

Enhancing emotional resilience in pre-service early childhood educators through digital learning environments

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ABSTRACT

Emotional resilience (ER) is a critical competence for pre-service teachers, enabling them to manage stress, adapt to change, and maintain professional functioning. Digital learning (DL) environments present both challenges and opportunities for developing ER, yet empirical studies on structured interventions in these contexts remain limited, particularly in early childhood education (ECE). This study examined the effect of a structured DL intervention on the development of ER among pre-service teachers in ECE contexts in Kazakhstan. A quasi-experimental pretest-posttest design with non-equivalent groups was employed, involving 165 female pre-service teachers. The intervention included scaffolded digital tasks, reflective exercises, and instructor-led feedback. Baseline ER scores were comparable between groups. Following the intervention, participants in the experimental group (EG) demonstrated significantly higher ER compared to those in the control group (CG). These results indicate that structured DL interventions can effectively enhance ER by fostering adaptive coping, self-regulation, and problem-solving skills. Embedding scaffolded digital tasks combined with reflection and feedback into teacher education programs may support the preparation of resilient, reflective, and emotionally competent educators.

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1. INTRODUCTION

The rapid digitalization of education is transforming teacher preparation worldwide. Digital learning (DL) environments have become a central component of higher education, influencing teaching practices, communication, and professional expectations [1]–[3]. As a result, pre-service teachers must adapt not only technically but also psychologically. Emotional resilience (ER), the capacity to cope with stress, adapt to change, and maintain functioning under challenging conditions, has emerged as a key competence in this context, enabling individuals to navigate uncertainty and professional demands effectively [4], [5]. In this context, strengthening ER is increasingly viewed as a pressing need in teacher education, as it directly relates to teachers' ability to cope with stress, prevent burnout, and maintain instructional quality. The growing complexity of DL environments further amplifies this need, requiring future educators to effectively manage both technological demands and emotional challenges.

Teaching is widely recognized as an emotionally demanding profession, particularly in early childhood education (ECE) [6]–[8]. Pre-service early childhood teachers (PSTs) are responsible for managing children’s developmental needs, maintaining classroom dynamics, and interacting with parents, all of which require strong emotional regulation competencies [9], [10]. Within DL environments, these demands may intensify due to reduced face-to-face interaction and increased technological challenges, potentially leading to higher levels of stress and cognitive load [11], [12]. Consequently, ER is critical for PSTs to succeed both academically and professionally.

ER can be theoretically grounded in established psychological frameworks, particularly resilience theory and self-regulation theory. Resilience theory conceptualizes resilience as a dynamic and context-dependent process rather than a stable trait, emphasizing individuals’ capacity to adapt, recover, and experience growth when confronted with adversity. In educational contexts, this perspective highlights the role of structured exposure to challenges combined with supportive conditions that facilitate adaptive functioning and long-term psychological development. Complementarily, self-regulation theory explains how individuals monitor, evaluate, and adjust their cognitive, emotional, and behavioral states in pursuit of goal attainment. Within this framework, ER can be understood as an emergent outcome of effective self-regulatory functioning, including emotional awareness, reflective processing, and adaptive strategy use.

In DL environments, these conditions intensify demands on learners’ self-regulatory capacity due to increased autonomy, reduced immediate instructor support, and heightened technological and cognitive load. Such learning contexts require continuous monitoring and adjustment of emotional and cognitive states to maintain task engagement and performance quality, positioning self-regulation as a central mechanism of effective learning in digital settings. Building on this theoretical foundation, the proposed mechanism suggests that structured DL challenges first activate cognitive and emotional appraisal processes, through which PSTs evaluate task demands as either manageable or stressful. These appraisals subsequently trigger self-regulatory responses, including goal adjustment, emotional modulation, strategic adaptation, and reflective evaluation. Repeated engagement in this cyclical process fosters the gradual development of adaptive coping strategies, thereby contributing to the strengthening of ER over time. Accordingly, the proposed model can be summarized as: digital challenge → cognitive-emotional appraisal → self-regulation → ER development. This framework clarifies the developmental mechanism underpinning the intervention by linking environmental demands with internal regulatory processes and resilience outcomes. The conceptual framework is shown in Figure 1.

