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How Technological Readiness Shapes Pre-Service Teachers' Digital Material Design Competencies: A Structural Equation Modeling Approach

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Abstract

Despite the growing emphasis on digital competencies in teacher education, many pre-service teachers struggle to design digital learning materials effectively. Among the influencing factors, technological readiness, defined as individuals' tendency to adopt and embrace new technologies, has emerged as a critical but underexplored predictor. This study investigates how technological readiness impacts digital material design competencies among pre-service teachers while also exploring the roles of gender and personal computer ownership. Drawing on data from 506 education students at a Turkish university, this study employed the Technological Readiness Scale and the Digital Material Design Competencies Scale. Structural equation modeling (SEM) confirmed that technological readiness significantly predicts digital material design competencies, highlighting the centrality of affective and cognitive preparedness over demographic or access-related variables. When gender, computer ownership, and grade level were controlled, technological readiness was found to be a significant predictor ($\beta = .63$, $p < .001$). These findings emphasize that fostering technological optimism and innovativeness may be more effective in enhancing digital competencies than focusing solely on access or demographic equity. The study suggests that teacher education programs should embed readiness-building interventions early in training to better equip pre-service teachers for technology-integrated classrooms.

Keywords: Digital competencies, Digital material design competencies, Educational technology, Pre-service teachers, Structural equation modeling, Technological readiness.

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Introduction

As education systems worldwide respond to rapid technological advancement, the digital preparedness of teachers has become a fundamental concern. In this evolving context, the ability to create and integrate digital learning materials has emerged as a key professional competency. Modern teacher education programs must therefore go beyond promoting basic digital literacy. They are increasingly called upon to prepare teachers who can design instructional materials, select and implement appropriate technologies, and evaluate their pedagogical impact (Redecker, 2017). These growing expectations place digital material design competence at the core of teacher preparation efforts.

Despite this emphasis, numerous studies continue to report that many pre-service teachers assess their digital competencies as modest or incomplete (Tatlı & Akbulut, 2017; Bediroğlu, 2021). While access to training and infrastructure certainly contributes to this issue, recent research suggests that psychological and affective factors also play a significant role in shaping digital competency development (Redecker, 2018; Muehlburger et al., 2022). One such factor is technological readiness, defined as an individual's general attitude and emotional orientation toward using new technologies. Rather than being a simple measure of experience or confidence, technological readiness comprises both encouraging and discouraging tendencies that jointly influence how people relate to digital tools (Parasuraman, 2000; Parasuraman & Colby, 2001; Rodríguez et al., 2024). This framework offers a valuable lens for understanding how teacher candidates either embrace or resist opportunities for digital learning and creation.

Within this framework, specific psychological traits such as optimism, innovativeness, discomfort, and insecurity are particularly relevant. Optimism is associated with positive beliefs about the benefits of technology, which can lead to more enthusiastic and experimental uses of digital tools in instruction (Blayone, 2018). Innovativeness supports risk-taking and a willingness to explore new tools, which are crucial for developing advanced digital design skills (Álvarez-Marín et al., 2023). Conversely, discomfort and insecurity often lead to avoidance behaviors and limited engagement with technology-rich tasks, thereby constraining the depth of digital integration (Pozas et al., 2022). These psychological tendencies are widely viewed as foundational to technology adoption and professional growth, suggesting they may significantly influence how pre-service teachers build instructional competencies.

Research Gaps and Context

However, while these theoretical associations are well established, the empirical relationship between technological readiness and digital material design competence among pre-service teachers remains underexplored. Most prior studies have either focused on in-service teachers or assessed general digital skills, neglecting this specific population. For example, Polat et al. (2022) highlight that e-learning readiness studies typically target K–12 or higher education teachers, with few examining other teacher levels. Similarly, Rafiq et al. (2022) point out a notable gap in research addressing whether pre-service teachers are ready to teach online, despite the abundance of TPACK-related studies.

In the Turkish context, only a handful of studies have touched on adjacent issues. Kabaran and Altan (2022) explored Turkish teacher candidates' reflections on digital material design, while Kaçar (2022) studied Turkish EFL pre-service teachers designing digital materials within the TPACK framework. Ata and Yıldırım (2019) used factor analysis and ANOVA to examine how attitudes and technical, cognitive, and social skills predicted Turkish pre-service teachers' self-reported digital literacy. Yet, none of these studies incorporated technological readiness as a predictor or employed multivariate modeling techniques to assess its relationship to digital design competence.

Moreover, demographic and contextual variables such as gender, grade level, and access to personal computers have been examined in isolation but rarely controlled for within an integrated analytical model. For instance, Demirtaş and Mumcu (2021) found that ICT and TPACK scores were higher among students in later years of study and those owning a personal computer, though gender showed no significant effect. Cuhadar (2018) reported differences in digital readiness based on gender and department, and Grande-de-Prado et al. (2020) observed that male trainees tended to rate their ICT skills higher than females. These findings suggest that variables such as year of study, computer access, and gender may influence digital competencies, yet their combined effects within a predictive framework remain underexamined. Structural Equation Modeling (SEM) offers a powerful methodological approach to address this gap. Though SEM has been used in related domains—for example, Chu et al. (2023) modeled Chinese pre-service teachers' digital teaching competence, and Falebita and Kok (2025) demonstrated that technological readiness predicts AI adoption—no existing study has used SEM to test whether technological readiness predicts digital material design competence in pre-service teachers while simultaneously controlling for relevant demographic variables.

Technological Readiness: A Multidimensional Framework

To understand how psychological factors, influence digital competency development, it is essential to examine the concept of technological readiness in depth. Technological readiness (TR), broadly defined as an individual's propensity to embrace, adopt, and effectively use new technologies, originates in Parasuraman's (2000) model. This model comprises four core psychological traits influencing openness to technology: optimism (a positive belief that technology offers benefits and improves productivity, enhancing learning and work environments), innovativeness (a tendency to seek out and try new technologies before others), discomfort (anxiety or a perceived lack of control over technology), and insecurity (doubts about technology's reliable functioning or trustworthiness in professional settings) (Parasuraman, 2000; Muehlburger et al., 2022). Within this framework, optimism and innovativeness act as adoption drivers, associated with curiosity, adaptability, and confidence, while discomfort and insecurity serve as inhibitors (Parasuraman, 2000).

