sustainability

MDPI

Article

Social Sustainability of the Teaching Profession: Pedagogical Beliefs and Pre-Service Teachers' Digital Competence in STEAM

Merve Şahin

Department of Child Development, Bayramiç Vocational School, Canakkale Onsekiz Mart University, Çanakkale 17700, Turkey; mervesahin@comu.edu.tr; Tel.: +90-5549975760

Abstract

The integration of digital technologies into early childhood education extends beyond mere technical necessity; it constitutes a fundamental pillar of social sustainability within the teaching profession. Yet, a persistent paradox remains in teacher education: the "Attitude–Competence Gap," where pre-service teachers' enthusiasm for technology fails to translate into practical proficiency. This study interrogates this disconnect within a STEAM framework, specifically examining whether digital competence is driven by general technological attitudes or domain-specific pedagogical beliefs. Utilizing an explanatory sequential mixed-methods design, we analyzed data from 200 Child Development students, followed by in-depth semi-structured interviews with 15 participants who exhibited high attitudes but low initial competence. Hierarchical regression analysis yielded a critical insight: while general attitudes toward digital storytelling did not predict competence ($p > 0.05$), pedagogical beliefs regarding the use of children's literature in mathematics were a strong predictor of technical proficiency ($\beta = 0.35$, $p < 0.001$). Qualitative evidence corroborated that students overcame technical limitations not through technological affinity but through a motivation to concretize abstract mathematical concepts via storytelling. These findings suggest that to foster sustainable STEAM education, teacher training curricula must prioritize the "why" (pedagogical conviction) over the "how" (technical mechanics), thereby closing the gap between digital intention and action. This study uniquely demonstrates that domain-specific pedagogical convictions, rather than general technological enthusiasm, are the fundamental drivers of digital competence in STEAM, providing an empirical basis for more resilient teacher education models.

Keywords: social sustainability; STEAM education; digital storytelling; TPACK; pedagogical beliefs; teacher education

Check for updates

Academic Editor: Hao-Chiang Koong Lin

Received: 5 January 2026
Revised: 27 January 2026
Accepted: 4 February 2026
Published: 6 February 2026

Copyright: © 2026 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

1. Introduction

Developing competencies that encompass creative thinking, collaboration, critical thinking, and digital literacy is among the fundamental objectives of contemporary educational systems [1,2]. The foundations of these competencies are established during early childhood, a period that necessitates active and interactive learning environments suited to children's developmental levels [3]. In this context, the integration of technology into educational settings and the pedagogical use of digital tools have gained increasing importance for Child Development Programs and educators [4]. However, the inclusion of technology in educational processes extends beyond a mere instrumental necessity; it entails a complex process that must be effectively managed by pre-service teachers. In this research, social sustainability is defined as the continuous development of teachers'

professional resilience and psychological flexibility, ensuring their long-term ability to adapt to technological evolution without compromising educational quality.

Technology integration poses a significant challenge for the pedagogical preparation of pre-service teachers, and this preparation is increasingly framed as a matter of social sustainability within the teaching profession. This process requires candidates to possess not only technical knowledge but also psychological foundations such as self-regulation and social–emotional competence [5]. Teachers' self-efficacy beliefs strongly predict their intention to integrate technology [6,7]. Consequently, effective pedagogical tools are needed to translate this intention into action and to support these competencies through concrete applications.

This study aims to ensure the social sustainability of the early childhood teaching profession by identifying the factors that drive pre-service teachers' digital competence through a STEAM framework, specifically focusing on the gap between general attitudes and domain-specific pedagogical beliefs.

1.1. Theoretical Background

1.1.1. Digital Storytelling and STEAM in Early Childhood

One prominent method facilitating this integration is digital storytelling (DST). DST is defined as the process of constructing a narrative by combining multimedia elements such as text, audio, images, and video [8,9]. In the context of preschool and mathematics education, DST offers the potential to concretize abstract mathematical concepts and integrate complex problem-solving skills into a narrative format, aligning with the interdisciplinary nature of STEAM (Science, Technology, Engineering, Arts, and Mathematics) education [10,11].

The transdisciplinary essence of STEAM education during the foundational years of childhood demands a shift from siloed instruction toward an integrated, inquiry-led pedagogical model. Within this landscape, digital storytelling emerges as a sophisticated cognitive bridge that enables young learners to synthesize logical–mathematical inquiry with creative, narrative-driven exploration. By contextualizing mathematical problems within the architecture of a story, educators can catalyze a process of "embodied meaning-making," transforming distal concepts into proximal, manageable challenges. Such a synthesis ensures that digital tools are perceived not as supplementary instruments but as intrinsic vehicles for semiotic mediation and intellectual curiosity.

Moreover, the deployment of digital narratives within a STEAM framework responds directly to the developmental imperatives of play-based and multisensory learning. This approach facilitates a transition from passive digital consumption to active participation in a socio-technical learning environment where collaborative problem-solving and critical thinking are paramount. From the vantage point of social sustainability, fostering this level of engagement in early childhood cultivates the cognitive resilience and adaptive capacity necessary for navigating an increasingly complex technological future. This shift ultimately redefines the educator's role as a designer of digital–pedagogical ecosystems, reinforcing the necessity for pre-service teachers to harmonize their technical skills with deep-seated pedagogical convictions.

The successful implementation of DST depends on Child Development Program students possessing the necessary Technological Pedagogical Content Knowledge (TPACK) [12]. The TPACK framework delineates the flexible types of knowledge required for effective technology integration [13,14].

1.1.2. Pedagogical Beliefs and Professional Competence

Literature reviews synthesize the fundamental effects of combining digital storytelling and game-based approaches on pre-service teachers within the TPACK framework. These effects can be examined under three main categories: cognitive, technical, and affective dimensions. First, regarding Enhanced TPACK and Pedagogical Impact, studies indicate that the process of creating digital stories leads to significant improvements in the TPACK levels of pre-service teachers [12,15]. However, technical competence alone is insufficient; addressing the necessity of AI integration, Çelik [16] emphasizes that the ethical integration of AI tools into the classroom requires not only technical proficiency but also ethical and pedagogical competence.

