technical issues that may arise during technology-enabled assessments	Very comfortable	Comfortable	Neutral	Somewhat uncomfortable	Very uncomfortable
	01 (1.67%)	02 (3.33%)	02 (3.33%)	07 (11.67%)	48 (80.00%)

Table 1 indicates that 83.33 per cent of teachers have not any proficiency in using digital devices (e.g., computers, tablets, smartphones) for educational purposes. 96.67 per cent of teachers have not received any formal training in utilizing educational software and applications for instructional activities and assessments. 100 per cent of

teachers are not familiar with learning management systems (LMS) and online platforms for managing and delivering assessments. 80 per cent of teachers feel very uncomfortable in troubleshooting basic technical issues that may arise during technology-enabled assessments.

Table-2: Competencies of Teachers in Data Analysis and Interpretation

Confidence in analyzing assessment data to identify students' strengths and areas for improvement	Very confident	Confident	Moderately confident	Somewhat confident	Not confident
	02 (3.33%)	02 (3.33%)	04 (6.67%)	07 (11.67%)	45 (75.00%)
Used assessment analytics software to interpret data and make data-driven instructional decisions	Yes, frequently	Yes, occasionally	No, but have some experience	No, have not used any analytics software	Not applicable
	00 (0.00%)	00 (0.00%)	01 (1.67%)	59 (98.33%)	00 (0.00%)
Ability to identify patterns and trends in assessment results to inform your teaching practices and curriculum planning	Highly skilled	Skilled	Moderately confident	Somewhat skilled	Not skilled
	02 (3.33%)	03 (5.00%)	05 (8.33%)	08 (13.37%)	42 (70.00%)

Utilized assessment data to adjust teaching methods and strategies for better student outcomes	Always	Often	Sometimes	Rarely	Never
	02 (3.33%)	04 (6.67%)	05 (8.33%)	04 (6.67%)	45 (75.00%)

Table 2 reveals that 75 per cent of teachers are not confident in analyzing assessment data to identify student's strengths and areas for improvement. 98.33 per cent of teachers have not used any analytics software to interpret data and make data-driven instructional decisions. 70 per cent of teachers are

not skilled in identifying patterns and trends in assessment results to inform their teaching practices and curriculum planning. 75 per cent of teachers never utilized assessment data to adjust teaching methods and strategies for better student outcomes.

Table-3: Competencies of Teachers in Personalization and Differentiation

Used assessments to cater to diverse learning styles and individual student needs	Always	Often	Sometimes	Rarely	Never
	25 (41.67%)	12 (20.00%)	05 (8.33%)	08 (13.33%)	10 (16.67%)
Incorporated adaptive learning tools and platforms to personalize assessments and provide targeted feedback	Yes, regularly	Yes, occasionally	No, but willing to try	No, have not used adaptive tools	Not applicable
	00 (0.00%)	00 (0.00%)	02 (3.33%)	58 (96.67%)	00 (0.00%)
Ability to use strategies that accommodate students with varying abilities and learning preferences during technology-enabled assessments	Highly effective	Effective	Moderately effective	Somewhat effective	Ineffective
	02 (3.33%)	02 (3.33%)	08 (13.33%)	08 (13.33%)	40 (66.68%)
Addressed individual student needs while designing technology-enabled assessments	Very well	Well	Adequately	Not very well	Poorly
	02 (3.33%)	02 (3.33%)	01 (1.67%)	22 (36.67%)	33 (55.00%)

Table 3 highlights that 41.67 per cent of teachers always used assessments to cater to diverse learning styles and individual student needs. 96.67 per cent of teachers have never used adaptive learning tools and platforms to personalize assessments and provide targeted feedback. 66.68 per cent of

teachers do not have any ability to use strategies that accommodate students with varying abilities and learning preferences during technology-enabled assessments. 55 per cent of teachers poorly addressed individual student needs while designing technology-enabled assessments.