In teacher education contexts, TR extends beyond these psychological attitudes to encompass technical competence, pedagogical adaptability, and psychological comfort (Aditya, 2021). Aditya (2021) defines a teacher's TR largely in terms of "the teacher's ability of utilizing technological software and hardware and the extent of their comfort to use it to facilitate teaching." Practically, TR is viewed as a multifaceted readiness for technology-enhanced teaching, integrating technological (knowledge of devices/tools), pedagogical (ability to adapt teaching methods), and psychological (motivation/attitudes) components, where deficits in one dimension can negatively impact others (Aditya, 2021).

The psychological components of TR have particularly strong implications for instructional design activities. Teacher candidates high in optimism are more likely to perceive digital tools as beneficial for classroom practice and explore their use in instructional design (Blayone, 2018). Similarly, an innovative mindset supports valuable experimentation and independent exploration for building technical skills and adapting resources (Álvarez-Marín et al., 2023). Conversely, high discomfort may inhibit engagement with basic software, and insecurity may lead to avoidance or minimal effort in technology-based tasks (Pozas et al., 2022). These psychological traits shape not only adoption but also the depth of skill development for effective classroom integration (Blayone, 2018; Pozas et al., 2022).

Empirical studies underscore TR's critical role in educational contexts. The Technology Readiness Index (TRI), adapted for educators, has been used to measure public school teachers' readiness, identifying segments like "explorers" and "laggards" and confirming the scale's cross-cultural validity (Badri et al., 2014). Crucially, during crises like the COVID-19 pandemic, TR proved pivotal: teachers with higher readiness (blending confidence, competence, and positive attitudes) experienced less stress, fewer disruptions, and greater success in adapting to emergency remote teaching (Pozas et al., 2022; Van der Spoel et al., 2020, cited in Pozas et al., 2022). Van der Spoel et al. (2020) argue TR is a "key professionalization factor" for successful EdTech integration. Conversely, low TR correlated with anxiety, burnout, and ineffective tech integration, hindering adoption and negatively impacting well-being (Pozas et al., 2022).

Despite TR's established importance, significant gaps persist in understanding its relationship to complex pedagogical tasks. Relatively few studies examine how specific TR components influence complex pedagogical tasks like designing educational content or evaluating learning materials (Blayone, 2018). Furthermore, antecedents beyond the core traits, such as prior ICT experience, self-efficacy, training, generational differences, contextual factors (e.g., infrastructure, support), and social-psychological dimensions like managing techno-stress, also shape teacher readiness and interact with its dimensions (Kim et al., 2019; Pozas et al., 2022). For instance, Pozas et al. (2022) found prior ICT experience strongly predicted readiness and coping during COVID-19. This highlights TR's multifaceted nature, where successful technology integration requires synergistic development across technical, pedagogical, and psychological domains, yet the mechanisms through which readiness influences skill acquisition beyond surface-level engagement remain unclear.

Digital Material Design Competency: Beyond Basic Technology Use

While technological readiness provides the psychological foundation for technology adoption, the practical application of these dispositions manifests through specific competencies. Digital material design competency represents teachers' ability to create effective digital instructional materials (multimedia lessons, interactive resources) that enhance learning. This competency extends far beyond basic technology use to encompass pedagogical integration, creativity, and evaluation (Göçen Kabaran & Uşun, 2021). This requires blending technological proficiency with pedagogical design: teachers must operate tools while contextualizing content to align with learning objectives.

Göçen Kabaran and Uşun (2021) operationalize this competency through four critical subdimensions. Designing and Developing encompasses creating original materials, Technical Competence involves using tools and software effectively, Techno-Pedagogical Competence requires integrating pedagogy with technology, and Application and Evaluation focuses on implementing and assessing impact. Each subdimension demands different combinations of technical skills, pedagogical knowledge, and creative thinking. Research reveals that these competencies are indeed multifaceted and challenging to develop. Teachers strong in innovative pedagogy show higher digital design skills (Kuloğlu, 2022), and pre-service teachers can develop "multifaceted digital capacities"—including designing digitally-enhanced materials—through targeted training (Kabaran & Altan, 2022). However, studies reveal significant gaps: while some pre-service teachers report moderate-to-high competency (Kadioglu & Ozkay, 2022), many lack confidence in aligning digital content with instructional goals or addressing learners' individual needs (Bediroğlu, 2021; Kuloğlu, 2022). This pattern suggests that effective design demands not only technical skills but also reflective thinking, decision-making, and technological fluency—capabilities that are unlikely to develop without positive internal dispositions toward technology (Bediroğlu, 2021).

Bridging Psychological Readiness and Design Competency

Given the complexity of both technological readiness and digital material design competency, understanding their relationship becomes crucial for teacher education. Although there is theoretical alignment between these constructs, very few studies have examined them in relation to each other. Most existing research focuses either on general digital literacy or on surface-level digital skills, leaving little known about how specific readiness traits support or inhibit the development of individual competencies involved in instructional design (Blayone, 2018; Pozas et al., 2022).

The theoretical connections suggest targeted relationships between specific readiness components and design competencies. For example, optimism may support the confidence needed to engage in the creative aspects of lesson planning and content development, while discomfort could limit the willingness to explore complex features of design platforms (Muehlburger et al., 2022). Innovativeness may encourage experimentation with advanced tools and multimedia applications, whereas insecurity might discourage the evaluation and revision of digital materials (Álvarez-Marín et al., 2023). These patterns suggest that the components of technological readiness may have differentiated effects on particular aspects of digital competence, yet these potential relationships remain largely theoretical.

