
Science Teacher Readiness on 21st Century Learning as Predicted by Digital Literacy and Digital Competence

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Abstract — Teachers' lack of readiness for 21st century learning remains a significant challenge in education. This study determined a predictive model of teachers' readiness using digital literacy and digital competence as predictors. Employing a predictive research design, the study involved 162 Science teachers from public secondary schools in the Division of Panabo City, selected through total population sampling. Data was gathered through surveys and analyzed using descriptive statistics, correlation, and multiple linear regression. Findings revealed that digital literacy and digital competence significantly and positively predict teachers' readiness, collectively explaining 38% of the variance. The results support Self Determination Theory, which emphasizes autonomy, competence, and relatedness as drivers of motivation and preparedness. It is recommended that future research explore additional variables to account for the remaining variance in readiness. Moreover, school leaders and policymakers may implement programs and training to strengthen teachers' digital literacy and competence.

Keywords: *digital literacy, digital competence, teachers' readiness, predictors, 21st-century learning*

I. INTRODUCTION

Teachers' lack of readiness negatively affects student learning outcomes. Without sufficient preparation, educators are unable to create engaging, technology-enhanced learning

environments that promote essential 21st-century skills (Somosot, 2020). Their lack of readiness hinders the shift toward innovative, student-centered instruction, limiting students' opportunities to engage meaningfully with learning content and real-world applications. This is consistent with Mendoza (2024), who found that readiness challenges constrained the effective implementation of student-centered learning in Araling Panlipunan classes, and with Elardo (2025), who reported disparities in teachers' preparedness that limited curriculum delivery.

In Malaysia, teachers' readiness for 21st-century learning remains a major challenge (Dahalan et al., 2019). Many still struggle to adapt their teaching practices because of limited pedagogical and technological skills. Dahalan et al. stressed that readiness must be central to educational reform, as it directly shapes the success of teaching and learning. This issue is not unique to Malaysia. In Finland, Ilomäki, Paavola, Lakkala, and Kantosalo (2016) also found uneven readiness among teachers, noting that while many had basic digital skills, they lacked confidence in integrating them into pedagogy. Both studies highlight that teacher readiness is the key to making student-centered learning effective in the 21st century.

In the Philippines, studies indicate that while teachers recognize the importance of 21st-century learning, many remain unprepared to implement it effectively in their teaching practices (Buenvinida et al., 2020). This lack of readiness continues to be a significant barrier to educational progress, limiting the development of skills essential for today's learners.

Existing studies focus primarily on preservice teachers or general teaching competencies, leaving a gap in understanding how in-service science teachers navigate 21st-century learning (Somosot, 2020). This study addresses that gap by examining the impact of digital literacy and digital competence on science teachers' readiness on 21st-century learning. Identifying these factors will provide insights that can help improve teacher training programs and enhance educational outcomes.

II. METHODOLOGY

This study employed a predictive research design, which aims to forecast or estimate outcomes based on one or more predictor variables. It focuses on identifying relationships that enable researchers to anticipate results rather than merely describe or explain phenomena. This

design extends traditional explanatory research by emphasizing the prediction of outcomes using both theoretical and empirical data (Van Witteloostuijn et al., 2022).

The study was conducted in the Division of Panabo City, specifically among Science teachers in the public secondary schools under the Department of Education (DepEd). This division serves as a vital educational hub in Davao del Norte, committed to delivering quality and equitable education in line with DepEd's national mission. The site was selected because of its active role in implementing 21st-century learning initiatives and its emphasis on strengthening digital literacy and competence among teachers. These characteristics make Panabo City Division an appropriate setting for examining how Science teachers' digital skills predict their readiness to engage in 21st-century learning practices.

The respondents of this study consisted of 162 Science teachers from public secondary schools in the Division of Panabo City, each with at least one year of teaching experience and carrying at least one subject load in Science. These participants were selected because they represent the entire population of Science teachers in the division, making them the most appropriate group for examining the predictive relationship between digital literacy, digital competence, and readiness for 21st-century learning.

This study employed a purposive sampling technique, specifically total population sampling, wherein all members of the target population were included as respondents. This approach was appropriate due to the relatively manageable population size and the unique, well-defined characteristics of the group. By capturing the perspectives of all Science teachers in the division, the study ensured complete representation, minimized sampling bias, and enhanced the accuracy and reliability of the findings.

Through this design, the study was able to describe, analyze, and interpret how digital literacy and digital competence predict Science teachers' readiness to create technology-enhanced, student-centered learning environments. The findings may serve as a valuable basis for future teacher training initiatives and policy development in the field of education. This study used a survey method to gather quantitative data from Science teachers. Surveys, administered through structured questionnaires, offered an efficient way to collect standardized information while capturing teachers' perspectives in a systematic manner (Creswell, 2018).