Table-4: Competencies of Teachers in Pedagogical Practices and Innovative Assessment Design

Design technology-enabled assessments that promote critical thinking, problem-solving, and creativity among students	Very well	Well	Adequately	Not very well	Poorly
	02 (3.33%)	02 (3.33%)	04 (6.67%)	19 (31.67%)	33 (55.00%)
Familiar with innovative assessment methods, such as gamified assessments and project-based evaluations, and how to integrate them into teaching	Highly familiar	Familiar	Moderately familiar	Somewhat familiar	Not familiar
	00 (0.00%)	00 (0.00%)	02 (3.33%)	01 (1.67%)	57 (95.00%)
Used technology to create assessments that encourage collaborative learning and peer assessment	Always	Often	Sometimes	Rarely	Never
	01 (1.67%)	02 (3.33%)	05 (8.33%)	02 (3.33%)	50 (83.34%)
Ability to design technology-enabled assessments that engage students and foster a positive learning experience	Highly skilled	Skilled	Moderately confident	Somewhat skilled	Not skilled
	00 (0.00%)	00 (0.00%)	01 (1.67%)	02 (3.33%)	57 (95.00%)

Table 4 describes that 55 per cent of teachers poorly designed technology-enabled assessments that promote critical thinking, problem-solving, and creativity among students. 95 per cent of teachers are not familiar with innovative assessment methods, such as gamified assessments and project-based evaluations, and how to integrate

them into teaching. 83.34 per cent of teachers never used technology to create assessments that encourage collaborative learning and peer assessment. 95 per cent of teachers are not skilled in designing technology-enabled assessments that engage students and foster a positive learning experience.

Table-5: Competencies of Teachers in Ethical Use of Technology in Assessment

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Ensure the security and integrity of technology-enabled assessments to prevent cheating or academic dishonesty	00 (0.00%)	00 (0.00%)	04 (6.67%)	05 (8.33%)	51 (85.00%)
Aware of the ethical considerations related to collecting and using student data during technology-enabled assessments	Yes, well-informed	Yes, to some extent	No, but have some understanding	Not aware of the ethical considerations	Not applicable
	00 (0.00%)	00 (0.00%)	10 (16.67%)	42 (70.00%)	08 (13.33%)
Promote digital citizenship and responsible technology use among students when conducting assessments online	Always	Often	Sometimes	Rarely	Never
	02 (3.33%)	01 (1.67%)	07 (11.67%)	05 (8.33%)	45 (75.00%)
ability to address ethical dilemmas that may arise during technology-enabled assessments in an appropriate and responsible manner	Highly capable	Capable	Moderately capable	Somewhat capable	Not capable
	00 (0.00%)	00 (0.00%)	00 (0.00%)	02 (3.33%)	58 (96.67%)

Table 5 indicates that 85 per cent of teachers are unable to ensure the security and integrity of technology-enabled assessments to prevent cheating or academic dishonesty. 70 per cent of teachers are not aware of the ethical considerations related to collecting and using student data during technology-enabled assessments. 75

per cent of teachers never promote digital citizenship and responsible technology use among students when conducting assessments online. 96.67 per cent of teachers believed that they are not capable of addressing ethical dilemmas that may arise during technology-enabled assessments in an appropriate and responsible manner.

In the present study investigator had used factor analysis statistical method to summarize and interpret the data scientific and systematic way. This strategy helped researcher to explain

interrelationships among variables in terms of their common underlying dimensions i.e. factors. Investigator had used SPSS and AMOS statistical software to analyze the data.