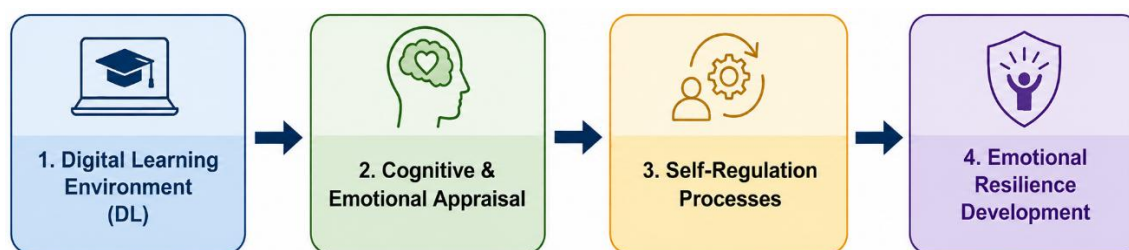


Figure 1. Conceptual framework of ER development in DL environments

Research consistently highlights the importance of ER in teacher effectiveness and well-being [13], [14]. Resilient teachers demonstrate higher adaptability and professional stability, manage classroom challenges more effectively, and exhibit stronger self-efficacy. DL environments present both risks, such as technostress and emotional fatigue, and opportunities for growth, offering flexible, resource-rich contexts that can foster self-regulation and reflective practice.

Prior studies have shown that ER is a developable capacity rather than a fixed trait [15], [16]. Day [17] demonstrated that resilience supports teachers’ long-term commitment and adaptability in changing educational contexts, while Duan *et al.* [18] emphasized the interplay of personal and contextual factors in sustaining teacher resilience, particularly during early career stages. Li [19] further highlighted that emotional demands are central to teaching and directly affect professional performance, with higher ER associated with lower burnout and greater self-efficacy. However, the majority of these studies focus on in-service teachers, leaving PSTs in ECE contexts underexamined [20].

The role of DL environments in teacher development has received increasing attention, with research examining digital competence, technostress, and online adaptation [21]. While DL environments can challenge teachers by imposing cognitive and emotional demands, they also provide opportunities for

experimentation, reflection, and collaborative problem-solving. Despite the growing body of research on DL in teacher education, important gaps remain. First, existing studies predominantly focus on technical competencies, digital adaptation, and technostress, while ER is typically treated as a secondary or contextual variable rather than a primary outcome. Second, the majority of resilience research has been conducted with in-service teachers, with limited attention to PSTs in ECE contexts, where emotional demands are especially pronounced [22], [23].

Moreover, there is a lack of empirically tested intervention-based studies that examine whether structured DL experiences can actively foster ER, rather than merely describe its levels. This creates a potential conceptual tension: while DL environments are often associated with increased stress and cognitive load, they are simultaneously assumed to support reflective practice and self-regulation, which are key mechanisms of resilience development. However, the conditions under which DL environments function as either a risk or a developmental resource for ER remain insufficiently understood. Given these considerations, fostering ER among pre-service teachers can be considered a critical priority both globally and within Kazakhstan. Globally, increasing educational complexity, rapid digitalization, and rising levels of teacher stress and burnout have intensified the need for socio-emotional competencies that support adaptability and well-being. In this context, ER is not merely a desirable attribute but a foundational component of sustainable teaching practice.

In Kazakhstan, this priority is further amplified by the ongoing transformation of higher education and the rapid integration of DL environments, which place additional cognitive and emotional demands on pre-service teachers. Despite these challenges, the development of ER has not yet been systematically embedded in teacher preparation programs, nor sufficiently examined in empirical research. Addressing this gap is essential to ensure that future early childhood educators are equipped not only with technical and pedagogical skills, but also with the emotional capacities necessary to function effectively in evolving educational contexts.

These gaps are particularly evident in the context of Central Asia, where research on teacher resilience in digital environments is still emerging [24]–[26]. In Kazakhstan, the rapid expansion of DL in higher education has created new challenges and opportunities for teacher preparation, yet empirical evidence on its impact on PSTs' emotional development remains limited [27], [28]. This focus aligns with current national education policies in Kazakhstan, which prioritize the digitalization of education and the development of teachers' digital competencies as key components of educational reform. For example, national frameworks emphasize the integration of digital technologies into teaching and the continuous professional development of educators, yet they primarily focus on technical and instructional skills, with limited attention to socio-emotional competencies such as ER. Therefore, there is a need for systematic empirical investigation that examines not only levels of ER but also the extent to which structured DL interventions can contribute to its development [29]–[32].