Three key implications emerge from this theoretical framework. First, psychological foundations reveal that TR's drivers (optimism, innovativeness) may enable the risk-taking and persistence needed for complex digital design tasks, while its inhibitors (discomfort, insecurity) could hinder the reflective practice required for techno-pedagogical competence. Second, a potential skill development loop may exist where pre-service teachers with higher technology acceptance demonstrate stronger digital design competency (Kadioglu & Ozkay, 2022), and conversely, training in digital design may boost TR components like confidence (Kabaran & Altan, 2022). Third, training imperatives suggest that without explicit attention to both psychological readiness and technical competency, teachers may continue to show low digital competence (Domínguez-González et al., 2025), necessitating programs that integrate technical skill development (Aditya, 2021), guided practice in pedagogical design (Göçen Kabaran & Uşun, 2021), and cultivation of psychological readiness (Kim et al., 2019). However, most studies in this area treat readiness and competence as uniform characteristics rather than complex constructs composed of distinct but interacting traits. As a result, research has not yet clarified which dispositions are most closely related to specific skills, nor how teacher education programs might address these relationships in their training models. Furthermore, most existing research relies on correlational or regression methods, rarely employing multivariate approaches like Structural Equation Modeling (SEM) that can account for latent variables and control for confounding factors.

Purpose and Hypothesis of the Current Study

This study addresses the identified gaps by empirically examining how technological readiness predicts digital material design competencies among Turkish pre-service teachers. Despite growing recognition of both constructs, research has yet to examine their relationship in this population. Most prior studies have treated them separately—for example, profiling teachers' readiness for technology integration (Cuhadar, 2018; Polat et al., 2022) or assessing their digital content creation skills (Göçen Kabaran & Uşun, 2021; Şimşek & Yazıcı, 2021)—but the link between a teacher's tech-readiness mindset and their ability to design digital materials remains unexplored. This gap is notable because theory suggests the two may be interconnected: a teacher unready to adopt new technology might also be hesitant or less effective in designing digital resources.

The study aims to contribute both theoretically and practically. Theoretically, it integrates two strands of teacher education research—technology adoption (tech readiness) and digital instructional design—offering a more holistic understanding of teacher preparedness in the digital era. Practically, it will inform teacher education: if technological readiness strongly influences digital design skill, then programs should embed strategies to boost readiness (e.g., building confidence with tech) alongside hands-on design training. Ultimately, this study seeks to help teacher educators prioritize and align their curricula so that pre-service teachers not only can use technology, but are also ready to harness it creatively in lesson design, closing the gap between tech potential and classroom practice.

To fully understand this relationship, it is also necessary to account for key contextual and demographic factors that may influence digital competency development. Variables such as gender, grade level, and personal computer ownership have been shown to affect technology-related outcomes in prior studies, though their roles often diminish when attitudinal factors like readiness are taken into account. Therefore, this study examines whether the predictive relationship between technological readiness and digital material design competencies holds when these variables are statistically controlled.

Based on the theoretical framework and existing literature, the following hypothesis is proposed: When gender, grade level, and personal computer ownership are controlled for, technological readiness will significantly and positively predict pre-service teachers' digital material design competencies.

Method

Research Design

This study employed a quantitative, cross-sectional design to investigate the predictive relationship between technological readiness and digital material design competencies among pre-service teachers. This design was selected as appropriate for examining complex variable interactions and establishing predictive relationships in educational technology research (Creswell & Creswell, 2023; Kline, 2016). Structural equation modeling (SEM) was utilized as the primary analytical approach to test the hypothesized model, enabling simultaneous assessment of multiple relationships among attitudinal, demographic, and contextual factors.

Participants

A convenience sample of 506 pre-service teachers from the Faculty of Education at Eskişehir Osmangazi University, Türkiye, participated in the study. The sample size was determined to exceed the minimum requirements for SEM analysis, following recommendations of at least 10 participants per parameter estimated (Kline, 2016). Participants' ages ranged from 18 to 25 years (M = 21.3, SD = 1.8), which is representative of the typical age range of undergraduate education students in Türkiye. Complete demographic characteristics of the sample are presented in Table 1.

Table 1. Participant Distribution by Demographic Characteristics

Variable	Group	N	Percentage
Gender	Female	384	75,9
	Male	122	24,1
Class level	1	144	28,4
	2	169	33,4
	3	55	10,9
	4	138	27,3
Personal Computer Ownership	Yes	373	73,7
	No	133	26,3
	Total	506	100,0

Instruments

To measure the constructs of interest, two validated scales were employed, selected for their established psychometric properties and relevance to the study's objectives. The Technological Readiness Scale and the Digital Material Design Competencies Scale were used to assess participants' technology adoption tendencies and digital material design skills, respectively. Both scales have been widely applied in educational technology research and have demonstrated validity in the Turkish context (Esen, 2011; Göçen Kabaran & Uşun, 2021).

Technological Readiness Scale (TRS)

Originally developed by Parasuraman (2000) and adapted for Turkish contexts by Esen (2011), the TRS measures individuals' propensity to adopt and use new technologies. The 36-item scale encompasses four sub-dimensions: Optimism (12 items; e.g., "Technology gives me more freedom"), Innovativeness (8 items; e.g., "I enjoy experimenting with new devices"), Discomfort (8 items; e.g., "I avoid technology that requires troubleshooting"), and Insecurity (8 items; e.g., "I don't trust automated systems"). Responses are recorded on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). In this study, the TRS demonstrated strong internal consistency (α = 0.89 overall), with subscale reliabilities ranging from 0.79 (Discomfort) to 0.85 (Optimism), which is consistent with prior validations (α = 0.88–0.94).

Digital Material Design Competencies Scale (DMDCS)

Developed by Göçen Kabaran and Uşun (2021) specifically for pre-service teachers, the DMDCS assesses abilities to create pedagogical digital materials. The 31-item scale comprises four subscales: Design/Development (10 items; e.g., "I can align multimedia content with learning objectives"), Technical Skills (8 items; e.g., "I can edit video clips for lessons"), Techno-pedagogical Integration (7 items; e.g., "I adapt materials for diverse learners"), and Implementation/Evaluation (6 items; e.g., "I assess digital materials' effectiveness"). All items are rated on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The scale showed excellent reliability in this study (α = 0.92 overall), with subscale reliabilities ranging from 0.81 (Implementation) to 0.88 (Design), closely aligning with the developers' original reports (α = 0.91).