Table-6: KMO and Bartlett's Test

KMO Measure of Sampling Adequacy		0.619
Bartlett's Test of Sphericity	Approx. Chi-Square	1265.134
	df	190
	Sig.	0.000

The Kaiser-Meyer-Olkin (KMO) is a statistical measure used to calculate the sampling sufficiency which needs to be more significant than 0.05 level for an appropriate study to proceed. Factor analysis can be inappropriate if the sample size of the study is below 50. The present study has a 60 sample size and

0.619 sampling ampleness (Mentioned in Table 6), which is enough for factor analysis. Bartlett's test is used to assess the consistency of the relationship among factors. Table 6 highlights that Bartlett's Test of Sphericity is significant at 0.01 level.

Figure-3: Factor Analysis Result (Standardized)

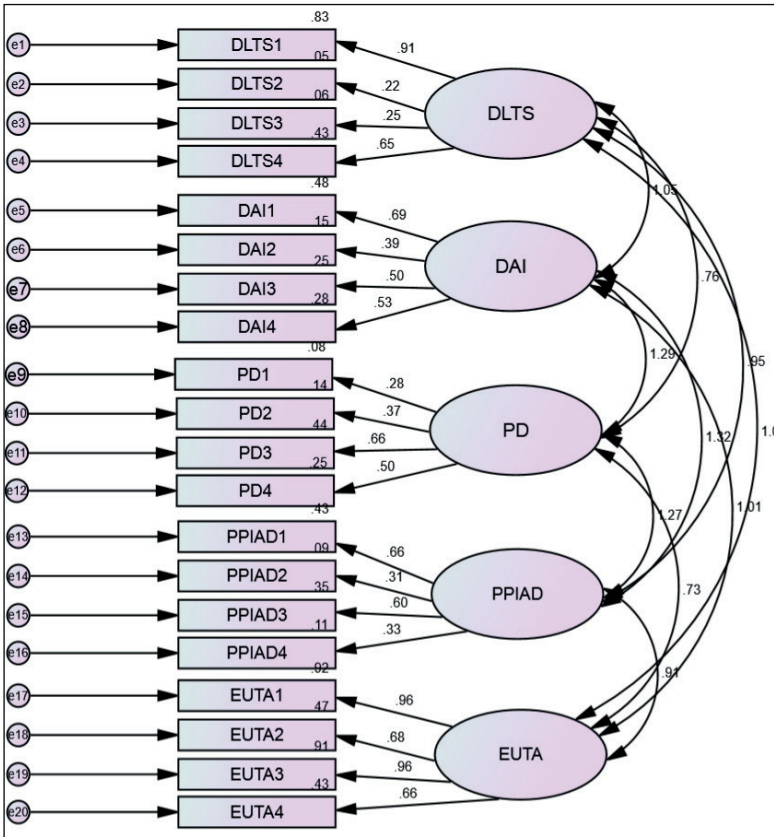


Table-7: Factor Analysis Result (Standardized) to Identify the Latent Variables

Code	Variables	Factor Loadings
Digital Literacy and Technology Skills (DLTS)		
DLTS1	Proficiency in Using Digital Devices	0.91
DLTS2	Formal Training	0.22
DLTS3	Familiarity with LMS	0.25
DLTS4	Comfortable in Troubleshooting Basic Technical Issues	0.65
Data Analysis and Interpretation (DAI)		
DAI1	Confidence in analyzing assessment data	0.69
DAI2	Used assessment analytics software	0.39
DAI3	Ability to identify patterns and trends in assessment	0.50
DAI4	Utilized assessment data to adjust teaching methods and strategies	0.53
Personalization and Differentiation (PD)		
PD1	Used assessments to cater to diverse learning styles	0.28
PD2	Incorporated adaptive learning tools and platforms	0.37
PD3	Ability to use strategies	0.66
PD4	Addressed individual student needs	0.50
Pedagogical Practices and Innovative Assessment Design (PPIAD)		
PPIAD1	Design technology-enabled assessments to promote critical thinking, problem-solving, and creativity	0.66
PPIAD2	Familiar with innovative assessment methods	0.31
PPIAD3	Used technology to create assessments	0.60
PPIAD4	Design technology-enabled assessments to engage students and foster positive learning experience	0.33
Ethical Use of Technology in Assessment (EUTA)		
EUTA1	Security and integrity of technology-enabled assessments	0.96
EUTA2	Awareness of the ethical considerations related to collecting and using student data	0.68
EUTA3	Promote digital citizenship and responsible technology use	0.96
EUTA4	ability to address ethical dilemmas	0.66