Beyond addressing theoretical gaps, the proposed intervention has important implications for teacher education practice. By embedding structured ER development within DL environments, this study demonstrates how emotional competencies can be systematically integrated into digital teacher training modules rather than treated as implicit or secondary outcomes. Such an approach contributes to bridging the persistent divide between technical digital skill development and socio-emotional preparation in teacher education programs.

The broader impact of fostering ER among pre-service early childhood educators extends beyond individual competence. Preparing resilient teachers may enhance the overall quality of ECE by improving classroom management, teacher–child interactions, and instructional stability. In addition, stronger ER is associated with reduced risk of burnout, greater professional longevity, and improved mental health outcomes. Consequently, integrating ER-focused interventions into digital teacher education may support not only individual teacher development but also the sustainability and effectiveness of the education system more broadly.

Importantly, the proposed approach also demonstrates strong potential for scalability and policy integration. Because the intervention is embedded within DL environments, it can be adapted and implemented across teacher education institutions with relatively low structural constraints. At a policy level, the findings may inform the development of national teacher education standards by highlighting the importance of explicitly integrating ER into digital and pedagogical training frameworks.

In this study, ER is operationalized as scores on the Connor-Davidson Resilience Scale (CD-RISC). The aim of this study is to examine the effect of a structured DL intervention on the development of ER among PSTs in ECE contexts in Kazakhstan. Accordingly, the study addresses the following research question: how does a structured DL intervention influence the development of ER among PSTs? Based on the theoretical framework and prior empirical findings, the following hypothesis (H1) was formulated: PSTs who participate in a structured DL intervention experimental group (EG) will demonstrate significantly higher posttest CD-RISC scores compared to those in the control group (CG).

2. METHOD

2.1. Study design

This study employed a quantitative quasi-experimental pretest-posttest design with non-equivalent groups [33] to examine ER among PSTs within DL environments in Kazakhstan. Quasi-experimental designs are particularly suitable in educational contexts where random assignment is not feasible, such as when participants are organized into pre-existing academic cohorts. In this study, participants were assigned to groups based on these cohorts, resulting in non-randomized allocation, which is typical for quasi-experimental research.

Pretest and posttest assessments were conducted to evaluate baseline equivalence between the EG and the CG, and to measure changes in ER following the structured DL intervention shown in Figure 2. This design allows for the analysis of both within-group changes over time and between-group differences, providing robust evidence regarding the intervention's effects while maintaining ecological validity in participants' natural educational setting. By combining methodological rigor with practical feasibility, this approach offers a systematic framework for understanding how structured DL experiences contribute to the development of ER among PSTs in authentic teacher education contexts.