To measure the variables, three adapted questionnaires were employed, each using a 4-point Likert scale. These included the Digital Literacy Scale by Bayrakcı and Narmanlıoğlu (2021), with 29 items (Cronbach's $\alpha = 0.878$); the Self-Assessment Tool from the European Digital Competence Framework for Educators by the European Commission (2019), with 20 items (Cronbach's $\alpha = 0.926$); and the Teachers' Readiness in Implementing 21st Century Learning Survey by Kaur (2023), with 23 items (Cronbach's $\alpha = 0.936$). These instruments were chosen for their proven reliability and suitability in assessing digital literacy, digital competence, and teacher readiness on 21st-century learning.

This study used descriptive statistics, correlation analysis, and multiple linear regression. Descriptive statistics, such as the mean and standard deviation, summarized the data and provided an overview of the variables (Kim & Mallory, 2023). Correlation analysis examined the relationships among digital literacy, digital competence, and teacher readiness, while regression analysis assessed the predictive power of digital literacy and competence in explaining variations in readiness for 21st-century learning.

The following scale was used to interpret the level of variables:

Scale	Level	Digital Literacy	Digital Competence	Science Teachers' Readiness
3.26 – 4.00	Very High	This means that digital literacy of the science teachers is always manifested.	This means that digital competence of the science teachers is always manifested.	This means that teachers' readiness is always observed.
2.50 – 3.25	High	This means that digital literacy of the science teachers is often manifested.	This means that digital competence of the science teachers is often manifested.	This means that teachers' readiness is often observed.
1.75 – 2.49	Low	This means that digital literacy of science teachers is sometimes manifested.	This means that digital competence of the science teachers is sometimes manifested.	This means that teachers' readiness is sometimes observed.
1.00 – 1.74	Very Low	This means that digital literacy of the science teachers is rarely manifested.	This means that digital competence of the science teachers is rarely manifested.	This means that teachers' readiness is rarely observed.

Standard Deviation Value of Ranges and Interpretation

<i>SD Value Range of Interpretation</i>	
0.00 – 0.50	Very low variability/responses are very consistent
0.51 – 1.00	Low variability / responses are relatively consistent
1.01 – 1.50	Moderate variability/responses vary significantly
1.51 – 2.00	High variability/responses vary significantly
Above 2.00	Very high variability/responses are highly dispersed

Correlation analysis was used to determine the strength and direction of relationships between variables without implying causation. Pearson's r was utilized as the statistical measure (Schober et al., 2023).

For the interpretation scale of r -value, the following scheme is used as proposed by Guilford (1956):

Computed r	Descriptive Interpretation
+/- 1.00	Perfect correlation
Between +/- 0.75 – +/- 0.99	High correlation
Between +/- 0.51 – +/- 0.74	Moderately high correlation
Between +/- 0.31 – +/- 0.50	Moderately low correlation
Between +/- 0.01 – +/- 0.30	Low correlation
0.00	No correlation

Multiple linear regression analysis was employed to examine the relationship between one dependent variable and multiple independent variables. It was used to predict outcomes and assess the influence of predictors simultaneously. Beta (β) coefficients were interpreted to determine the strength and direction of each predictor (Hair et al., 2023).

β Value Range	Predictive Strength
$\pm 0.00 - \pm 0.09$	Very Weak
$\pm 0.10 - \pm 0.29$	Weak
$\pm 0.30 - \pm 0.49$	Moderate
$\pm 0.50 - \pm 0.69$	Strong
± 0.70 and above	Very Strong

III. RESULTS AND DISCUSSION

Table 1 presents the descriptive statistics of the study variables, namely: digital literacy (in terms of ethics and responsibility, general knowledge and functional skills, daily usage, advanced production, privacy and security, and social dimension), digital competence (in terms of professional engagement, digital resources, teaching and learning, assessment of learning, empowering learners, and facilitating learner's digital competence), and science teachers' readiness (in terms of knowledge and awareness, skills, and attitudes). It includes the sample size, mean, standard deviation, and corresponding descriptive levels.

Specifically, digital literacy obtained a mean of 3.36, described as *very high*, indicating strong digital literacy among Science teachers. Most indicators were likewise rated very high, except advanced production (Mean = 2.68) and social dimension (Mean = 3.14), which were rated *high*. The standard deviation of 0.41 suggests low variability, reflecting generally consistent responses, though advanced production showed wider differences.