The present study has analyzed data through the confirmatory factor analysis method. The study has found a total of 45 variables (20 observed

variables and 25 unobserved variables). The study is recursive in nature, which means no variable in the study has any effect on itself. The result of the study indicates that it has five major variables such as 'Digital Literacy and Technology Skills' (DLTS), 'Data Analysis and Interpretation' (DAI), 'Personalization and Differentiation' (PD), 'Pedagogical Practices and Innovative Assessment Design'(PPIAD), Ethical Use of Technology in Assessment' (EUTA). The majority of the observed variables (DLTS1, DLTS4, DAI1, DAI4, PD3, PPIAD1, PPIAD3,

EUTA1, EUTA2, EUTA3, and EUTA4) have high factor loading values (more than 0.5). A few observed variables, such as DAI3 and PD4, have equal 0.50 factor loading values. Some observed variables like DLTS2, DLTS3, DAI2, PD1, PD2, PPIAD2, and PPIAD4 have less than 0.50-factor loadings values. This means these observed variables are also influential factors for the development of teachers' competencies in effective technology-enabled assessment for the holistic development of students.

Table-8: Factor Analysis Result (Standardized) to Identify the Correlations

Variables			Estimate
DLTS	<-->	DAI	1.053
DAI	<-->	PD	1.291
PD	<-->	PPIAD	1.266
PPIAD	<-->	EUTA	.915
DLTS	<-->	EUTA	1.076
DLTS	<-->	PD	.755
DLTS	<-->	PPIAD	.945
DAI	<-->	PPIAD	1.321
DAI	<-->	EUTA	1.009
PD	<-->	EUTA	.732

Table 8 points out that five major variables, such as 'Digital Literacy and Technology Skills', 'Data Analysis and Interpretation', 'Personalization and Differentiation', 'Pedagogical Practices and Innovative Assessment Design', and Ethical Use of Technology in Assessment' are highly correlated (above 0.70) among each other. It means all major variables are influential factors for the development of teachers' competencies in effective technology-enabled assessment for the holistic development of students.

Findings of the Study

- The study has found a total of 45 variables (20 observed variables and 25 unobserved variables). The result of the study indicates that it has five major variables such as 'Digital Literacy and Technology Skills', 'Data Analysis and Interpretation', 'Personalization and Differentiation', 'Pedagogical Practices and Innovative Assessment Design', and Ethical Use of Technology in Assessment'. The majority of the observed variables (DLTS1, DLTS4, DAI1, DAI4, PD3,

