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Trauma-Informed Game-Based Learning: A Technological Approach to Enhancing Children's Resilience in Post-Disaster Education

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Abstract. Often natural disasters not only disrupt the physical infrastructure of communities but also the emotional well-being and educational continuity of children. This study investigates the potential of trauma-informed game-based learning as an innovative educational strategy to enhance resilience and learning engagement among children aged 7–12 years old in post-disaster contexts. Developed in response to an earthquake in Central Java, Indonesia, a digital learning game integrates trauma-sensitive pedagogical principles with interactive gameplay elements designed to foster emotional safety and cognitive stimulation. A mixed-methods approach was employed, involving 42 children, alongside teachers and psychologists, to evaluate the effectiveness of this intervention. The quantitative findings revealed a statistically significant reduction in trauma symptoms, as measured by the child post-traumatic stress disorder symptom scale and an increase in students' learning motivation. The qualitative data further supported these outcomes, highlighting improved emotional expression and classroom participation. The results emphasize the importance of merging trauma-aware design with educational technology to support children's psychological recovery while maintaining academic engagement. Trauma-informed game-based learning presents a promising model for addressing both emotional and educational needs in disaster-affected areas, offering a scalable and context-sensitive approach to resilience-building through learning.

Keywords: Game-based learning; disaster education; children's resilience; educational technology

1. Introduction

Natural disasters such as earthquakes, floods, and volcanic eruptions happen often in Indonesia. These disasters create major challenges for infrastructure and education. Children are especially vulnerable. They face disruptions in schooling

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and emotional and psychological stress. Children and youth who experience trauma and show mental health symptoms may develop post-traumatic stress disorder (PTSD). Careful diagnostic evaluation is needed (Cruz et al., 2022). These children are also at risk for problems with cognitive functions. This includes intelligence quotient, memory, attention, and language skills. These challenges can harm academic performance. They may also lead to discipline problems, poor attendance, and behavioral issues. Symptoms being internalized may also increase (Maynard et al., 2019). Traditional education methods often do not address these emotional needs, which shows the importance of adaptive learning strategies.

Trauma-informed education offers a helpful framework. It recognizes the emotional effects of adversity. It also aims to create a supportive and responsive learning environment (Thomas et al., 2019). Simultaneously, the use of technology in education is growing. Multimedia courseware is being used more often (Cruz et al., 2022). Educational researchers have examined how these technologies support innovative teaching and learning approaches. The integration of information and communication technologies has paved the way for using multimedia tools and digital games as alternative instructional methods (Foster & Shah, 2020). However, trauma-informed design in educational games, especially in disaster-prone areas in the Global South, is still not well explored.

This research examined the design and implementation of a trauma-informed, game-based learning (GBL) tool created for children affected by an earthquake in Central Java, Indonesia. It aimed to evaluate its effectiveness in reducing trauma symptoms and enhancing engagement. This article contributed to research on disaster-responsive education and the integration of educational technology with empathy.

2. Literature Review

2.1 Trauma-Informed Education: Creating Safe Spaces for Learning After Disasters

Trauma from natural disasters, such as loss of home or injury, can severely disrupt children's ability to engage with education. Trauma-informed education prioritizes emotional safety, empathy, and stability, focusing on the psychological and developmental needs of learners recovering from trauma. This approach acknowledges that trauma can affect cognitive functions such as memory, attention, and emotional regulation, which are essential for learning (Overstreet & Chafouleas, 2016). Symptoms such as anxiety, withdrawal, and difficulty concentrating may persist after trauma, leading to poor academic performance and psychological disorders if left unaddressed (Galvan et al., 2021).