Similarly, digital competence recorded a mean of 3.51, also *very high*, showing that teachers are highly competent in integrating digital skills into their professional practice. All indicators were rated very high, with a standard deviation of 0.39, indicating consistent responses across the group. Finally, Teachers' readiness achieved a mean of 3.68, likewise *very high*, reflecting strong preparedness for 21st-century learning. All indicators—knowledge and awareness, skills, and attitude—were rated very high. The standard deviation of 0.33 suggests very low variability, highlighting highly consistent responses among teachers.

TABLE 1
DESCRIPTIVE STATISTICS (N=162)

Variables	Standard Deviation	Mean	Descriptive Level
Digital Literacy	0.41	3.36	Very High
<i>Ethics and Responsibility</i>	<i>0.20</i>	<i>3.83</i>	<i>Very High</i>
<i>General Knowledge and Functional Skills</i>	<i>0.58</i>	<i>3.26</i>	<i>Very High</i>
<i>Daily Usage</i>	<i>0.44</i>	<i>3.63</i>	<i>Very High</i>
<i>Advanced Production</i>	<i>1.11</i>	<i>2.68</i>	<i>High</i>
<i>Privacy and Security</i>	<i>0.50</i>	<i>3.62</i>	<i>Very High</i>
<i>Social Dimension</i>	<i>0.70</i>	<i>3.14</i>	<i>High</i>
Digital Competence	0.39	3.51	Very High
<i>Professional Engagement</i>	<i>0.55</i>	<i>3.49</i>	<i>Very High</i>
<i>Digital Resources</i>	<i>0.47</i>	<i>3.51</i>	<i>Very High</i>
<i>Teaching and Learning</i>	<i>0.43</i>	<i>3.62</i>	<i>Very High</i>
<i>Assessment of Learning</i>	<i>0.65</i>	<i>3.45</i>	<i>Very High</i>
<i>Empowering Learners</i>	<i>0.59</i>	<i>3.43</i>	<i>Very High</i>
<i>Facilitating Learner's Digital Competence</i>	<i>0.49</i>	<i>3.54</i>	<i>Very High</i>
Teachers' Readiness	0.33	3.68	Very High
<i>Knowledge and Awareness</i>	<i>0.38</i>	<i>3.73</i>	<i>Very High</i>
<i>Skills</i>	<i>0.51</i>	<i>3.54</i>	<i>Very High</i>
<i>Attitude</i>	<i>0.37</i>	<i>3.76</i>	<i>Very High</i>

Table 2 presents the correlation between the independent variables (digital literacy and digital competence) and the dependent variable (science teachers' readiness). It includes the r-values, p-values, decisions on the null hypothesis, and corresponding interpretations.

The correlation analysis revealed statistically significant positive relationships between the independent variables and teachers' readiness. Digital literacy demonstrated a moderately low positive correlation with teachers' readiness ($r = .49$, $p = .001$), indicating that higher levels of digital literacy are associated with greater readiness among teachers. Similarly, digital competence showed a moderately high positive and significant relationship with teachers' readiness ($r = .59$, $p = .001$), suggesting that teachers who possess stronger digital competence tend to exhibit higher levels of readiness. Since both relationships were significant at the .05 level, the null hypotheses were rejected, confirming that digital literacy and digital competence are meaningfully and significantly associated with teachers' readiness.

TABLE 2
CORRELATION TABLE (N=162)

Variables	Teachers' Readiness			
	r-value	p-value	Decision on H_0	Interpretation
Digital Literacy	0.49	.001	Reject H_0	Moderately Low Positive, Significant
Digital Competence	0.59	.001	Reject H_0	Moderately High Positive, Significant

Level of Significance: 0.05

Decision Rule: Reject H_0 if $p < 0.05$

Table 3 presents the results of the multiple linear regression analysis, including the unstandardized coefficients (B), standard errors, standardized coefficients (β), t-values, p-values, and corresponding decisions. The regression analysis indicates that the combined predictors significantly explained variations in teachers' readiness ($R^2 = .38$, $p < .001$), suggesting that 38% of the variance in teachers' readiness is accounted for by digital literacy and digital competence.

The unstandardized coefficient for digital literacy ($B = 0.18$, $\beta = 0.23$, $p = .002$) indicates that digital literacy exerts a positive and statistically significant influence on teachers' readiness. Similarly, digital competence demonstrated a stronger positive and significant influence on teachers' readiness ($B = 0.38$, $\beta = 0.46$, $p < .001$), indicating that teachers with higher levels of digital competence tend to exhibit greater readiness. The overall model showed a moderately strong relationship between the predictors and teachers' readiness ($R = .62$), and the regression model was statistically significant ($F = 50.5$, $p < .001$). Since both predictors were significant at the .05 level, the null hypotheses were rejected, confirming that digital literacy and digital competence have meaningful and significant combined influences on teachers' readiness, with digital competence emerging as the stronger contributing variable.