- PPIAD1, PPIAD3, EUTA1, EUTA2, EUTA3, and EUTA4) have high factor loading values (more than 0.5). Few observed variables like DAI3 and PD4 have equal 0.50 factor loadings values. Some observed variables like DLTS2, DLTS3, DAI2, PD1, PD2, PPIAD2, and PPIAD4 have less than 0.50-factor loadings values.
- The results of the study indicated that five major variables such as 'Digital Literacy and Technology Skills', 'Data Analysis and Interpretation', 'Personalization and Differentiation', 'Pedagogical Practices and Innovative Assessment Design', Ethical Use of Technology in Assessment' are highly correlated (above 0.70) among each other.
 - 83.33 per cent of teachers have not any proficiency in using digital devices (e.g., computers, tablets, smart phones) for educational purposes.
 - 96.67 per cent of teachers have not received any formal training in utilizing educational software and applications for instructional activities and assessments.
 - 100 per cent of teachers are not familiar with learning management systems (LMS) and online platforms for managing and delivering assessments.
 - 80 per cent of teachers feel very uncomfortable in troubleshooting basic technical issues that may arise during technology-enabled assessments.
 - 75 per cent of teachers are not confident in analyzing assessment data to identify student's strengths and areas for improvement.
 - 98.33 per cent of teachers have not used any analytics software to interpret data and make data-driven instructional decisions.
 - 70 per cent of teachers are not skilled in identifying patterns and trends in assessment results to inform their teaching practices and curriculum planning.
 - 75 per cent of teachers never utilized assessment data to adjust teaching methods and strategies for better student outcomes.
 - 41.67 per cent of teachers always used assessments to cater to diverse learning styles and individual student needs.
 - 96.67 per cent of teachers have never used adaptive learning tools and platforms to personalize assessments and provide targeted feedback.
 - 66.68 per cent of teachers do not have any ability to use strategies that accommodate students with varying abilities and learning preferences during technology-enabled assessments.
 - 55 per cent of teachers poorly addressed individual student needs while designing technology-enabled assessments.
 - 55 per cent of teachers poorly designed technology-enabled assessments that promote critical thinking, problem-solving, and creativity among students.
 - 95 per cent of teachers are not familiar with innovative assessment methods, such as gamified assessments and project-based evaluations, and how to integrate them into teaching.
 - 83.34 per cent of teachers never used technology to create assessments that encourage collaborative learning and peer assessment.
 - 95 per cent of teachers are not skilled in designing technology-enabled assessments that engage students and foster a positive learning experience.

- 85 per cent of teachers are unable to ensure the security and integrity of technology-enabled assessments to prevent cheating or academic dishonesty.
- 70 per cent of teachers are not aware of the ethical considerations related to collecting and using student data during technology-enabled assessments.
- 75 per cent of teachers never promote digital citizenship and responsible technology use among students when conducting assessments online.
- 96.67 per cent of teachers believed that they are not capable of addressing ethical dilemmas that may arise during technology-enabled assessments in an appropriate and responsible manner.

Discussion

The present study delves into the essential competencies that teachers need to effectively employ technology-enabled assessment for the holistic development of secondary-level students. The study's findings underscore several critical gaps in teachers' competencies like digital literacy, data analysis skills, and their ability to design innovative, personalized assessments - issues and shed light on the urgent need for comprehensive training and professional development programmes to address these shortcomings.

Comparing the findings of this study with previous research, it becomes evident that the challenges identified in this study are not isolated occurrences but are consistent with the broader landscape of technology integration in education. The literature review highlighted the growing importance of digital competencies in education, with Shute and Rahimi (2017) noting

the essential role of technology in formative assessments, particularly through personalized feedback and adaptive learning tools. However, the current study found that 96.67 per cent of teachers had not received formal training in educational software and applications, and 100 per cent were unfamiliar with learning management systems (LMS) and online platforms for assessments. This finding mirrors the work of Cifuentes, Maxwell, and Bulu (2011), who found a gap in teacher preparation programmes for digital assessment tools, leading to a lack of confidence in utilizing technology for assessment purposes. This gap in digital literacy, as identified in the study, is an essential barrier to the effective integration of technology-enabled assessments. The review of literature also depicted the importance of teachers' ability to analyze and interpret assessment data to offer personalized feedback, a key competency identified by Ertmer and Ottenbreit-Leftwich (2010) and Pawar & Yoon (2021). In the present study, 75 per cent of teachers were not confident in analyzing assessment data, and 98.33 per cent had never used analytics software to interpret data. This significant deficiency in data interpretation abilities is concerning, as it limits the potential of technology-enabled assessments to support personalized learning and intervention. The literature suggests that addressing this gap through professional development could improve teachers' capacity to use data effectively, enhancing student outcomes, as discussed by Shute and Rahimi (2017). Innovative assessment designs, such as gamified assessments, project-based evaluations, and collaborative learning, were emphasized in the literature as essential for fostering critical thinking and student engagement (William, 2006; Looney, 2019). However, the present study's findings revealed that 95 per cent of teachers were not familiar