The acquisition of such pedagogical competence by future educators directly fosters the higher-order thinking skills targeted within instructional processes. In this regard, Computational Thinking and Problem Solving skills emerge as critical components. Digital storytelling (DST) activities have been shown to support problem-solving skills [17,18]. Furthermore, enabling students to design their own educational games using visual programming tools such as ScratchJr has been found to enhance both their Computational Thinking skills [19,20] and creativity [21]. Crucially, this design process impacts not only the pre-service teacher but also the academic achievement of the child, who constitutes the ultimate target audience. Indeed, an experimental study by Preradovic et al. [22] demonstrated that children in an experimental group utilizing digital stories achieved statistically significant higher results in mathematical literacy compared to a control group. Finally, the sustainability of cognitive and technical gains depends on practitioners' beliefs and attitudes toward technology. From the perspective of Attitude and Practice, it is emphasized that teachers should integrate familiar digital and non-digital resources rather than relying on unfamiliar tools [23]. Such positive experiences acquired during the process reinforce pre-service teachers' self-efficacy and their intentions to develop positive attitudes toward technology integration [24].

Pedagogical beliefs function as internal filters through which pre-service teachers evaluate the utility and instructional potential of digital tools. These beliefs are not merely peripheral attitudes but represent a dynamic cognitive architecture that governs "pedagogical risk-taking" when candidates encounter complex technological challenges. When a teacher's conviction regarding the efficacy of a specific method—such as the integration of children's literature into mathematics—is firmly established, it serves as a catalyst for professional self-regulation and intentional praxis. This psychological foundation allows the educator to pivot from the perceived difficulty of technical mechanics to the intrinsic value of pedagogical outcomes. Within this framework, professional competence emerges as more than a collection of technical skills; it is a manifestation of professional resilience, where the "pedagogical why" provides the essential momentum to bridge the gap between digital intention and practical action.

1.1.3. The Attitude–Competence Gap in Teacher Education

This study addresses a gap in the existing literature by analyzing Child Development Program students' attitudes, competencies, and pedagogical strategies within the context of DST through a holistic perspective.

The persistence of the "Attitude–Competence Gap" underscores a critical nuance in teacher education: the distinction between pervasive digital nativity and specialized instructional design capacity. High technological enthusiasm often masks a "fluency illusion," where pre-service teachers' comfort with intuitive digital interfaces in their personal lives creates a false sense of preparedness for the rigorous demands of pedagogical integration. This divergence is conceptually situated at the intersection of affective readiness and cogni-

tive load management. While a positive attitude lowers the affective filter for technology adoption, it does not automatically mitigate the technical friction inherent in synthesizing multi-layered STEAM concepts within a digital medium. Consequently, the transition from an enthusiastic observer to a competent digital practitioner requires more than motivational support; it demands a structured scaffolding of Technological Pedagogical Content Knowledge (TPACK) that enables candidates to navigate the complexities of the "design-thinking" process. By interrogating this gap, teacher education programs can move beyond the binary of technophobia versus technophilia, instead fostering the professional resilience essential for the social sustainability of the contemporary teaching workforce.

Moving beyond existing studies, the analysis of pre-service teachers' interactions with digital tools highlights a current necessity in the field. The originality of this study lies in the methodological depth designed to address this deficiency. In particular, the in-depth analysis of the "Attitude–Competence Gap" observed in quantitative findings through qualitative interviews will clearly elucidate how high motivation toward technology relates to practical proficiency. The findings obtained extend beyond a mere technical assessment to offer a broader professional perspective. This integrated analysis makes a unique contribution to the field by demonstrating how the development of technological competencies supports self-efficacy and self-regulation skills, which are essential for the social sustainability of the teaching profession [5]. In this regard, the analysis of Child Development Program students' interactions with digital tools highlights a current necessity and gap in the literature. While existing research generally focuses solely on the pedagogical or technical impact of digital storytelling, this study presents a multidimensional perspective by combining quantitative data—encompassing both attitude (affective) and competence (cognitive) dimensions—with qualitative reflections regarding the challenges candidates face and the pedagogical strategies they develop (specifically, TPACK and game integration). Specifically, by conducting an in-depth analysis of the "Attitude–Competence Gap" observed in the quantitative findings through qualitative interviews, this study elucidates how high motivation toward technology correlates with practical proficiency. While self-efficacy and self-regulation were not directly measured as quantitative variables in this study, they serve as the theoretical psychological foundation for the observed qualitative transformations in digital competence, supporting the long-term professional resilience required for social sustainability.

2. Materials and Methods

2.1. Research Design

This study employed an Explanatory Sequential Mixed Methods Design, adhering to the integration standards and procedural rigor established by Creswell and Plano Clark [25]. This methodological choice was justified by the need for 'complementarity'; the qualitative phase was specifically designed to expand upon the quantitative results by explaining the underlying mechanisms of the 'Attitude–Competence Gap' that statistical data alone could not fully elucidate. By following this sequential standard, the research ensures a more robust and nuanced interpretation of how pedagogical beliefs bridge the gap between technological intent and practical proficiency.

The research process was conducted in two distinct phases. In the first phase, a predictive correlational design was employed to determine the extent to which pre-service teachers' attitudes and pedagogical beliefs predict their digital storytelling competence [26]. Following the statistical analysis, a qualitative case study design was implemented to examine the underlying mechanisms of the quantitative results in depth [27]. Within this framework, the 'case' was defined as the specific phenomenon of the 'Attitude–Competence Gap' observed among the candidates within the context of the Child Development program.

This methodology allowed for investigating why high attitudes did not translate into competence and how pedagogical beliefs bridged this gap.

In line with this purpose, the research addresses the following questions:

1. What are the descriptive levels of Child Development Program students' attitudes, competencies, and pedagogical beliefs regarding the digital storytelling process?
2. To what extent do pre-service teachers' digital storytelling attitudes and their beliefs about using children's literature in mathematics predict their digital storytelling competence?
3. How do the qualitative pedagogical reflections of the students explain the statistical relationships (or lack thereof) observed in the regression model?

2.2. Participants

The research was conducted within the Child Development Program of a Vocational School affiliated with a state university in the Marmara Region, Turkey. This institution offers a two-year associate degree curriculum focused on early childhood education. For the quantitative phase of the study, a total population sampling (census) strategy was employed, aiming to reach the entire universe of students enrolled in the 1st and 2nd years of the program. Consequently, the quantitative sample consisted of 200 students, representing the accessible population in its entirety. This sample size exceeds the minimum requirements for the hierarchical regression analysis conducted in this study, ensuring sufficient statistical power and representativeness. As detailed in Table 1, the majority of the participants were female (89.5%), and the distribution between 1st-year (51%) and 2nd-year (49%) students was balanced.

Table 1. Demographic Characteristics of Participants (N = 200).