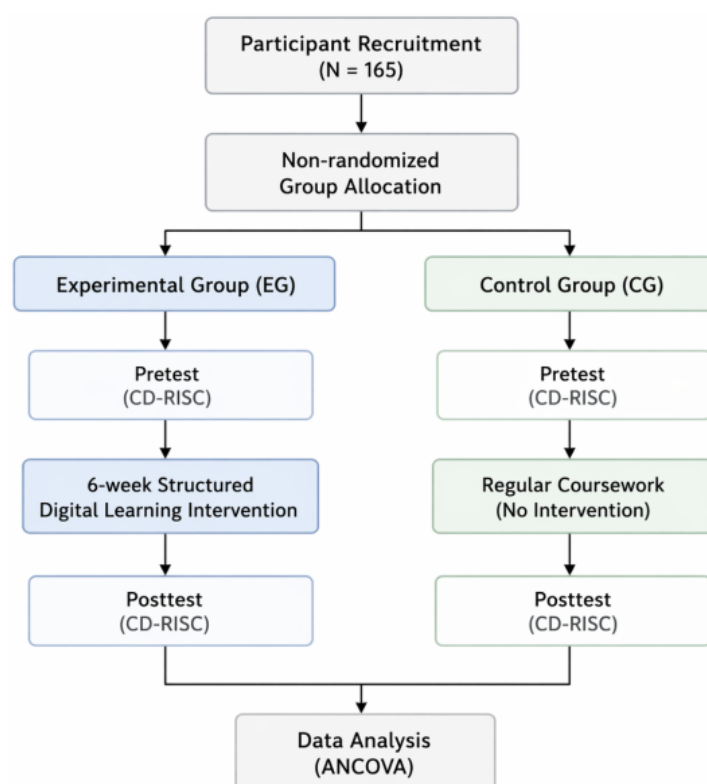


Figure 2. Flowchart of the study design

2.2. Sampling

The study included 165 PSTs from South Kazakhstan Research University named after M. Auezov, recruited from the 3rd and 4th year cohorts of the Preschool Education and Training program using a convenience sampling approach. Participants were allocated to groups based on their existing academic cohorts, resulting in CG (n=84) and EG (n=81). This allocation method reflects the non-randomized nature of quasi-experimental designs. All participants were female, reflecting the gender distribution typical of preschool education programs in Kazakhstan. This homogeneity should be considered when generalizing findings to male PSTs. Both groups were comparable in terms of age and academic year, as verified by descriptive statistics. All participants provided written informed consent, and participation was voluntary. Inclusion criteria were enrollment in the Preschool Education and Training program, being a 3rd or 4th year student, and having no prior professional teaching experience in preschool settings. Exclusion criteria included any previous formal teaching experience in preschool institutions and incomplete survey responses. The demographic and academic characteristics of participants are summarized in Table 1.

Table 1. Characteristics of study participants

Characteristics	CG (n=84)	EG (n=81)	Total (N=165)
Age (years, M $\pm$ SD)	20.8 $\pm$ 1.1	21.0 $\pm$ 1.2	20.9 $\pm$ 1.15
Gender	Female: 84 (100%)	Female: 81 (100%)	165 (100%)
Academic year			
3rd year	42 (50%)	40 (49%)	82 (50%)
4th year	42 (50%)	41 (51%)	83 (50%)

2.3. Procedure

The study was conducted during the 2025 spring semester in accordance with established ethical standards for research involving human participants. Ethical approval was obtained from the Research Ethics Committee of South Kazakhstan Research University named after M. Auezov, and all participants provided written informed consent, with assurances of confidentiality and voluntary participation. The research followed a structured pretest–posttest design.

At baseline, all participants in both the EG and the CG completed the ER assessment under standardized conditions, including identical instructions, equal time allocation (50 minutes), and consistent supervision. Completed pretest responses were collected immediately and securely stored to ensure data integrity. Any incomplete or inconsistent responses were excluded from analysis based on predefined criteria. These procedures provided a reliable measure of baseline ER, enabling evaluation of changes after the intervention. Baseline equivalence between groups was examined using independent-samples t-tests, indicating no statistically significant differences between groups in pretest ER scores. In addition, pretest scores were included as a covariate in subsequent analyses, analysis of covariance (ANCOVA) to control for initial differences between groups.

Following the pretest, the EG participated in a six-week structured DL intervention integrated into their standard coursework, while the CG continued regular academic activities without additional structured elements. No alternative intervention was provided to the CG, helping to attribute observed differences to the structured DL intervention, while acknowledging the non-randomized design. The intervention consisted of structured digital tasks, reflective exercises, and feedback/discussion sessions, with activities progressively increasing in complexity to scaffold the development of ER. Participants engaged in both independent and guided tasks, received formative feedback, and reflected on their emotional responses and coping strategies throughout the intervention. The design of the intervention was informed by resilience theory and self-regulation theory, ensuring that challenges, reflection, and feedback mechanisms targeted the development of ER.

Upon completion of the six-week intervention, a posttest ER assessment was administered to both groups under the same standardized conditions as the pretest. Participants were provided with clear instructions and sufficient time to complete the assessment. All responses were collected immediately, screened for completeness and consistency, and only valid responses were included in the final dataset.

2.4. Intervention

The EG participated in a six-week structured DL intervention integrated into their standard coursework. The intervention aimed to provide PSTs with scaffolded opportunities to experience, reflect on, and strengthen their ER in response to professionally relevant digital challenges. The intervention was delivered via Moodle, the program's learning management system (LMS), through weekly 50-minute instructor-led online sessions, consistent with standard university class durations in Kazakhstan, ensuring ecological validity. All sessions were instructor-led by the same instructor and followed a standardized session structure, ensuring consistent instructions, time allocation, and virtual classroom conditions across participants.