with innovative assessment methods, and 83.34 per cent had never used technology to create assessments that encourage collaborative learning. This gap aligns with the concerns expressed by Garcia and Martinez (2019), who noted the need for teachers to be trained in innovative assessment strategies that foster critical thinking and collaboration. The lack of familiarity with these methods underscores the need for professional development programmes that focus on innovative, technology-driven assessment strategies. The review of literature also discussed the ethical dimensions of technology in education, particularly concerning data privacy and digital citizenship, as highlighted by UNESCO (2024). The current study corroborates these concerns, revealing that 70 per cent of teachers were not aware of ethical considerations related to collecting and using student data during technology-enabled assessments. Moreover, 75 per cent of teachers reported not promoting digital citizenship and responsible technology use among students. These findings echo the call from UNESCO (2024) and Yadav (2024) for a deeper focus on ethical issues in teacher training, particularly in the context of technology integration. Teachers must be equipped not only with technical skills but also with an understanding of ethical and responsible technology use to ensure equitable and secure assessments.

Overall, the present study's findings are consistent with the broader discourse in the literature, which stresses the need for comprehensive teacher training in digital literacy, data analysis, innovative assessment strategies, and ethical considerations. By addressing these competencies through targeted professional development, teachers can become more effective in leveraging technology to enhance student learning and support holistic development. This

study aligns with the recommendations of Darling-Hammond et al. (2017) and Guskey & Yoon (2009), who emphasized the importance of continuous training in enabling teachers to adapt their instructional practices to accommodate the demands of technology-enabled assessments.

Educational Implications

The findings of the study reveal critical insights into the competencies of teachers in utilizing technology-enabled assessment for the holistic development of students. These findings have significant educational implications:

- 1. Teacher Training and Professional Development:** The study highlights the urgent need for comprehensive teacher training and professional development programmes focusing on digital literacy and technology integration. Teachers must be equipped with the necessary skills to use digital devices, educational software, learning management systems, and online platforms effectively.
- 2. Data Analysis and Interpretation:** Teachers need support in data analysis and interpretation to make informed instructional decisions. Professional development should focus on using analytics software to interpret assessment data and identify students' strengths and areas for improvement, leading to personalized feedback and targeted interventions.
- 3. Personalized Learning and Differentiation:** To foster an inclusive learning environment, teachers should receive training in designing technology-enabled assessments that cater to diverse learning styles and individual student needs. Utilizing adaptive learning tools and platforms can help personalize assessments and provide targeted feedback.

4. Innovative Assessment Design:

Teacher training programmes should emphasize innovative assessment methods, such as gamified assessments and project-based evaluations, and how to integrate them into teaching. These assessments can promote critical thinking, problem-solving, and creativity among students.

5. Ethical Considerations and Digital Citizenship:

Teachers must be aware of ethical considerations related to data privacy, security, and responsible technology use during technology-enabled assessments. Promoting digital citizenship among students will help create a responsible and ethical online learning environment.

6. Collaborative Learning and Peer Assessment:

Teachers should be encouraged to use technology to design assessments that foster collaborative learning and peer assessment. This can enhance student engagement and provide valuable learning experiences.

7. Addressing Ethical Dilemmas:

Teachers need support and guidance in addressing ethical dilemmas that may arise during technology-enabled assessments. Professional development programmes can help teachers develop strategies for handling such situations appropriately and responsibly.

8. Promoting Positive Learning Experiences:

Teachers should be empowered to use technology to create assessments that engage students and foster positive learning experiences. Engaging and interactive assessments can enhance student motivation and learning outcomes.

9. Equity and Access:

Policymakers and educational institutions should work towards bridging the digital divide to ensure equitable access to technology-enabled assessment tools for all students. Providing access to technology for both teachers and students is crucial for successful implementation.