Characteristic	Sub-Categories	*n*	%
Grade Level	1st Year	102	51.0
	2nd Year	98	49.0
Gender	Female	179	89.5
	Male	21	10.5
Digital Storytelling Experience	Yes	55	27.5
	No	145	72.5
Course Experience with Children's Lit.	Yes	71	35.5
	No	129	64.5

Note. The gender imbalance (89.5% female) reflects the typical demographic distribution of Child Development programs in Turkey.

For the qualitative phase, a criterion-based purposeful sampling strategy was adopted to select a specific subgroup from the larger quantitative pool. The primary selection criterion was the identification of the "Attitude–Competence Gap." Accordingly, 15 students were recruited who exhibited high scores on the Attitude Scale (M > 3.83) but comparatively low scores on the Competence Scale (M < 3.08). This sample size (N = 15) was deemed adequate for the qualitative case study component, as it meets the recommended thresholds for achieving data saturation in phenomenological and case study research, allowing for a deep exploration of the participants' pedagogical transformations and technical challenges.

Qualitative Study Group: The qualitative interview group was determined via purposeful sampling based on the results of the quantitative data analysis. Specifically, 15 Child Development Program students were selected to explore different experiences and perspectives regarding the process. These participants were specifically targeted from among students who exhibited high scores on the Digital Storytelling Attitude Scale despite having

low scores on the Digital Storytelling Competence Scale (referred to as the "Attitude–Competence Gap"). This selection criterion aimed to provide an in-depth analysis of this contradictory phenomenon.

2.3. Data Collection Tools

Data were collected using three validated quantitative instruments and a semi-structured interview form designed to align with the research objectives.

Beliefs about Using Children's Literature in Mathematics Teaching Scale (BUCLMT): Developed by Durmaz [28], this instrument assesses pre-service teachers' pedagogical beliefs regarding the integration of literary works into mathematics education. The scale comprises 33 items. For the current study, the instrument demonstrated high internal consistency ($\alpha = 0.879$), indicating strong reliability for the collected data. The construct validity of the scale was previously established through factor analysis by the original developer.

Digital Story Tools Competence Scale (DSTCS): To evaluate participants' self-efficacy in digital narrative creation, material design, and technical tool usage, the scale developed by Çelik [29] was utilized. Consisting of 17 items, the scale provided a robust measure of technical proficiency in this research context, yielding an excellent Cronbach's Alpha reliability coefficient of ($\alpha = 0.973$). The construct validity of the DSTCS was previously confirmed through exploratory and confirmatory factor analyses in its original development study.

Digital Storytelling Attitude Scale (DSAS): This 31-item scale was employed to determine the affective tendencies and general attitudes of the candidates toward the digital storytelling method [30]. In the present study, the scale exhibited high reliability ($\alpha = 0.877$), confirming its suitability for measuring the participants' attitudes. The original developers established the scale's construct validity using factor analysis, ensuring its effectiveness in measuring affective tendencies toward digital storytelling.

Semi-Structured Interview Form: For the qualitative phase, a semi-structured interview protocol was developed to explore the participants' design experiences and pedagogical reflections in depth. The interview questions were formulated specifically to investigate the study's central "Attitude–Competence Gap" hypothesis. The protocol focused on four key themes: (1) challenges encountered during the concept selection and design phases; (2) the pedagogical functions assigned to visuals and characters; (3) strategies employed to integrate mathematical concepts with game mechanics; and (4) the participants' reflections on their professional development and technical adaptation processes. To ensure content validity and clarity, the draft questions were reviewed by three field experts prior to implementation.

2.4. Data Analysis

Quantitative data were analyzed using SPSS 26.0 software. Initially, descriptive statistics (mean and standard deviation) and Pearson correlation coefficients were calculated to observe the general trends and inter-relationships among variables. Subsequently, a two-step Hierarchical Linear Regression Analysis was employed to identify the determinants of digital storytelling competence. This specific analysis method was chosen to isolate the predictive power of pedagogical beliefs (BUCLMT) after controlling for the effect of general attitudes toward technology (DSAS). Prior to conducting the hierarchical regression analysis, the assumptions of normality, linearity, homoscedasticity, and absence of multicollinearity were verified. Skewness and kurtosis values were within the acceptable range of ± 1.5, indicating a normal distribution. Linearity was confirmed through an inspection of partial regression plots and a plot of studentized residuals against the predicted values. To check for multicollinearity, Variance Inflation Factor (VIF) and Tolerance values were examined. The VIF values were found to be well below the critical threshold of 10

(Max VIF = 1.03), and Tolerance values were greater than 0.10, indicating that there was no multicollinearity issue among the independent variables. Finally, the Durbin–Watson statistic was calculated as 1.89, falling within the acceptable range (1.5–2.5), which confirmed that the residuals were independent. Qualitative data were analyzed using qualitative content analysis technique [31]. This approach was selected to identify, code, and categorize the primary patterns within the participants' responses and to quantify the frequency of these codes for integration with the quantitative results.

3. Results

In this section, the findings obtained from the quantitative and qualitative data collection tools to address the research sub-problems are presented using a descriptive and thematic approach, respectively. The mean (M) and standard deviation (SD) values of the general scores obtained from the three scales used in the research are shown in Table 2.

Table 2. Descriptive Statistical Results Regarding Research Variables.

Variables	*N*	Mean ($\bar{X}$)	Median (Med)	Standard Deviation (SD)
Digital Storytelling Competence	200	3.08	3.14	1.00
Digital Storytelling Attitude	200	3.83	3.84	0.41
Beliefs about Using Children's Lit. in Math. Teaching	200	3.20	3.24	0.41

3.1. Descriptive Statistics and Correlations

Examination of Table 2 reveals that the participants' scores for the "Digital Storytelling Attitude" variable (M = 3.83; Med = 3.84) are noticeably higher compared to the other variables. This finding indicates that the participants possess a strong and positive disposition toward the use of digital storytelling. Furthermore, the remarkably low standard deviation associated with this variable (SD = 0.41) suggests a highly homogeneous structure within the group regarding this positive attitude; in other words, the participants' views are highly consistent with one another.

Similarly, the variable "Beliefs about Using Children's Literature in Mathematics Teaching" (M = 3.20; Med = 3.24) demonstrates a positive trend, and the low standard deviation (SD = 0.41) reveals that this belief is also consistent within the group.