TABLE 3
REGRESSION TABLE (N=162)

Variables	Unstandardized Coefficients		Teachers' Readiness Standardized Coefficients				
	B	Std. Error	Beta	t	Sig.	Decision on H_0	Interpretation
(Constant)	1.68	0.19	—	8.45	.001	—	—
Digital Literacy	0.18	0.05	0.23	3.13	0.002	Reject	Positive Significant Influence
Digital Competence	0.38	0.06	0.46	6.19	.001	Reject	Positive Significant Influence

Model Summary:

$R = 0.62$ | $R^2 = 0.38$ | $F = 50.5$ | $p = <.001$

Level of Significance: 0.05

Decision Rule: Reject H_0 if $p < 0.05$

Predictive Model: $TR = 01.68 + 0.18(DL) + 0.38(DC)$

Summary of Findings

Based on the statistical results, the study found that digital literacy and digital competence are both significantly and positively related to teachers' readiness. This means that as teachers become more digitally literate and competent, their level of readiness for 21st century learning also increases. Moreover, both variables were found to have a significant positive influence on teachers' readiness, showing that they are important factors in preparing teachers for modern educational demands.

The findings of the study highlight the important role of digital literacy and digital competence in shaping teachers' readiness for 21st century learning. The results showed that digital literacy is significantly related to teachers' readiness, suggesting that teachers who are more familiar and comfortable with digital tools tend to feel more prepared in today's technology-driven classrooms. This supports earlier studies which explain that digitally literate teachers are more confident and better able to adapt to modern teaching practices (Villarba et al., 2023; Taheri & Pennington, 2024). However, this finding is not always consistent with other research, which points out that being skilled in using technology does not always mean being ready to apply it effectively in teaching (Labor & Escandallo, 2024).

Similarly, the study found that digital competence is significantly related to teachers' readiness. This implies that teachers who not only know how to use technology but can apply it effectively in teaching are more prepared for the demands of 21st century education. This finding agrees with studies showing that digital competence helps teachers integrate technology more meaningfully into their lessons (Aleño et al., 2024; Gallego Joya et al., 2025). On the other hand, some studies argue that even if teachers are digitally competent, they may still struggle to translate these skills into classroom practice due to limited training or lack of support (Althubyani, 2024).

When it comes to predicting teachers' readiness, the results further revealed that digital literacy and digital competence both serve as significant predictors. This means that these two factors can help explain why some teachers are more prepared than others in implementing 21st century learning. This finding is supported by studies which emphasize that teachers who are digitally skilled and confident are more capable of integrating technology into their teaching (Tzafilkou et al., 2023; Afrizal et al., 2025). However, this result also contrasts with research

suggesting that having digital skills alone is not enough, especially when teachers lack proper pedagogical training or institutional support (Gudmundsdottir & Hatlevik, 2018). Overall, the findings suggest that while digital literacy and digital competence are essential in preparing teachers for the 21st century, they are not the only factors that matter. Teachers also need proper training, support, and opportunities to apply these skills effectively in real classroom situations.

IV. CONCLUSION

The findings show that digital literacy and digital competence both play a significant role in predicting the readiness of Science teachers for 21st century learning, explaining 38% of the variation. This suggests that these skills are important in helping teachers become more prepared for modern classroom demands.

The results also align with Self-Determination Theory, which explains that readiness improves when autonomy, competence, and relatedness are supported. In this study, digital literacy reflects teachers' independence, digital competence reflects their ability to apply skills effectively, and readiness reflects their ability to connect with others in the learning environment. Overall, the findings suggest that strengthening digital literacy and digital competence not only builds teachers' skills but also helps them become more confident and ready to meet the challenges of 21st century teaching.

V. RECOMMENDATIONS

Aligned with the findings of the study, it is recommended that future research further explore other factors that may explain the remaining 62% of teachers' readiness. It would also be helpful to conduct exploratory studies to identify other possible predictors or indicators of readiness beyond digital literacy and digital competence.

In practice, school leaders and policymakers are encouraged to make the most of available resources by strengthening training programs, support systems, and policies that enhance teachers' digital literacy and digital competence. By doing so, teachers can become more confident, capable, and ultimately more ready to meet the demands of 21st century classrooms.

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