10. Curriculum Integration:

The study underscores the need to integrate technology-enabled assessment seamlessly into the curriculum. Teachers should receive support in aligning assessment practices with pedagogical goals, promoting effective teaching and learning.

The study's educational implications emphasize the importance of empowering teachers with the necessary competencies to leverage technology-enabled assessment effectively. By addressing these implications through teacher training and professional development initiatives, educational institutions can create an environment that fosters holistic student development, prepares learners for the future, and maximizes the potential of technology in education.

Limitations of the Study

While this study provides valuable insights into the competencies required for effective technology-enabled assessment, there are several limitations to consider.

1. The study was conducted with a sample of only 60 secondary school teachers from Suti, Murshidabad, West Bengal.
2. The focus of the study was specifically on secondary school teachers' competencies in technology-enabled assessment, excluding other aspects of teaching

practice that may also influence students' holistic development.

3. The study only examined secondary school teachers' perceptions at a particular point in time, without investigating changes in competencies over an extended period.
4. The data collected through a self-constructed 5-point scale is based on self-reporting, which may lead to response biases such as social desirability or overestimation of competencies. Teachers may have provided answers they perceived to be ideal rather than their actual practices, potentially influencing the accuracy of the results.

These limitations suggest that while the findings are significant, further research with a larger and more diverse sample, as well as longitudinal studies, could provide a more comprehensive understanding of teachers' competencies in effective technology-enabled assessment for holistic development of students.

Conclusion

The study sheds light on the critical importance of teachers' competencies in effective technology-enabled assessment for the holistic development of students at the secondary level of school education. The findings highlight significant gaps in teachers' digital literacy and technological skills, as well as their lack of training in utilizing educational software and online platforms for assessments. This lack of proficiency hinders their ability to create engaging and personalized learning experiences for students. Furthermore, the study reveals that a majority of teachers struggle with analyzing and interpreting assessment data, limiting

their capacity to identify students' strengths and areas for improvement. This deficiency hampers their ability to provide targeted feedback and interventions, impeding students' progress and growth. Innovative assessment designs that promote critical thinking, problem-solving, and collaboration are also lacking among the teachers surveyed. This highlights the need for professional development programmes that familiarize educators with cutting-edge assessment methods, such as gamified assessments and project-based evaluations, to enrich student learning experiences. Additionally, ethical considerations and data privacy concerns emerge as significant challenges for teachers. Many educators are unaware of the ethical dilemmas that may arise during technology-enabled assessments and lack the knowledge to navigate such situations responsibly.

In conclusion, the study underscores the urgency for comprehensive teacher training and professional development programmes that prioritize technology integration and digital literacy. Equipping teachers with the necessary competencies to leverage technology effectively will empower them to create engaging and personalized learning experiences, foster essential skills, and ensure the holistic development of their students. Addressing these competencies will not only shape the future of education but also prepare students to thrive in the digital age, becoming adaptable, critical thinkers, and responsible digital citizens. Policymakers, educational institutions, and stakeholders must collaborate to bridge these competency gaps and harness the full potential of technology-enabled assessment for the betterment of education.