In contrast, the "Digital Storytelling Competence" scores (M = 3.08; Med = 3.14) exhibit a lower central tendency compared to the other two variables, hovering near a moderate level. The most striking finding regarding this variable is the high standard deviation (SD = 1.00) relative to the others. This indicates a significant divergence of opinion among participants regarding their own competence perceptions; the group displays a heterogeneous distribution, meaning some participants perceive themselves as highly competent while others feel inadequate.

In summary, while participants possess a strong and homogeneous positive attitude toward digital storytelling, their perceptions of their own competence are both lower and characterized by significant disparities within the group.

Pearson Correlation Analysis was conducted to examine the relationships between the participants' (*N* = 200) "Digital Storytelling Competence," "Digital Storytelling Attitude," and "Beliefs about Using Children's Literature in Mathematics Teaching." The results are presented in Table 3.

Table 3. Results of Correlation Analysis Between Research Variables.

Variables	1	2	3
1. Digital Storytelling Competence	1		
2. Digital Storytelling Attitude	0.004	1	
3. Beliefs about Using Children's Lit.	0.334 **	−0.167 *	1

Note: * Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

According to the analysis results, a positive, near-moderate, and statistically significant relationship was detected between "Digital Storytelling Competence" and "Beliefs about Using Children's Literature in Mathematics Teaching" ($r = 0.334$; $p < 0.01$).

Furthermore, a low-level but statistically significant negative relationship was found between "Digital Storytelling Attitude" and "Beliefs about Using Children's Literature in Mathematics Teaching" ($r = -0.167$; $p < 0.05$).

Significantly, no statistically significant relationship was observed between "Digital Storytelling Competence" and "Digital Storytelling Attitude" ($r = 0.004$; $p > 0.05$). This lack of correlation reinforces the "Attitude–Competence Gap" identified in the descriptive statistics, suggesting that high enthusiasm does not necessarily correspond to high technical proficiency.

3.2. Predictors of Digital Storytelling Competence: A Hierarchical Regression Analysis

A two-step hierarchical linear regression analysis was conducted to evaluate the predictive power of pre-service teachers' attitudes and pedagogical beliefs on their digital storytelling competence (Table 4).

Table 4. Hierarchical Regression Analysis Predicting Digital Storytelling Competence.

Predictor	Model 1		Model 2	
	B	β	B	β
Constant	3.04 *		−0.21	
Step 1				
Digital Storytelling Attitude (DSAS)	0.01	0.004	0.15	0.06
Step 2				
Beliefs about Using Children's Lit. (BUCLMT)			0.85 *	0.35 *
R^2	0.00		0.12	
F	0.00		12.86 *	
ΔR^2	0.00		0.12 *	
ΔF	0.00		25.72 *	

Note. N = 200. * $p < 0.001$. Dependent Variable: Digital Storytelling Competence (DSTCS).

In the first step (Model 1), Digital Storytelling Attitude was entered as the sole predictor. The results indicated that attitude alone did not significantly predict competence, $F(1, 198) = 0.003$, $p = 0.956$, accounting for a negligible portion of the variance ($R^2 < 0.001$).

In the second step (Model 2), Beliefs about Using Children's Literature in Mathematics Teaching (BUCLMT) was added to the model. The inclusion of this variable resulted in a statistically significant improvement in model fit, explaining an additional 11.5% of the variance in digital competence ($\Delta R^2 = 0.115$, $\Delta F(1, 197) = 25.72$, $p < 0.001$).

The final model revealed that while attitude remained a non-significant predictor ($\beta = 0.06$, $p > 0.05$), pedagogical beliefs significantly and positively predicted digital competence ($\beta = 0.35$, $p < 0.001$). These findings suggest that pre-service teachers' proficiency in

creating digital stories is driven not by their general enthusiasm for technology but by their pedagogical beliefs regarding the effectiveness of storytelling in mathematics education.

3.3. Qualitative Findings

The qualitative findings obtained from the semi-structured interviews are presented under themes such as concept selection, design, pedagogical strategies, and personal contribution.

Table 5 presents student opinions regarding the developmental appropriateness of the mathematical concepts selected for digital storytelling and game activities, as well as the difficulties encountered during the process. All participants (n = 15) stated that basic concepts such as counting and addition were developmentally appropriate for the preschool level. Furthermore, the suitability of the selected concepts for concretization was emphasized by all participants.

Table 5. Student Views on the Concept Selection Process in Digital Storytelling.

Theme	Code	Participants	Frequency (n)	Quote (Source)
Concept Selection and Appropriateness—Developmental Appropriateness	Basic Skills (Counting/Addition, etc.)	S1–S15	15	"The concept of counting is fundamental and appropriate for preschool." (S2)
	Suitability for Concretization	S1–S15	15	"Children understood better with concrete examples like elephants and ants." (S4)
Concept Selection and Appropriateness—Difficulties and Factors	Initial Ignorance/Hesitation	S1, S2, S3, S5, S8, S9, S10, S14	8	"At first, I didn't know what to do; I had to do some research." (S9)
	Most Difficult: Accurate/Simple Design	S2, S3, S4, S7, S13	5	"We struggled because we needed to create a simple yet effective design." (S2)
	Teacher Guidance	S1, S3, S6, S7	4	"Our instructor suggested this concept, and we worked accordingly." (S3)

Regarding the challenges faced, a significant number of students (n = 8) reported experiencing hesitation and a lack of knowledge at the beginning of the process. Additionally, creating a simple yet effective design was identified as the most challenging aspect by some participants (n = 5). A smaller group (n = 4) indicated that teacher guidance played an influential role in their concept selection.

As shown in Table 6, the students' views on the visual strategies used in the digital story and game design process, as well as the functions of the characters, are presented. All participants (n = 15) emphasized that visuals were effective in concretizing mathematical concepts. Furthermore, a significant portion of the students (n = 10) stated that visuals assisted in mental visualization and that children actively participated in the story by interpreting these visuals. The use of examples from daily life was also highlighted (n = 10), with participants noting that this facilitated the children's ability to establish connections.

Regarding the use of characters, the function of building empathy and attracting interest came to the forefront (n = 12). Additionally, characters eliciting affective responses such as curiosity and discovery (n = 6), as well as teacher or family figures assuming a guidance role (n = 5), were notable findings.

Table 6. Child Development Program Students' Views on Visual Strategies and Character Functions.