The intervention comprised three core components: i) structured digital tasks; ii) guided reflective exercises; and iii) instructor-led feedback and discussion sessions. For example, in early sessions, participants were asked to design a short digital lesson for a virtual preschool setting using Moodle tools (e.g., uploading instructional materials and creating interactive activities). A sample reflection prompt included: "What challenges did you experience while designing this lesson, and how did you manage your emotional response?" In later sessions, participants completed more complex tasks, such as adapting lesson plans to unexpected scenarios (e.g., limited student engagement or technical issues). Corresponding reflection prompts included: "How did you respond to unexpected difficulties, and what strategies helped you maintain focus and continue the task?"

Participants engaged in structured digital tasks, including digital lesson planning, creation of instructional materials, and adaptation of lessons for virtual preschool contexts, with tasks progressively increasing in complexity over the six weeks, from basic activities to integrated lesson simulations. Following each task, they completed guided reflective exercises to evaluate their emotional responses, coping strategies,

and adaptive behaviors, fostering self-regulation and awareness of resilience processes. Additionally, weekly instructor-led feedback and discussion sessions were conducted to review tasks and address challenges. These sessions provided formative guidance on emotional responses, adaptive strategies, and problem-solving approaches, with early sessions emphasizing support and later sessions promoting independent reflection and peer discussion. This progressive and integrative design aligns with resilience theory and self-regulation theory, conceptualizing ER as a developable capacity cultivated through iterative engagement, reflection, and structured feedback. Table 2 summarizes the weekly sequence of activities, including tasks, reflective exercises, and feedback sessions.

Table 2. Weekly structure of the DL intervention

Week	Component	Description of activities
1	Digital tasks+initial reflection	Introduction to Moodle platform and DL tools; completion of basic online teaching tasks; brief guided reflection on initial experiences and perceived challenges.
2	Reflection+instructor feedback	Structured reflection on Week 1 tasks using reflection journals; identification of emotional responses; instructor feedback on challenges and coping strategies.
3	Digital tasks (increased complexity)+reflection	Development and adaptation of instructional materials for virtual preschool lessons; application of digital teaching strategies; guided reflection on emotional responses and coping strategies.
4	Feedback+guided discussion	Instructor-led online session (50 min) reviewing prior tasks; discussion of challenges encountered; introduction of adaptive coping and self-regulation strategies.
5	Integrated tasks+reflection+feedback	Advanced digital tasks combining lesson design and classroom management scenarios; guided reflection on emotional responses and problem-solving approaches; formative instructor feedback.
6	Reflection+summative discussion	Final reflection and group discussion; evaluation of accumulated experiences; consolidation of adaptive coping strategies; synthesis of learning outcomes related to ER.

2.4.1. Teacher education context

The teacher education program integrates DL components throughout the curriculum, including engagement with Moodle, educational software, and blended learning activities simulating professional teaching scenarios. These activities support the development of instructional planning, classroom management, and reflective practice in technology-mediated contexts. Within this educational setting, ER is emphasized as an important competence for professional readiness. The curriculum promotes reflective practice, adaptive problem-solving, and coping strategies, which are essential for managing challenges in both face-to-face and DL environments. The structured digital tasks and reflective exercises implemented in the EG were designed to align with these curricular objectives, providing opportunities for PSTs to engage in emotionally and cognitively demanding situations. This alignment ensured that the intervention was consistent with the existing program structure while introducing a more systematic and explicit focus on ER development. By situating the study within a national teacher education program in Kazakhstan, the research supports the ecological validity of the study context and enables examination of how PSTs demonstrate ER under authentic DL conditions.

2.5. Instrument

ER was assessed using the CD-RISC-25 [34], a widely validated self-report instrument designed to measure resilience as the ability to cope with stress, adapt to change, and maintain psychological functioning under adversity. The CD-RISC-25 is a standardized measure and was used in its adapted Kazakh-language version for the present study. The adaptation process followed established guidelines for cross-cultural adaptation of psychological instruments. First, the original English version was independently translated into Kazakh by two bilingual experts fluent in both languages. The translations were synthesized into a single version through consensus discussion. Subsequently, a panel of five experts in ECE and educational psychology evaluated the translated items for semantic equivalence, cultural relevance, and conceptual clarity. Items were revised based on expert feedback, and content validity was ensured through iterative review.