References

- Albinson, P., Cetinkaya, D., & Orman, T. (2020). Using technology to enhance assessment and feedback: A framework for evaluating tools and applications. *Proceedings of the 2020 9th International Conference on Educational and Information Technology (ICEIT 2020)*, Oxford, United Kingdom. <https://doi.org/10.1145/3383923.3383940>
- Anderson, M., & Kumar, M. (2019). *Digital divide persists even as lower-income Americans make gains in tech adoption*. Pew Research Center. <https://www.urbanismnext.org/resources/digital-divide-persists-even-as-lower-income-americans-make-gains-in-tech-adoption>
- Brown, T., & Lee, R. (2021). Technology-enhanced formative assessment: A study of teachers' perspectives. *Computers & Education*, 157, 104036.
- Cifuentes, L., Maxwell, G., & Bulu, Ş. (2011). Technology integration through professional learning community. *Journal of Educational Computing Research*, 44(1), 59-82. <https://doi.org/10.2190/EC.44.1.d>
- Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective Teacher Professional Development*. Learning Policy Institute. <https://eric.ed.gov/?id=ED606743>
- Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, beliefs, and culture intersect. *Journal of Research on Technology in Education*, 42(3), 255-284. <https://doi.org/10.1080/15391523.2010.10782551>
- Fletcher, C., Iannucci, C., & Scanlon, D. (2024). A teacher's self-study of digitally-enabled assessment practices to support enhancements in assessment literacy in primary physical education. *Curriculum Studies in Health and Physical Education*, 15(3), 255-273. <https://doi.org/10.1080/25742981.2023.2265903>
- Garcia, P., & Martinez, S. (2019). Technology-enhanced assessment for learning: A comprehensive review of its purposes, forms, and affordances. *Educational Technology Research and Development*, 67(2), 287-310.
- Gulikers, J. T. M., Bastiaens, T. J., & Kirschner, P. A. (2004). A five-dimensional framework for authentic assessment. *Educational Technology Research and Development*, 52(3), 67-86. <https://doi.org/10.1007/BF02504669>
- Guskey, T., & Yoon, K. S. (2009). What works in professional development? *Phi Delta Kappan*, 90(7), 495-500. <https://doi.org/10.1177/003172170909000709>
- Hartnett, M. K., Brown, M., & Anderson, B. (2014). Learning in the digital age: How are the ways in which we learn changing with the use of technologies? In A. St. George, S. Brown, & J. O'Neill (Eds.), *Facing the big questions in teaching: Purpose, power and learning* (2nd ed., pp. 116-125). Cengage Learning. https://www.researchgate.net/publication/272942538_Learning_in_the_digital_age_How_are_the_ways_in_which_we_learn_changing_with_the_use_of_technologies
- Looney, J. (2019). Digital Formative Assessment: A review of the literature. Assess@learning. <http://www.eun.org/documents/411753/817341/Assess%40+Learning+Literature+Review/be02d527-8c2f-45e3-9f75-2c5cd596261d>
- Pawar, M. A., & Yoon, K. S. (2021). Role of digital literacy among teachers and students in 21st century India. *Educational Resurgence Journal*, 3(6), 93-101. <https://coed.dypvp.edu.in/educational-resurgence-journal/documents/july-2021/14.pdf>
- Selwyn, N. (2016). *Education and technology: Key issues and debates*. Bloomsbury Publishing.
- Shute, V. J., & Rahimi, S. (2017). Review of computer-based assessment for learning in elementary and secondary education. *Journal of Computer Assisted Learning*, 33(1), 1-19. <https://doi.org/10.1111/jcal.12172>

- Smith, A., & Johnson, J. (2020). Examining teachers' digital competencies and their relationship with student achievement. *Educational Technology & Society*, 23(2), 1-13.
- UNESCO. (2022). *The use of technology in the assessment of learning outcomes: Opportunities and challenges*. <https://unesdoc.unesco.org/ark:/48223/pf0000378784>
- UNESCO. (2024). *What you need to know about digital learning and transformation of education*. <https://www.unesco.org/en/digital-education/need-know>
- Wiliam, D. (2006). *Assessment for learning: Why, what and how*. https://www.researchgate.net/publication/258423298_Assessment_for_learning_why_what_and_how
- Yadav, V. (2024). *Equity in Education: Addressing the Digital Divide*. <https://www.linkedin.com/pulse/equity-education-addressing-digital-divide-vanshika-yadav-id8ec>
- Youngren, J. (2021). *Impacts of collaborative learning on student engagement*. Dissertations, Theses, and Projects. 483. <https://red.mnstate.edu/thesis/483>