Theme	Code	Participants	Frequency (*n*)	Quote (Source)
Story and Game Design—Visual Strategies	Concretizing Concepts via Visuals	S1–S15	15	"It became easier for children to understand the concept with visuals." (S6)
	Mental Visualization/Interpretation	S1, S2, S3, S4, S6, S7, S10, S11, S12, S14	10	"Children followed the story by reading the visuals." (S10)
	Examples from Daily Life	S2, S3, S5, S6, S7, S11, S12, S13, S14, S15	10	"We provided examples from daily life using animals." (S5)
Story and Game Design—Function of Characters	Building Empathy/Attracting Interest	S2, S3, S4, S5, S6, S7, S9, S10, S11, S12, S13, S15	12	"The characters were very cute; children bonded with them immediately." (S7)
	Character Behavior (Curiosity/Ambition)	S2, S3, S4, S5, S6, S15	6	"The character being curious encouraged the children to learn." (S15)
	Guidance Role (Teacher/Family)	S1, S2, S6, S12, S14	5	"The teacher character provided guidance and reinforced the concept." (S6)

Table 7 presents the students' views regarding the pedagogical strategies employed during the digital story and game processes. All participants (*n* = 15) stated that they utilized the active/experiential learning method, which ensures children's active participation. A significant majority of the participants (*n* = 12) indicated that the games integrated into the stories were effective in reinforcing the concepts.

Table 7. Child Development Program Students' Views on Implemented Learning and Problem-Solving Strategies.

Theme	Code	Participants	Frequency (*n*)	Quote (Source)
Pedagogical Strategies—Learning Method	Active/Experiential Learning	S1–S15	15	"Children participated one-on-one by using the materials." (S11)
	Story–Game Integration (Reinforcement)	S1, S3–S13	12	"The game was linked to the story, and the concept was established better." (S12)
Pedagogical Strategies—Developmental Support	Analytical/Logical Thinking	S1–S15	15	"Children were able to establish cause-and-effect relationships and perform analyses." (S10)
Pedagogical Strategies—Problem-Solving Mechanism	Guided Questions/Prediction	S1, S2, S4, S5, S6, S8, S9, S11, S14, S15	10	"We made guiding prompts like 'How many are left?'" (S4)
	Problems within the Plot (Loss, etc.)	S1, S2, S5, S8, S11, S15	6	"In the story, the bird loses its wheat, and the children find a solution." (S8)
	Subtraction/Reduction with Concrete Materials	S2, S4, S11, S15	4	"They saw subtraction concretely as the beans decreased." (S11)

Furthermore, all participants (*n* = 15) expressed that they supported analytical and logical thinking skills. Within the scope of problem-solving strategies, methods such as guided questions and prediction (*n* = 10), problem situations embedded in the story (*n* = 6),

and reduction/subtraction operations using concrete materials (n = 4) were observed to be implemented.

Table 8 illustrates the personal contributions of the digital storytelling process to the Child Development Program students and the changes reflected in their educator identities. All participants (n = 15) positively evaluated the process in terms of developing digital literacy skills. Furthermore, the majority (n = 10) stated that they experienced development in skills such as concretizing and simplifying concepts, as well as creativity and imagination.

Table 8. Coded Views Regarding the Personal Contribution of the Process and Changes in Educator Perspective among Child Development Program Students.

Theme	Code	Participants	Frequency (n)	Quote (Source)
Personal Contribution—Acquired Skills	Digital Literacy/Learning New Programs	S1–S15	15	"I used such a digital program for the first time and learned a lot." (S6)
	Simplifying/Concretizing the Concept	S1, S3, S5, S7, S8, S9, S10, S11, S12, S15	10	"When I gamified the difficult subject, it became more concrete." (S8)
	Development of Creativity/Imagination	S1, S3, S5, S6, S8, S9, S10, S11, S12, S14	10	"My imagination developed while writing the scenario." (S10)
Educator Perspective—Changing Attitudes	Seeing that Digital is Effective	S1–S15	15	"I didn't think it would be this effective; the children loved it." (S13)
	Positive Attitude/Change of Opinion	S1, S2, S3, S5, S7, S8, S9, S10, S11, S12, S13, S14	12	"Seeing that digital works so well changed my mind." (S14)
	Initial Feeling of Anxiety/Difficulty	S1, S3, S5, S8, S9, S10, S13	7	"I thought I would struggle a lot at first, but I was able to do it." (S5)

Regarding the educator perspective, all students (n = 15) realized that digital tools are effective instructional instruments. A significant portion (n = 12) reported that they were initially prejudiced against this method but developed a positive attitude by the end of the process. However, some participants (n = 7) expressed that they experienced technical difficulties and anxiety at the beginning of the process. The synthesis of these themes reveals that technical anxiety is not a barrier to competence when the pedagogical intent (concretizing math through stories) is strong enough to drive self-regulation.

3.4. Integrated Analysis of Quantitative and Qualitative Findings

Table 9 presents a joint display comparing the quantitative findings with the corresponding qualitative codes, summarizing the "Attitude–Belief–Competence" triangle.

Table 9 presents a comparative analysis of the quantitative scale results and the codes obtained from qualitative views. Notable patterns across three fundamental dimensions are as follows:

Regarding the High Attitude Score (M = 3.83), participants' general attitudes toward the digital storytelling process were found to be highly positive. This finding is supported by qualitative codes such as "Seeing that Digital is Effective" (n = 15) and "Positive Attitude/Change of Opinion" (n = 12). It is evident that students realized the contribution of digital tools to education through experience, evolving from initially neutral or hesitant stances to positive ones throughout the process.

Table 9. Comparative Analysis of Quantitative and Qualitative Data: The Triangle of Attitude, Belief, and Competence.

Quantitative Findings	Associated Qualitative Codes	Interpretation
High Attitude (M = 3.83)	Change of Opinion/ Positive Attitude (n = 12) Seeing that Digital is Effective (n = 15)	Students realized the contribution of digital materials to education by the end of the process.
Low Competence (M = 3.08)	Initial Ignorance/ Hesitation (n = 8) Initial Feeling of Anxiety/Difficulty (n = 7)	A lack of technical knowledge and feelings of inadequacy regarding self-confidence were experienced prior to implementation.
High Pedagogical Belief (M = 3.20)	Suitability for Concretization (n = 15) Story–Game Integration (n = 12)	The digital storytelling method was found to be powerful for concretizing and reinforcing concepts in mathematics teaching.

Regarding the Low Competence Score (M = 2.98), participants did not feel technically competent during the digital story creation process. This result aligns with the qualitative codes of "Initial Ignorance/Hesitation" (n = 8) and "Initial Feeling of Anxiety/Difficulty" (n = 7). A lack of technical skills and low self-confidence were felt at the beginning of the process, which was reflected in the quantitative competence scores. However, considering that all participants successfully completed the project by the end of the process, this situation can be interpreted as a transitory inadequacy rather than a permanent deficiency.