Data Collection Procedures

Data were collected during the spring semester of 2023 using an electronic survey administered via Google Forms. Participants received a standardized invitation through their institutional email addresses, which included the study's purpose, confidentiality assurances, and a direct link to the survey. Prior to survey completion, participants read and provided informed consent electronically. No financial or academic incentives were offered to minimize coercion risks, adhering to ethical guidelines for voluntary participation (APA, 2020). The survey remained accessible for four weeks, with follow-up reminder emails sent at weekly intervals (7, 14, and 21 days) to enhance response rates. The final dataset was cleaned and prepared for analysis following standard procedures for missing data assessment and outlier detection.

Statistical Analysis

Data analysis was conducted using IBM AMOS (version 25.0) to examine the relationships between technological readiness, digital material design competencies, and demographic variables. The analysis followed a multi-step approach to ensure robust model testing. Initially, descriptive statistics (means, standard deviations, and frequency distributions) were computed to characterize the sample. Data screening procedures were implemented to assess data quality and assumptions. Outliers were assessed using Cook's distance values, with no values exceeding 1, indicating the absence of multivariate outliers in the dataset (Yurt, 2023). Subsequently, skewness and kurtosis values were calculated; all fell within the ±1 range, confirming that the normality assumption was met (Hair et al., 1995). Multicollinearity was evaluated using variance inflation factor (VIF) values, all of which were below 3, indicating no multicollinearity issues (Yurt, 2023). Bivariate analysis was conducted using Pearson correlation coefficients to assess linear associations between continuous variables prior to the main analysis. Structural equation modeling (SEM) was then employed as the primary multivariate analysis to test the hypothesized predictive relationships. In the SEM model, technological readiness was specified as an exogenous latent variable, digital material design competencies as the endogenous variable, and gender, class level, and personal computer ownership as observed covariates. Model fit was evaluated using multiple goodness-of-fit indices (χ^2, RMSEA, CFI, SRMR, TLI, and IFI), following Hu and Bentler's (1999) recommendations for robust SEM evaluation.

Results

Correlation Analysis Results

Table 3 shows the correlations between demographic variables (grade, gender, computer ownership), technological readiness factors (optimism, innovativeness, discomfort, insecurity), and digital material design competencies (design and development, technical skills, technological pedagogical competence, and implementation and evaluation competence). Significant positive correlations were found between optimism and all dimensions of technological competencies: design and development ($r = .31$, $p < .01$), technical skills ($r = .36$, $p < .01$), technological pedagogical competence ($r = .27$, $p < .01$), and implementation and evaluation competence ($r = .30$, $p < .01$). Similarly, innovativeness was strongly and positively associated with design and development ($r = .47$, $p < .01$), technical skills ($r = .48$, $p < .01$), and moderately with other dimensions. In contrast, discomfort and insecurity were negatively correlated with technological competencies. The discomfort was negatively related to design and development ($r = -.13$, $p < .01$) and technical skills ($r = -.16$, $p < .01$), while insecurity was negatively associated with design and development ($r = -.15$, $p < .01$) and technical skills ($r = -.13$, $p < .01$). These results suggest that negative emotional reactions toward technology can hinder perceptions of competence.

Table 3. Descriptive Statistics and Pearson Correlation Coefficients

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11
1. Grade	-	-	-										
2. Gender [a]	-	-	.07	-									
3. PC [b]	-	-	.45**	-.03	-								
4. Optimism	38.12	5.03	.18**	.12**	.14**	-							
5. Innovativeness	21.83	3.60	.13**	.19**	.13**	.48**	-						
6. Discomfort	34.23	4.14	-.11*	-.04	-.18**	-.17**	-.21**	-					
7. Insecurity	31.98	5.29	-.05	-.17**	-.07	-.19**	-.21**	.42**	-				
8. DDC	27.27	5.94	.19**	.10*	.15**	.31**	.47**	-.13**	-.15**	-			
9. TC	26.14	4.94	.18**	.19**	.21**	.36**	.48**	-.16**	-.13**	.68**	-		
10. TPC	27.99	4.92	.22**	.03	.13**	.27**	.28**	-.06	.01	.61**	.65**	-	
11. IE	21.22	3.73	.28**	.01	.16**	.30**	.28**	-.05	.02	.48**	.57**	.71**	-

Note: *$p < .05$, **$p < .01$, [a] 0= Female, 1= Male, [b] 0= No, 1= Yes, PC= Personal computer, DDC= Design and development competence, TC= Technical competence, TPC= Techno pedagogical competence, IE= Implementation and evaluation

Computer ownership showed significant moderate positive correlations with all competency dimensions, especially technical skills ($r = .21$, $p < .01$) and implementation-evaluation competence ($r = .16$, $p < .01$), indicating access to personal technology is associated with stronger perceived skills. The grade was also positively correlated with all technology competencies, with the strongest correlation observed with implementation and evaluation competence ($r = .28$, $p < .01$). Gender showed relatively weak correlations, with a modest positive correlation between being female and optimism ($r = .12$, $p < .01$) and innovativeness ($r = .19$, $p < .01$).

These results indicate that higher optimism and innovativeness are positively related to technological competence, whereas discomfort and insecurity are negatively related. In addition, access to personal technology and higher grades are associated with greater perceived technological skills. A structural equation modeling (SEM) analysis was conducted as part of the advanced statistical procedures to explore the predictive relationships among these variables further.

Structural Equation Model Analysis Results

This study conducted a structural equation modeling (SEM) analysis to examine the effect of technological readiness on digital material design competencies among preservice teachers. The model included grade level, gender, and personal computer ownership as control variables. The fit indices indicated that the model fit the data well. Specifically, the chi-square to degrees of freedom ratio (χ^2/df) was found to be 3.52, which falls within the acceptable range ($2 \leq \chi^2/df \leq 5$). Additionally, RMSEA = .07 ($0 \leq$ RMSEA $\leq .08$), SRMR = .045 ($0 \leq$ SRMR $\leq .08$), CFI = .95 ($.90 \leq$ CFI ≤ 1.00), IFI = .95 ($.90 \leq$ IFI ≤ 1.00), and TLI = .95 ($.90 \leq$ TLI ≤ 1.00) all support the overall goodness of fit of the model (Hu & Bentler, 1999; Kline, 2016). The path diagram of the model is presented in Figure 1. The standardized path coefficients, standard errors, critical ratios, and significance levels of the hypothesized relationships are detailed in Table 6.