A back-translation procedure was then conducted by an independent bilingual expert who was blind to the original instrument. The back-translated English version was compared with the original CD-RISC-25, and discrepancies were discussed and resolved by the research team to ensure conceptual equivalence. The pre-final Kazakh version was pilot-tested with a sample of pre-service teachers (PSTs; $n=20$) to assess clarity, comprehensibility, and cultural appropriateness. Minor wording adjustments were made based on participant feedback. The pilot sample was not included in the main analysis.

Psychometric properties of the adapted scale were evaluated using the main study sample. Internal consistency reliability was excellent, with Cronbach's alpha of $\alpha=0.91$. Construct validity was examined using confirmatory factor analysis (CFA), which supported an acceptable model fit for a unidimensional structure of resilience in this sample (comparative fit index (CFI)=0.93, root mean square error of approximation (RMSEA)=0.06, standardized root mean square residual (SRMR)=0.05). Although the original CD-RISC-25 has been conceptualized as a multidimensional instrument, a unidimensional model was tested in the present study to represent overall resilience as a global construct. Alternative multidimensional structures were considered; however, they did not demonstrate superior model fit or improved substantive interpretability in this sample and were therefore not retained for further analyses. Theoretically, the present study conceptualizes ER as an overarching adaptive capacity rather than distinct subcomponents, particularly in the context of PSTs development in DL environments. Empirically, the unidimensional structure demonstrated satisfactory model fit indices in this sample, supporting the adequacy of a global resilience score for subsequent analyses.

Each item is rated on a 5-point Likert scale ranging from 0 (not true at all) to 4 (true nearly all the time), yielding a total score range of 0 to 100, with higher scores indicating greater resilience. For the purposes of this study, only the total CD-RISC score was used as a continuous variable; no subscale scores were calculated. Changes in ER were analyzed by comparing pre-test and post-test scores between the experimental and CGs using appropriate inferential statistical methods.

2.6. Data analysis

All data were coded and analyzed using IBM SPSS Statistics version 28. Prior to inferential analyses, descriptive statistics were computed for the CD-RISC total score, including mean, standard deviation, minimum, maximum, skewness, and kurtosis to assess data distribution characteristics within each group. Baseline equivalence between the EG and CG was examined using independent-samples t-tests on pretest CD-RISC scores. The effect of the intervention on ER was evaluated using ANCOVA, with posttest CD-RISC scores as the dependent variable, group (EG vs. CG) as the fixed factor, and pretest scores as the covariate. This method was employed to adjust for potential baseline differences and to provide a more accurate estimation of the intervention effect. Prior to conducting ANCOVA, its assumptions were tested. The homogeneity of regression slopes assumption was confirmed by a non-significant interaction between group and pretest scores, $F(1, 162)=0.87$, $p=.35$. The assumption of homogeneity of variances was supported by Levene's test, $F(1, 163)=1.12$, $p=.29$. Normality of residuals was verified using the Shapiro-Wilk test, $W=0.98$, $p=.08$. In addition, the linear relationship between the covariate and the dependent variable was verified. Effect size was reported using partial eta squared (η^2_p) to quantify the proportion of variance explained by group membership. For additional interpretability, Cohen's d was calculated based on group differences in adjusted posttest means using standard conventions for interpretation. Statistical significance was set at $p<0.05$ (two-tailed). It should be noted that additional covariates such as prior digital competence, academic achievement (GPA), and baseline stress levels were not included in the present analysis, as the study design focused on quasi-EG comparison with pretest adjustment as the primary method for controlling initial group differences in ER.

3. RESULTS

Descriptive statistics for total ER, measured using the CD-RISC, are presented in Table 3. At pretest, both the CG and the EG showed comparable baseline ER scores, confirming baseline equivalence prior to the intervention. Post-intervention, the EG demonstrated a higher mean score compared to the CG, indicating an overall improvement in ER. The CG showed minimal change between pretest and posttest scores. These results suggest that participation in the structured DL intervention may enhance overall ER among PSTs.