Regarding the High Belief in Pedagogical Contribution (M = 3.83), participants harbor a strong belief in the pedagogical impact of digital storytelling. This finding is supported by qualitative themes such as "Suitability for Concretization" (n = 15) and "Story–Game Integration" (n = 12). Participants stated that abstract mathematical concepts could be concretized through storytelling and that this process facilitated children's learning.

In conclusion, the comparative analysis reveals that despite participants' high interest in technological applications, their technical competencies are relatively lower. Nevertheless, the strong belief in the pedagogical contribution demonstrates the significant potential for the adoption of this method.

Table 10 elucidates how the pedagogical strategies adopted by students during the digital story-based mathematics teaching process are revealed through qualitative data and how these strategies overlap with quantitative findings. A comparative analysis is presented along four fundamental pedagogical applications.

Participants created learning environments where children used materials one-on-one, ensuring active participation in the learning process. The qualitative code "Active/Experiential Learning" (n = 15) supports this approach. This finding coincides with the general framework of the BUCLMT scale, indicating that students found this method effective for reinforcing concepts.

Qualitatively, codes such as "Problem Solving Mechanism" (n = 10) and "Analytical Thinking" (n = 15) demonstrate that students incorporated problem-based elements into their stories. This suggests that digital stories, within a structured scenario, allow children to establish cause-and-effect relationships and generate solutions. Quantitatively, this strategy parallels the high pedagogical belief scores in the BUCLMT scale, showing that students consider this approach effective.

All participants prioritized concretization in their story and game designs for children, as evidenced by the codes "Concretizing Concept with Visuals" (n = 15) and "Empathy with Character" (n = 12). This strategy facilitated the understanding of abstract mathematical

concepts. Visual-supported learning rendered the learning process more child-centered and permanent.

Table 10. Quantitative–Qualitative Comparison of Pedagogical Applications and Instructional Effects.

Prominent Pedagogical Application	Qualitative Codes	Quantitative Equivalent
Active and Hands-on Learning	Active/Experiential Learning (n = 15)	Consistent with the items representing positive pedagogical outcomes in the BUCLMT scale.
Problem-solving based structured plot	Problem Solving Mechanism (n = 10) Analytical Thinking (n = 15)	Suggests development of higher-order thinking skills.
Concretization with visuals and characters	Concretizing Concept with Visuals (n = 15) Empathy with Character (n = 12)	Learning was facilitated; child-centeredness increased.
Digital literacy and adaptation to technology	Digital Literacy (n = 15)	Progress in competence exists, although the initial level was low.

Finally, although participants experienced initial difficulties in using digital tools, they reported improvements in their digital skills by the end of the process ("Digital Literacy," n = 15). This is consistent with the Competence Scale score (M = 2.98), which, despite being relatively low, reflects the initial struggle. The weakness in technical competencies at the beginning made adaptation difficult, but significant gains were realized by the conclusion of the process. This comparison demonstrates that pedagogical applications are supported by both qualitative codes and quantitative data, indicating a multifaceted development of the learning process.

In conclusion, this integrated analysis demonstrates a clear alignment between the statistical predictors of competence and the lived experiences of pre-service teachers. While the quantitative data identifies pedagogical beliefs as a robust driver of technical proficiency, the qualitative evidence clarifies the mechanism behind this relationship: the 'pedagogical why' (concretizing math through stories) provides the necessary cognitive momentum to bridge the 'Attitude–Competence Gap.' This synergy underscores that for social sustainability in the teaching profession, technological mastery must be anchored in domain-specific instructional convictions, effectively transforming passive enthusiasm into intentional, evidence-based digital praxis.

4. Discussion

This study was designed to explore effective pathways for teaching mathematical concepts in early childhood education by deeply examining how digital story- and game-based instructional strategies are experienced by Child Development Program students. Addressing how attributes such as creative thinking, digital literacy, and pedagogical versatility, which form the foundation of 21st-century skills, can be cultivated in pre-service teachers remains a priority for contemporary educational systems [1,32]. Accordingly, this research aimed to understand the on-site effects of technology-supported instructional practices by revealing the attitudes, competencies, and pedagogical beliefs of university students regarding the digital story-based mathematics teaching process through both quantitative and qualitative data. Furthermore, by addressing the technical, pedagogical, and personal development dimensions of the process, the study examined the aspects of digital transformation that influence not merely instrumental usage but also professional identity.

A critical examination of the factors influencing pre-service teachers' digital competence revealed a counter-intuitive outcome that challenges conventional expectations.

The hierarchical regression analysis demonstrated that a positive attitude toward digital storytelling, often assumed to be a precursor to technology adoption, failed to significantly predict technical competence. This finding suggests that mere enthusiasm for technology—while helpful for initial engagement—is insufficient to drive the development of complex digital production skills.

However, the introduction of pedagogical beliefs into the regression model fundamentally altered the picture. The belief in the efficacy of children's literature for mathematics teaching emerged as a robust predictor of digital competence. This pivotal finding aligns with the core philosophy of STEAM education, indicating that technology integration is associated less with technical affinity and more strongly predicted by domain-specific pedagogical convictions. In other words, students successfully acquired digital skills not simply because they liked the technology but because they believed in the power of the story as a pedagogical vehicle to concretize abstract mathematical concepts. This underscores that for sustainable teacher education, the motivation to overcome technical hurdles is closely linked to the "why" (pedagogical belief) rather than just the "how" (technical skill).

However, the lack of a significant predictive relationship between general attitudes and digital competence in this study contrasts with several findings in the literature grounded in the Technology Acceptance Model (TAM). Some research suggests that a positive disposition toward technology serves as a primary determinant of both the intention to use and the eventual mastery of digital tools [6,24]. For instance, studies emphasizing 'technological playfulness' argue that individuals with higher digital enthusiasm tend to engage more frequently with software, thereby naturally reducing the technical friction that leads to competence. Furthermore, while this study positions pedagogical conviction as the primary bridge across the 'Attitude–Competence Gap,' other scholars highlight that extrinsic barriers—such as inadequate technical infrastructure or a lack of specific software training—can remain insurmountable despite strong instructional beliefs. Acknowledging these divergent perspectives underscores that the dominance of pedagogical belief over general enthusiasm may be particularly heightened in domain-specific contexts like STEAM, where the complexity of the content necessitates a more goal-oriented motivation than mere technological affinity.