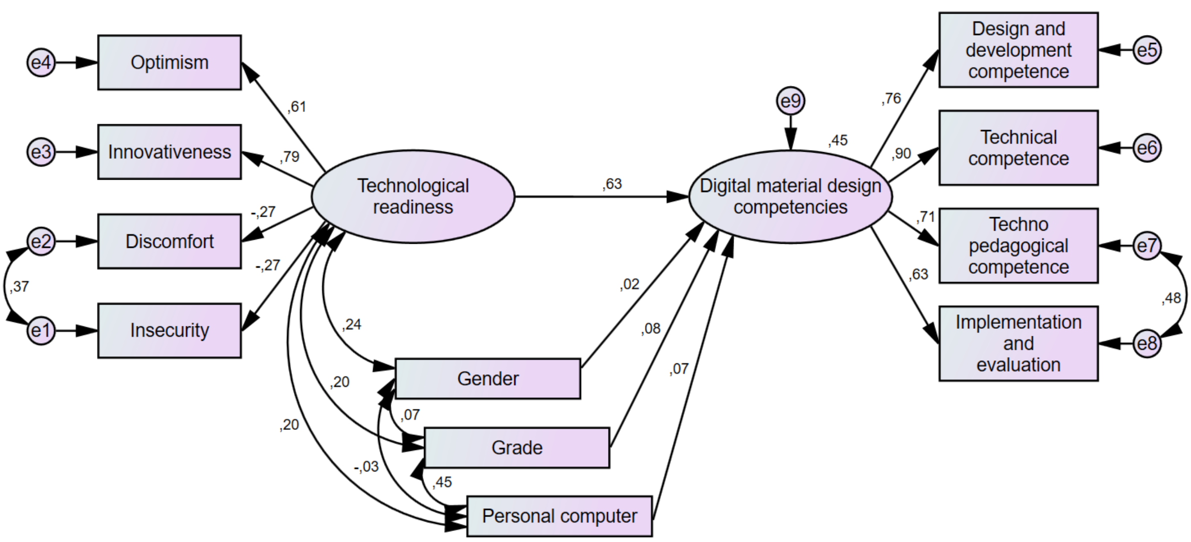

Figure 1. Structural Equation Model, χ^2=119.51, df= 34, p<.001

Table 6. Path Estimates in the Structural Equation Model (R^2 = .45)

Dependent		Predictor	β	S.E.	C.R.	P	%95 CI	
							Lower	Upper
Technological readiness	--->	Digital material design competencies	0,63	0,11	8,50	***	0,51	0,74
Gender	--->	Digital material design competencies	0,02	0,47	0,36	0,72	-0,09	0,12
Grade	--->	Digital material design competencies	0,08	0,18	1,67	0,10	-0,03	0,17
Personal computer	--->	Digital material design competencies	0,07	0,49	1,43	0,15	-0,03	0,16

Note: ***p < .001

As shown in Table 6, technological readiness was found to significantly and positively predict digital material design competencies (β = .63, p < .001). This finding suggests that preservice teachers who perceive themselves as technologically ready are likelier to demonstrate higher competencies in designing digital materials. The explained variance (R^2 = 0.45) demonstrates the model has strong explanatory power for digital material design competencies. In contrast, the control variables, gender (β = .02, p = .72), grade level (β = .08, p = .10), and personal computer ownership (β = .07, p = .15)—did not exhibit statistically significant effects on digital material design competencies. Although these variables were not significant predictors, their inclusion in the model is important for controlling potential confounding effects. In summary, the model reveals a substantial pathway from technological readiness to digital material design competencies, underscoring the central role of technological preparedness in developing digital content design skills.

Discussion

This study aimed to examine the predictive role of technological readiness on digital material design competencies among Turkish pre-service teachers, using structural equation modeling (SEM). Data were collected from 506 students at a public university in Türkiye, and validated scales were used to measure technological readiness and design competencies. The SEM model controlled for gender, grade level, and personal computer ownership. Results showed that technological readiness significantly and positively predicted digital material design competencies, while the control variables were not significant.

Main Findings

The primary hypothesis of this study proposed that technological readiness would significantly and positively predict digital material design competencies among pre-service teachers, even when gender, grade level, and personal computer ownership were statistically controlled. The structural equation modeling analysis fully supported this hypothesis (β = .63, p < .001), indicating a robust and positive relationship between readiness and digital design competencies.

This finding reinforces the idea that attitudes and psychological dispositions toward technology, particularly optimism and innovativeness, are critical drivers of meaningful engagement with digital content creation. Furthermore, the importance of digital material design competencies extends beyond pre-service teachers to in-service educators. Demircioğlu and Yurt (2024) found that classroom teachers' digital material design skills, assessed using the Digital Material Design Competencies Scale (Göçen Kabaran & Uşun, 2021), positively correlated with their professional competence perceptions, with design and development skills as a significant predictor. This suggests that proficiency in creating pedagogically sound digital materials not only enhances pre-service teachers' readiness for technology-integrated classrooms, as demonstrated in this study, but also bolsters in-service teachers' professional confidence. The consistency of these findings across teacher populations highlights the need for teacher education programs to prioritize digital material design training alongside fostering technological readiness, thereby supporting both pre-service preparation and ongoing professional development. Consequently, pre-service teachers with strong emotional and cognitive readiness for technology are better equipped to develop competencies for designing effective digital materials.

The observed predictive effect of technological readiness aligns with previous research suggesting that affective variables can enhance digital performance more strongly than access or experience alone (Blayone, 2018; Kim et al., 2019). Similar to findings by Álvarez-Marín et al. (2023), optimism and innovativeness were found to be positively associated with design competency subdimensions, supporting the argument that positive technology attitudes drive both engagement and experimentation. Moreover, the result supports Pozas et al. (2022), who argue that teachers with higher readiness profiles are more adaptive and less stressed in technology-intensive teaching environments. This suggests that readiness does not merely reflect personality or attitude, it has tangible consequences for competency development.