Table 3. Descriptive statistics of ER

Group	N	Pretest M	Pretest SD	Posttest M	Posttest SD	Min	Max
CG	84	78.4	10.1	78.6	10.2	55	102
EG	81	78.7	10.3	84.0	9.4	60	108

To visually illustrate differences in post-intervention ER between groups, a boxplot of CD-RISC scores for the CG and the EG is presented in Figure 3. The plot shows that the EG has a higher median score compared to the CG, with a relatively similar distribution of scores. This visual pattern is consistent with the results of the ANCOVA analysis. Overall, these findings suggest that the structured DL intervention was associated with higher ER scores in the EG.

To assess the effect of the intervention while controlling for baseline differences, an ANCOVA was conducted with posttest CD-RISC scores as the dependent variable, group (EG vs. CG) as the independent variable, and pretest scores as a covariate. The analysis revealed a statistically significant between-group effect on posttest scores, $F(1, 162)=18.76$, $p<0.001$, $\eta^2_p=0.10$. Table 4 presents the ANCOVA results for posttest CD-RISC scores.

These results indicate that PSTs in the EG demonstrated significantly higher post-intervention CD-RISC scores compared to those in the CG, after controlling for baseline differences. This suggests that participation in the structured DL intervention was associated with improved ER. Overall, the findings provide empirical support for the potential of structured DL environments to enhance ER among PSTs.

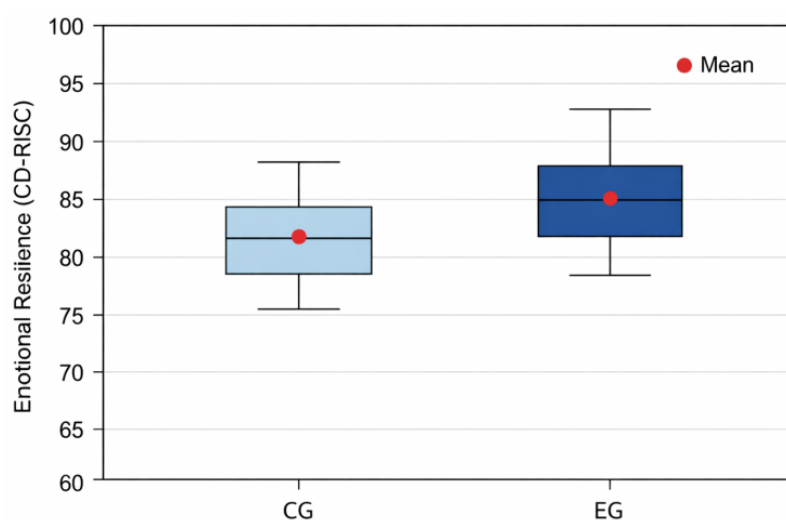


Figure 3. Posttest ER by group

Table 4. ANCOVA for posttest CD-RISC

Variable	F	df	p	Partial η^2_p	Interpretation
Group (EG vs. CG)	18.76	(1, 162)	<0.001	0.10	Medium effect

4. DISCUSSION

The present study investigated the development of ER among PSTs within DL environments in Kazakhstan. The findings indicate that participation in a structured DL-based intervention was associated with a significant increase in ER, as evidenced by higher post-intervention CD-RISC scores in the EG compared to the CG. These results align with previous research suggesting that resilience can be enhanced through structured educational experiences that involve challenge, reflection, and feedback [35]–[37].

From a theoretical perspective, the findings support the view that resilience is a dynamic and developable capacity rather than a stable trait. The findings suggest that DL environments can serve not only as instructional spaces but also as developmental contexts that support psychological adaptation. The observed effect may be partly explained by the design of the intervention, which integrated progressively challenging digital tasks with guided reflection and instructor feedback. Such design features likely created sustained opportunities for PSTs to regulate emotional responses and engage in adaptive coping strategies during task completion. This aligns with previous research suggesting that resilience is a dynamic and developable capacity rather than a stable trait [38]–[41].

However, the observed improvements in ER may not be attributed solely to reflective processes. An alternative explanation is that increased familiarity and competence in using digital tools over time may have reduced task-related uncertainty and cognitive load, thereby indirectly contributing to improved emotional outcomes. As PSTs became more confident in navigating digital environments, perceived task difficulty may have decreased, which could have positively influenced self-reported resilience. Future studies should consider including measures of digital competence and perceived task difficulty to disentangle these effects.