The students' strong pedagogical beliefs regarding the use of children's literature in mathematics teaching were clearly reflected in the quality of the activities they designed. Candidates combined their Technological, Pedagogical, and Content Knowledge (TPACK) while designing activities using the concretization strategy. Fundamental mathematical concepts (counting, addition, length) were integrated into the plot of the story. This approach aligns with findings by Kildan and Incikabi [12], indicating a meaningful shift toward the "triad intersection of TPACK". The primary strategy employed by the candidates was to present the problem through the story. Codes such as "In the story, the bird loses its wheat, and the children find a solution" and "We made guiding prompts like 'How many are left?'" demonstrate that the candidates attempted to apply problem-solving skills through analytical thinking. This parallels Computational Thinking studies that emphasize the importance of algorithmic thinking and problem concretization [19,20]. The games designed by the students were based on the principle of active and experiential learning. Characters served not merely as figures but performed pedagogical functions that triggered affective responses such as empathy and curiosity. In this way, the concretization of abstract mathematical concepts through visual-technological tools supports the potential to increase children's creativity and motivation [33].

The digital story preparation process facilitated a lasting transformation in the candidates' professional identities, extending beyond mere technical skill acquisition. The fact that candidates overcame their initial technical anxiety and successfully completed the

process indicates that their self-regulation skills were strengthened through practice. This is closely related to the social sustainability aspect of the teaching profession. Şahin [5] emphasizes that coping with technological challenges and gaining professional flexibility rely on psychological foundations such as self-regulation, representing a long-term professional investment. Child Development Program students reported gains such as "my imagination developed" and "I used such a digital program for the first time and learned a lot". This high level of creativity and digital literacy creates a strong intention for implementation in future teaching practices [24]. These results suggest that professional identity development is not a byproduct of technical training but a conscious pedagogical evolution driven by the intent to improve learning outcomes.

5. Conclusions

This study set out to explore the paradox of "high enthusiasm but limited skill" in early childhood teacher education, revealing that the path to digital competence is paved not by technological affinity but by pedagogical conviction. The findings confirm the existence of an "Attitude–Competence Gap," demonstrating that pre-service teachers' general positive attitudes toward technology are insufficient to predict their technical proficiency. However, the critical role of domain-specific beliefs emerged as the bridge across this gap. The regression analysis provided empirical evidence that students who grasp the pedagogical power of children's literature in mathematics—a core tenet of the STEAM approach—are significantly more likely to overcome technical hurdles and achieve digital competence.

These results suggest potential pathways for informing teacher education policies aimed at supporting the social sustainability of the profession. Since general technological attitudes may not directly translate into practice, teacher training programs could benefit from reconsidering their focus from merely trying to "motivate" candidates to use technology. Instead, curricula might prioritize strengthening pedagogical beliefs, specifically understanding how arts and literature serve mathematical learning. When future teachers perceive the educational necessity of a digital tool, they may be more intrinsically motivated to develop the requisite technical skills. Consequently, digital storytelling should not be taught as an isolated technical skill but as an integral component of domain-specific methodology courses, such as "Mathematics Teaching" or "Special Teaching Methods," within a holistic TPACK framework.

Beyond curriculum redesign, the study also highlights the importance of the implementation process. To foster peer learning and technical transfer, candidates should be encouraged to develop complex digital projects in heterogeneous groups, mixing those with high technical skills and those with strong pedagogical backgrounds. Furthermore, ensuring that these digital stories are tested in real classroom settings with children would allow candidates to observe the tangible impact of their designs, thereby reinforcing their professional self-efficacy.

5.1. Limitations

Despite its contributions, this study has several limitations that should be acknowledged. First, the sample was drawn from a single vocational school in Turkey, which may limit the generalizability of the findings to different institutional or cultural contexts. Second, the reliance on self-reported scales for measuring competence and attitudes may introduce social desirability bias. Furthermore, the cross-sectional nature of the data precludes drawing definitive conclusions about the long-term development of digital skills. Acknowledging these contextual and methodological boundaries is essential for a balanced interpretation of the results.

5.2. Future Research

Future research should build upon these findings by examining whether the competence gained through this belief-driven approach is transferred to actual teaching practices after graduation through longitudinal studies. Additionally, while this study focused on basic concepts like counting, further research could investigate the effectiveness of the digital storytelling and gamification approach in teaching more complex mathematical topics, such as data analysis and geometry, which require higher-order scaffolding, thereby ensuring the continuous and sustainable development of early childhood mathematics education.

Funding: This research was funded by Çanakkale Onsekiz Mart University Scientific Research Projects Coordination Unit, grant number 2025-YÖNP-0114, and conducted in collaboration with the Ministry of Youth and Sports, Çanakkale Youth Center.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Social and Humanities Ethics Committee of Çanakkale Onsekiz Mart University (protocol code 30/80 and date of approval 21 March 2025).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author due to privacy restrictions.

Conflicts of Interest: The author declares no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Abbreviations

The following abbreviations are used in this manuscript:

DST	Digital Storytelling
TPACK	Technological Pedagogical Content Knowledge
BUCLMT	Beliefs about Using Children's Literature in Mathematics Teaching Scale
DSTCS	Digital Story Tools Competence Scale
DSAS	Digital Storytelling Attitude Scale

References

1. United States Department of Education. *Partnership for 21st Century Skills (P21). Framework for 21st Century Learning*; United States Department of Education: Washington, DC, USA, 2019.
2. Wing, J.M. Computational Thinking. *Commun. ACM* **2006**, *49*, 33–35. [CrossRef]
3. Van Den Heuvel-Panhuizen, M.; Elia, I. Young Children's Views on Mathematics Education: An Empirical Study. *Educ. Stud. Math.* **2012**, *81*, 105–120.
4. Çiftçi, Z.; Taşkın, Ö. Okul Öncesi Öğretmen Adaylarının Dijital Hikâye Anlatımına Yönelik Yeterlilik Düzeyleri Ve Tutumları. *Uluslar. Erken Çocukluk Eğit. Çalış. Derg.* **2021**, *6*, 1–17.
5. Şahin, M. Analyzing the Foundations of Social Sustainability in Teacher Education: A Study of Self-Regulation, Social-Emotional Expertise, and AI-TPACK. *Sustainability* **2025**, *17*, 8613. [CrossRef]
6. Joo, Y.J.; Park, S.; Lim, E. Factors Influencing Pre-Service Teachers' Intention to Use Technology: TPACK, Teacher Self-Efficacy, and Technology Acceptance Model. *J. Educ. Technol. Soc.* **2018**, *21*, 48–59.
7. Yang, Y.-F.; Tseng, C.C.; Lai, S.-C. Enhancing Teachers' Self-Efficacy Beliefs in AI-Based Technology Integration into English Speaking Teaching Through a Professional Development Program. *Teach. Teach. Educ.* **2024**, *144*, 104582. [CrossRef]
8. Lambert, J. *Digital Storytelling Cookbook and Traveling Companion*; Digital Diner: Berkeley, CA, USA, 2003.
9. Robin, B.R. The Educational Uses of Digital Storytelling. *J. Comput. High. Educ.* **2008**, *20*, 220–233.
10. Yıldız, N.; Güler, Y. Okul Öncesi Matematik Eğitiminde Dijital Hikâye Anlatımının Kavram Öğrenimine Etkisi. *Eğit. Bilim* **2020**, *45*, 173–195.
11. Sadik, A. Digital Storytelling: A New Tool for the Presentation of Educational Materials. *J. Comput. High. Educ.* **2008**, *19*, 85–99.