This study distinguishes itself from prior work by testing the hypothesis using a structural equation modeling (SEM) framework while controlling for key demographic variables. Whereas earlier studies tended to treat readiness or competency as isolated constructs, this research integrated them within a unified model, showing that readiness explains a substantial portion of variance in design competencies ($R^2 = .45$). Furthermore, the study fills a notable gap in the literature by focusing on Turkish pre-service teachers, a population underrepresented in EdTech readiness studies, and showing that attitudinal factors may have greater impact than structural ones (e.g., ownership or gender). This not only adds cultural nuance to the global discourse but also highlights the need for readiness-focused interventions in teacher education programs.

Control Variables Analysis

Gender

Gender did not significantly predict digital material design competencies when technological readiness was controlled ($\beta = .02$, $p = .72$), indicating that male and female pre-service teachers exhibited similar competency levels when they shared comparable attitudes and readiness toward technology. This finding aligns with recent research by Campos and Scherer (2023), which suggests that gender differences in digital skills are narrowing in higher education, especially in contexts with standardized, technology-integrated curricula. It also supports Redecker's (2017) DigCompEdu framework, which highlights how equitable access and structured training can help close traditional digital skill gaps. However, the result contrasts with earlier studies (e.g., Campos & Scherer, 2024; Vázquez-Cano et al., 2017) that reported gender-based disparities in digital literacy or technical abilities. A key distinction in the present study is its inclusion of affective-motivational variables such as technological readiness, which may account for the absence of gender-related variance. Thus, the findings contribute to the growing body of literature suggesting that in environments emphasizing readiness and equity in training, demographic factors like gender may play a diminished role in predicting digital teaching competencies.

Individual Computer Ownership

Although pre-service teachers who owned a personal computer initially demonstrated higher digital design competency scores, this effect became non-significant in the structural equation model after accounting for technological readiness ($\beta = .07$, $p = .15$). This indicates that personal access to digital devices alone does not guarantee competence in digital material design unless it is accompanied by attitudinal readiness, such as confidence and willingness to engage with new technologies. This finding aligns with the Technology Readiness Index (Parasuraman, 2000), which highlights psychological drivers, such as optimism and innovativeness, as key determinants of effective technology use.

The critical role of attitudinal factors is further evidenced by the widespread sense of unpreparedness among teacher candidates. Recent studies reveal that many pre-service teachers feel ill-equipped for digital teaching: Dolezal et al. (2025) found that roughly half of surveyed pre-service teachers "do not feel sufficiently prepared by their study program to foster digital competence." This preparation gap is compounded by research demonstrating that teachers' confidence and perceived readiness strongly influence their technological competence. Dai et al. (2023) report that pre-service teachers' ICT self-efficacy has a strong positive association with their digital competence, while infrastructure support has a weaker, though still positive, effect. Similarly, Marais (2023) emphasizes that during COVID-19, many students lacked the skills to effectively use even the technology that institutions provided, underscoring the dual importance of access and competence.
Pre-service teachers themselves articulate these challenges through their feedback and experiences. In focus groups, advanced teacher candidates expressed eagerness to learn digital skills but requested more structured collaboration and guidance to reach professional-level digital material design capabilities (Dai et al., 2023). When provided with dedicated support through a 14-week course, the majority of students "could successfully experience [the] digital material design process" and felt "improved enough to practice teaching with digital materials and resources" (Kabaran & Altan, 2022). However, they also encountered concrete technical obstacles, with students noting difficulties such as "Prezi is very difficult to use… Organizing templates… are very difficult" and concerns about premium features requiring payment in platforms like Canva. Such feedback highlights what Kabaran & Altan (2022) call the teacher's "double challenge" of mastering both technology use and effective pedagogical design with digital tools.

Unlike studies in low-resource settings (e.g., Mallillin et al., 2020), where limited access to technology posed a significant barrier, the current study, conducted in a relatively high-access environment (73.7% ownership rate), suggests that attitudinal factors outweigh access in predicting digital competence. In practice, this means teacher education programs should not only provide devices and software to ensure students aren't limited to basic tools like phones in the classroom (Dolezal et al., 2025), but also embed hands-on, scaffolded instruction in material design to build confidence and competence simultaneously. When programs implement such comprehensive approaches, pre-service teachers report significant gains, but when they don't, many candidates feel they lack both access and readiness for digitally-rich teaching. These results underscore the need to embed readiness-building strategies within teacher education programs, especially in settings where technological infrastructure is already available. They also imply that resource-provision efforts should be coupled with psychological and pedagogical support to foster meaningful and sustained learning outcomes, addressing both external factors (access to technology and support) and internal factors (attitudes, confidence, and thorough training) simultaneously.

Grade Level

Grade level was not a significant predictor of digital material design competencies when technological readiness was included in the model ($\beta = .08$, $p = .10$), despite a moderate correlation found in initial bivariate analyses ($r = .28$, $p < .01$). This suggests that although upper-grade students—particularly those in their fourth year—tend to demonstrate more advanced design skills, these improvements are likely attributable to prolonged exposure to technology-rich learning environments rather than mere academic progression. This finding is consistent with Koyuncuoğlu (2022), who noted that project-based courses and sustained engagement with digital tools enhance design competencies. The absence of a significant direct effect in the structural equation model implies that, once technological readiness is considered, grade level loses its predictive value. Therefore, fostering technological readiness early in teacher education programs may be equally, if not more, critical than relying on passive competency development over time, highlighting the importance of embedding structured, psychologically informed interventions throughout all stages of teacher training.

Limitations and Future Directions

This study, while offering meaningful insights, is not without limitations. First, it utilized a cross-sectional design, which restricts causal inference. Longitudinal studies are needed to examine how technological readiness and design competencies evolve over time. Second, data were collected from a single institution, limiting generalizability across diverse educational contexts in Türkiye. Third, although the study controlled for key demographic variables, it did not account for factors such as digital self-efficacy, frequency of technology use, or prior training experiences. Future research should incorporate these variables and explore potential mediators or moderators to gain a deeper understanding of the mechanisms linking readiness and competency.