The results are consistent with prior studies demonstrating that experiential and reflective learning approaches can enhance adaptive coping skills in pre-service teachers [42]–[45]. In this study, the integration

of structured tasks, reflection, and feedback likely created repeated opportunities for PSTs to engage with academic challenges in a supported environment. Overall, the findings indicate that carefully designed DL environments can facilitate psychological adaptation by structuring meaningful engagement with academic demands and supporting the development of ER over time.

4.1. Implications for teacher education

The findings suggest that structured DL interventions integrating scaffolded tasks, guided reflection, and feedback can support the development of ER in PSTs. By engaging in progressively challenging digital activities, PSTs develop adaptive coping and self-regulation skills essential for teaching practice. Such activities may include scenario-based simulations of classroom disruptions, digital microteaching tasks with peer review, and problem-based cases requiring emotional decision-making in classroom contexts.

At the instructional level, teacher educators should embed structured opportunities for challenge, reflection, and formative feedback into course design. Reflection can be operationalized through short digital reflection journals, post-task emotion logs, and guided prompts focused on emotional triggers and coping strategies. Feedback may be delivered via rubrics, peer-assessment protocols, and brief instructor conferencing after digital activities. This integration strengthens both cognitive engagement and emotional readiness for practice in digital and physical classrooms.

At the institutional level, DL-based interventions may be integrated into competency-based teacher education programs to systematically develop socio-emotional competencies alongside pedagogical skills. Assessment strategies may include longitudinal resilience portfolios, scenario-based performance tasks, and cumulative reflection records documenting emotional responses over time. At the policy level, ER should be explicitly embedded within national teacher education standards, particularly in digital competence and professional readiness frameworks.

4.2. Limitations

Several limitations of this study should be acknowledged. First, although a pretest–posttest quasi-experimental design was employed, the use of non-equivalent groups limits the strength of causal inference, as residual baseline differences in ER may not be fully eliminated. To mitigate this issue, baseline equivalence was assessed using pretest scores, and ANCOVA was applied to statistically adjust for initial group differences. However, despite this statistical control, the absence of random assignment remains a key constraint on causal interpretation.

In addition, several internal validity threats commonly associated with quasi-experimental designs should be considered. Maturation effects may have influenced the results, as participants could have naturally developed coping or self-regulation skills over the six-week intervention period independent of the treatment. Testing effects are also possible due to repeated administration of the CD-RISC, which may have sensitized participants to the construct being measured. Furthermore, instructor-related effects cannot be ruled out, as the intervention was delivered by a single instructor; thus, variations in instructional style, feedback, or interaction may have contributed to the observed outcomes. Although efforts were made to standardize intervention procedures and minimize extraneous influences, these limitations should be considered when interpreting the findings, particularly regarding the extent to which observed changes in ER can be attributed exclusively to the intervention.

5. CONCLUSION

This study examined the development of ER among PSTs within DL environments in Kazakhstan. Findings indicate that participation in a structured six-week DL intervention, incorporating guided digital tasks, reflective exercises, and instructor-led feedback, significantly enhanced overall ER. The intervention fostered adaptive capacities such as stress management, emotion regulation, and problem-solving, supporting the development of key resilience-related skills. These results highlight the potential of DL contexts not only as platforms for knowledge acquisition but also as environments that actively cultivate coping strategies and professional readiness. By engaging PSTs in authentic, challenging, and reflective digital tasks, the intervention provided opportunities to encounter manageable stressors, reflect on emotional responses, and develop strategies for effective coping, thereby supporting holistic resilience development. Practically, these findings suggest that preschool teacher education programs may benefit from systematically integrating structured digital tasks with reflective exercises and feedback mechanisms. Such curricular strategies can better prepare future teachers to navigate the emotional and cognitive demands of ECE in both digital and traditional classroom contexts. Overall, this research contributes to understanding how targeted interventions within DL environments can enhance ER, supporting the preparation of adaptive, reflective, and emotionally competent early childhood educators.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : Conceptualization

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So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The corresponding author may provide study data upon reasonable request.

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