12. Kildan, A.O.; Incikabi, L. Effects on the Technological Pedagogical Content Knowledge of Early Childhood Teacher Candidates Using Digital Storytelling to Teach Mathematics. *Education 3-13* **2015**, *43*, 238–248. [CrossRef]
13. Mishra, P.; Koehler, M.J. Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. *Teach. Coll. Rec.* **2006**, *108*, 1017–1054. [CrossRef]
14. Ning, Y.; Zhang, C.; Xu, B.; Zhou, Y.; Wijaya, T.T. Teachers' AI-TPACK: Exploring the Relationship Between Knowledge Elements. *Sustainability* **2024**, *16*, 978. [CrossRef]
15. Aldemir Engin, R.; Gedik Altun, S.D. The Effect of Digital Storytelling on the Development of Preservice Mathematics Teachers' Technological Pedagogical Content Knowledge. *J. Educ. Teach. Train.* **2023**, *14*, 265–277.
16. Çelik, İ. Towards Intelligent-TPACK: An Empirical Study on Teachers' Professional Knowledge to Ethically Integrate Artificial Intelligence (AI)-Based Tools into Education. *Comput. Hum. Behav.* **2022**, *138*, 107468. [CrossRef]
17. Angeli, C.; Voogt, J.; Fluck, A.; Webb, M.; Cox, M.; Malyn-Smith, J.; Zagami, J. A K-6 Computational Thinking Curriculum Framework: Implications for Teacher Knowledge. *J. Educ. Technol. Soc.* **2016**, *19*, 47–57.
18. Jonassen, D.H. Designing Research-Based Instruction for Story Problems. *Educ. Psychol. Rev.* **2003**, *15*, 267–297. [CrossRef]
19. Haşlaman, T.; Mumcu, F.; Uslu, N.A. Fostering Computational Thinking Through Digital Storytelling: A Distinctive Approach to Promoting Computational Thinking Skills of Pre-Service Teachers. *Educ. Inf. Technol.* **2024**, *29*, 18121–18147. [CrossRef]
20. Serpe, A. Theory and Practice of Storytelling with Scratchjr to Develop Early Maths Skills. In Proceedings of the International Conference on Education and New Developments, Virtual, 26–28 June 2021.
21. Li, Q.; Lemieux, C.; Vandermeiden, E.; Nathoo, S. Are You Ready to Teach Secondary Mathematics in the 21st Century? A Study of Preservice Teachers' Digital Game Design Experience. *J. Res. Technol. Educ.* **2013**, *45*, 309–337. [CrossRef]
22. Preradovic, N.M.; Lesin, G.; Boras, D. Introduction of Digital Storytelling in Preschool Education: A Case Study from Croatia. *Digit. Educ. Rev.* **2016**, *30*, 94–105.
23. Nussbaum, M.; Diaz, A. Classroom Logistics: Integrating Digital and Non-Digital Resources. *Comput. Educ.* **2013**, *69*, 493–495. [CrossRef]
24. Kukul, V. Should I Use Digital Storytelling in My Future Classroom? Why or Why Not? Investigating Pre-Service Math Teachers' Acceptance of Digital Storytelling. *E-Learn. Digit. Media* **2024**, *21*, 70–86. [CrossRef]
25. Creswell, J.W.; Plano Clark, V.L. *Designing and Conducting Mixed Methods Research*, 3rd ed.; Sage Publications: Thousand Oaks, CA, USA, 2018.
26. Fraenkel, J.R.; Wallen, N.E.; Hyun, H.H. *How to Design and Evaluate Research in Education*, 8th ed.; McGraw-Hill: Columbus, OH, USA, 2012.
27. Yin, R.K. *Case Study Research and Applications: Design and Methods*, 6th ed.; Sage Publications: Thousand Oaks, CA, USA, 2018.
28. Durmaz, B. *Matematik Öğretiminde Çocuk Edebiyatının Kullanımı Ve Örnek Uygulamalar 2 (Proje ID:218B442)*; TÜBİTAK 4005 Bilim Ve Toplum Yenilikçi Eğitim Uygulamaları; TÜBİTAK: Kavaklıdere, Türkiye, 2019.
29. Çelik, T. Dijital Hikâye Araçlari Kullanimi Yetkinliği Ölçeği (Dhakyö): Ölçek Geliştirme Çalışması. *Uluslar. Türk. Edeb. Kült. Eğit. Derg.* **2021**, *10*, 1580–1597.
30. Yıldırım, M.; Ogur, E. Dijital Hikâye Kullanımına Yönelik Tutum Ölçeği (DHKYTÖ): Ölçek Geliştirme Çalışması. *Korkut Ata Türk. Araşt. Derg.* **2023**, *12*, 1113–1135.
31. Miles, M.B.; Huberman, A.M.; Saldaña, J. *Qualitative Data Analysis: A Methods Sourcebook*, 3rd ed.; Sage Publications: Thousand Oaks, CA, USA, 2014.
32. Starčič, A.I.; Cotic, M.; Solomonides, I.; Volk, M. Engaging Preservice Primary and Preprimary School Teachers in Digital Storytelling for the Teaching and Learning of Mathematics. *Br. J. Educ. Technol.* **2016**, *47*, 29–50. [CrossRef]
33. Yüksel-Arslan, P.; Yildirim, S.; Robin, B.R. A Phenomenological Study: Teachers' Experiences of Using Digital Storytelling in Early Childhood Education. *Educ. Stud.* **2016**, *42*, 427–445. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.