Conclusion

This study demonstrates that technological readiness is a significant and robust predictor of digital material design competencies among Turkish pre-service teachers, even when demographic factors such as gender, grade level, and computer ownership are accounted for. By integrating readiness theory and employing structural equation modeling, the study fills a notable gap in the literature and emphasizes the psychological dimensions of technology integration in teacher education. These findings suggest that attitudes such as optimism and innovativeness are not only desirable traits but essential foundations for developing advanced digital teaching skills.

Practical Recommendations

Teacher education programs should go beyond technical training and invest in cultivating technological readiness early in the curriculum. Courses should include opportunities to foster optimism and innovativeness, such as project-based learning, design tasks, and reflective practices around technology use. Policymakers should also ensure that efforts to provide device access are paired with interventions that support teachers' emotional and cognitive readiness for technology. Finally, educators should treat digital material design not merely as a technical task but as a pedagogical process that requires confidence, creativity, and adaptability.

Author(s)' Statements on Ethics and Conflict of Interest

***Ethics Statement*:** The study was approved by the Eskişehir Osmangazi University Social and Humanities Research Ethics Committee (Date: 12.10.2022; Issue Number: 2022-15).
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References

Aditya, D. S. (2021). *Embarking digital learning due to COVID-19: Are teachers ready? Journal of Technology and Science Education*, *11*(1), 104–116. https://doi.org/10.3926/jotse.1109

Álvarez-Marín, A., Velázquez-Iturbide, J. Á., & Castillo-Vergara, M. (2023). The acceptance of augmented reality in engineering education: The role of technology optimism and technology innovativeness. *Interactive Learning Environments, 31*(6), 3409–3421. https://doi.org/10.1080/10494820.2021.1928710

APA (American Psychological Association). (2020). *Publication manual of the American Psychological Association* (7th ed.). https://doi.org/10.1037/0000165-000

Ata, R., & Yıldırım, K. (2019). Exploring Turkish Pre-Service Teachers' Perceptions and Views of Digital Literacy. *Education Sciences*, *9*(1), 40. https://doi.org/10.3390/educsci9010040

Badri, M., Al-Rashedi, A., Yang, G., Mohaidat, J., & Al-Hammadi, A. (2014). Technology readiness of school teachers: An empirical study of measurement and segmentation. *Journal of Information Technology Education: Research, 13,* 257–275. http://www.jite.org/documents/Vol13/JITEv13ResearchP257-

275Badri0616.pdf

Bediroğlu, R. (2021). *Fen bilgisi öğretmen adaylarının dijital öğretim materyali geliştirme öz-yeterlikleri*. [Unpublished master dissertation]. Yıldız Teknik University.

Blayone, T. (2018). Reexamining digital-learning readiness in higher education: Positioning digital competencies as key factors and a profile application as a readiness tool. *International Journal on E-Learning, 17*(4), 425–451. https://www.learntechlib.org/primary/p/178285/

Campos, D. G., & Scherer, R. (2024). Digital gender gaps in Students' knowledge, attitudes and skills: an integrative data analysis across 32 Countries. *Educ Inf Technol 29,* 655–693. https://doi.org/10.1007/s10639-023-12272-9

Chu, J., Lin, R., Qin, Z., Chen, R., Lou, L., & Yang, J. (2023). Exploring factors influencing pre-service teachers' digital teaching competence and the mediating effects of data literacy: Empirical evidence from China. *Humanities and Social Sciences Communications, 10*, 508. https://doi.org/10.1057/s41599-023-02016-y

Creswell, J. W., & Creswell, J. D. (2023). *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed.). SAGE Publications

Cuhadar, C. (2018). Investigation of pre-service teachers' levels of readiness to technology integration in education. *Contemporary Educational Technology, 9*(1), 61-75. https://doi.org/10.30935/cedtech/6211

Dai, W. (2023). An empirical study on English preservice teachers' digital competence regarding ICT self-efficacy, collegial collaboration and infrastructural support. *Heliyon, 9*(9), e19538. https://doi.org/10.1016/j.heliyon.2023.e19538.

Demircioğlu, E., & Yurt, E. (2024). The importance of digital material design skills for classroom teachers' perceptions of professional competence: A relational study. *Cumhuriyet International Journal of Education*, *13*(2), 489–499. https://doi.org/10.30703/cije.1346916

Demirtaş, B., & Mumcu, F. (2021). Pre-service teachers' perceptions of ICT and TPACK competencies. *Acta Educationis Generalis, 11*(2), 60–82. https://doi.org/10.2478/atd-2021-0013

Dolezal, D., Motschnig, R., & Ambros, R. (2025). Pre-service teachers' digital competence: A call for action. *Education Sciences, 15*(2), 160. https://doi.org/10.3390/educsci15020160.

Domínguez-González, M. Á., Luque de la Rosa, A., Hervás-Gómez, C., & Román-Graván, P. (2025). Teacher digital competence: Keys for an educational future through a systematic review. *Contemporary Educational Technology, 17*(2), e577. https://doi.org/10.30935/cedtech/16168

Esen, M. (2011). *Bireysel ve kurumsal hazıroluşun teknoloji kabulüne etkisi: Elektronik insan kaynakları yönetimi (E-İKY) alanında ampirik bir araştırma [The effect of individual and organizational readiness on technology acceptance: An empirical study in the field of electronic human resources management]*. [Doctoral dissertation], Kocaeli University.

Falebita, O.S., & Kok, P.J. (2025). Artificial intelligence tools usage: A structural equation modeling of undergraduates' technological readiness, self-efficacy and attitudes. *Journal for STEM Educ Res 8*, 257-282 (2025). https://doi.org/10.1007/s41979-024-00132-1

Göçen Kabaran, G., & Altan, B. A. (2022). Reflections of pre-service teachers on digital material design after practising digitally-enhanced instructional events. *Psycho-Educational Research Reviews, 11*(3), 675–691. https://doi.org/10.52963/PERR_Biruni_V11.N3.20

Göçen Kabaran, G., & Uşun, S. (2021). Digital material design competencies scale (DMDCS): A scale development study. *Educational Technology Theory and Practice, 11*(1), 59–76. https://doi.org/10.17943/etku.864296

Grande-de-Prado, M., Cañón, R., García-Martín, S., & Cantón, I. (2020). Digital competence and gender: Teachers in training. *Future Internet, 12*(11), 204. https://doi.org/10.3390/fi12110204

Hair , J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1995). *Multivariate data analysis*. Englewood Cliffs, NJ: Prentice-Hall.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Kabaran, G. G., & Altan, B. A. (2022). Reflections of pre-service teachers on digital material design after practising digitally-enhanced instructional events. *Psycho-Educational Research Reviews, 11*(3), 675–691. https://doi.org/10.52963/PERR_Biruni_V11.N3.20

Kaçar, I. G. (2022). Pre-service EFL teachers as digital material designers: A case study into the TPACK development in the Turkish context. *Teaching English with Technology, 22*(3-4), 107–130. https://eric.ed.gov/?id=EJ1367618

Kadioğlu, N., & Özkay, Ö. (2022). Teachers' competence in designing digital materials and their acceptance and use of technology. In E. Ben Attou, M. L. Ciddi, & M. Ünal (Eds.), *Proceedings of the 2022 International Conference on Studies in Education and Social Sciences* (ICSES 2022). International Society for Technology in Education.

Kim, H.J., Hong, A.J. & Song, HD. (2019). The roles of academic engagement and digital readiness in students' achievements in university e-learning environments. *Int J Educ Technol High Educ 16*, 21. https://doi.org/10.1186/s41239-019-0152-3

Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press

Koyuncuoglu, D. (2022). Analysis of digital and technological competencies of university students. *International Journal of Education in Mathematics, Science, and Technology, 10*(3), 234–245. https://doi.org/10.46328/ijemst.2583

Kuloğlu, A. (2022). The relationship between innovative pedagogy practice and digital material design competencies of teachers. *International Online Journal of Educational Sciences, 14*(3), 567–580. https://doi.org/10.15345/iojes.2022.03.009

Mallillin, L. L., Mendoza, L. C., Mallillin, J. B., Felix, R. C., & Lipayon, I. C. (2020). Implementation and readiness of online learning pedagogy: A transition to COVID-19 pandemic. *European Journal of Open Education and E-Learning Studies, 5*(2), 1–15. https://doi.org/10.46827/ejoe.v5i2.3321

Marais, E. (2023). The development of digital competencies in pre-service teachers. *Research in Social Sciences and Technology, 8*(3), 134-154.https://doi.org/10.46303/ressat.2023.28

Muehlburger, M., Krumay, B., Koch, S., & Currle, S. (2022). Individual digital transformation readiness: Conceptualisation and scale development. *International Journal of Innovation Management, 26*(5), 2250014. https://doi.org/10.1142/S1363919622400138

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). McGraw-Hill.

Parasuraman, A. (2000). Technology readiness index (TRI): A multiple-item scale to measure readiness to embrace new technologies. *Journal of Service Research, 2*(4), 307–

320. https://doi.org/10.1177/109467050024001

Parasuraman, A., & Colby, C. L. (2001). *Techno-ready marketing: How and why your customers adopt technology*. Free Press

Polat, E., Hopcan, S., & Yahşi, Ö. (2022). Are K–12 teachers ready for e-learning? *International Review of Research in Open and Distributed Learning, 23*(2), 214–241. https://doi.org/10.19173/irrodl.v23i2.6082

Pozas, M., Letzel-Alt, V., & Schneider, C. (2022). "The whole is greater than the sum of its parts" – Exploring teachers' technology readiness profiles and its relation to their emotional state during COVID-19 emergency remote teaching. *Frontiers in Education, 7*, Article 1045067. https://doi.org/10.3389/feduc.2022.1045067

Rafiq, K. R. M., Yunus, M. M., & Susiati, S. (2022). Re-envisioning technological pedagogical content knowledge and online teaching readiness of English for foreign language pre-service teachers in language teacher education. *Frontiers in Psychology, 13*, 927835. https://doi.org/10.3389/fpsyg.2022.927835

Redecker, C. (2017). *European Framework for the Digital Competence of Educators: DigCompEdu*. Publications Office of the European Union. https://publications.jrc.ec.europa.eu/repository/handle/JRC107466

Rodríguez, R. F., Horna, R. F. C., Placido, J. M. M., & Barbuda, J. J. M. (2024). Influence of digital skills on the academic performance of university students: A socioeconomic approach. *Revista De Gestão Social E Ambiental, 18*(2), e04995. https://doi.org/10.24857/rgsa.v18n2-055

Şimşek, M., & Yazıcı, N. (2021). Examining the digital learning material preparation competencies of pre-Service mathematics teachers. *Participatory Educational Research, 8*(3), 323-343. https://doi.org/10.17275/per.21.68.8.3

Tatlı, Z. ve Akbulut, H. İ. (2017). Öğretmen adaylarının alanda teknoloji kullanımına yönelik yeterlilikleri. *Ege Eğitim Dergisi, 18*(1), 31-55. https://doi.org/10.12984/egeefd.328375

Van der Spoel, I., Noroozi, O., Schuurink, E., and van Ginkel, S. (2020). Teachers' online teaching expectations and experiences during the Covid19-pandemic in the Netherlands. Eur. J. Teach. Educ. 43, 623–638. doi:10.1080/02619768.2020.1821185

Vázquez-Cano, E., Meneses, E.L. & García-Garzón, E. (2017). Differences in basic digital competences between male and female university students of Social Sciences in Spain. *Int J Educ Technol High Educ 14*, 27. https://doi.org/10.1186/s41239-017-0065-y

Yurt, E. (2023). *Sosyal bilimlerde çok değişkenli analizler için pratik bilgiler: SPSS ve AMOS uygulamaları [Practical Insights for Multivariate Analyses in Social Sciences: SPSS and AMOS Applications]*. Nobel.