The trauma-informed model shifts educators from instructors to supportive facilitators. Samhsa (2014) outlined the five principles in the model as safety, trust, choice, collaboration, and empowerment. These guide educators to establish predictable routines, use supportive language, and avoid triggers. Within these themes, socio-culturally specific practices are elucidated, including the Indonesian value of mutual assistance ("*gotong royong*"), storytelling ("*tuturan*"),

and the role of religiosity as a form of psychosocial support (Parrott et al., 2024). Integrating trauma-informed principles into GBL offers a promising solution. Games are effective tools for increasing students' intrinsic motivation and engagement in learning processes. They support active learning and scaffolded instruction personalized to individual needs (Ekin et al., 2023). Trauma-informed practices and trauma-informed education components include counseling services, skill development, and teacher psychoeducation (Norrish & Brunzell, 2023). This holistic approach is essential for resilient recovery in disaster-prone regions.

2.2 Game-Based Learning: Empowering Children Through Playful Education

Game-based learning leverages game elements, such as challenges, rewards, and narratives, to achieve educational goals through interactive, experiential learning (Adipat et al., 2021). It is widely recognized for its ability to engage and motivate students by incorporating elements of challenge, fantasy, and curiosity, thereby making learning more enjoyable and effective (Choosang et al., 2023; Olivas Castellanos et al., 2024; Yepes Zuluaga & Arias, 2024).

Research has shown that GBL can significantly enhance learning outcomes across various domains, including logical-mathematical, naturalistic, and linguistic abilities. It also improves memorization skills and motivation among primary school students (Alipova, 2024). Various types of games, strategies, and puzzles have also proven highly effective in strengthening students' computational skills (Al-Hassan et al., 2025).

The effective implementation of GBL requires thoughtful design and integration into the curriculum. This involves aligning game dynamics with real-world challenges and ensuring pedagogical soundness. Despite its growing popularity, a need for more empirical research remains to validate the educational benefits of GBL. Systematic reviews have emphasized the importance of high-quality studies to establish their effectiveness (Jenson & De Castell, 2023).

In disaster recovery contexts, initiatives such as International Rescue Committee's Healing Classrooms and United Nations Children's Fund's digital game trials in Lombok and Palu have demonstrated the potential of GBL to support both academic learning and psychosocial healing (UNICEF, 2021). To be truly impactful in such settings, GBL must be trauma-sensitive, incorporating hopeful narratives, inclusive characters, and cooperative gameplay. Integrating trauma-informed principles into GBL creates a holistic educational approach that promotes both learning and emotional recovery for children affected by disasters.

2.3 Children and Post-Disaster Trauma

Children are highly vulnerable to the psychological impacts of natural disasters, often developing anxiety, depression, or PTSD (Wang & You, 2022). Traumatic events—such as losing loved ones or homes—can disrupt children's emotional and cognitive development. Children with PTSD often exhibit symptoms similar to adults, such as intrusive memories, avoidance of reminders, and hyperarousal (Steil & Rosner, 2022). However, these symptoms can present differently depending on the child's age and developmental stage (Onnis & Carucci, 2023).

PTSD in children can be triggered by various traumatic events, including natural disasters, accidents, violence, and abuse. Unlike adults, children often struggle to verbalize their emotions, making traditional talk-based therapy less effective unless they adapted to their developmental stage. While many recover over time, early intervention is key to preventing long-term mental health issues (Powell et al., 2021).

Recent technological advancements – such as virtual reality – have contributed to the evolution of digital media art, transforming traditional artistic expression into immersive, interactive experiences (Li & Li, 2022; Zheng & An, 2023; Le Roux & Cobham, 2022). Digital storytelling and interactive media art are expanding the boundaries of creative expression and audience engagement (Kun, 2019; Miller, 2025) Even in evacuation settings, play supports emotional stability and learning continuity.

When trauma-informed, GBL bridges education and emotional recovery. As part of a long-term psychosocial strategy involving teachers, parents, and communities, it supports healing while sustaining academic progress – critical in disaster-prone regions such as Central Java.

3. Methodology

This study adopted a mixed-methods approach, combining a quasi-experimental design to assess changes in PTSD symptoms among post-disaster children with qualitative interviews to explore user experiences. This integration provided a comprehensive view of how trauma-informed educational games support children's psychological recovery.

3.1 Participants

The study involved 42 children aged 7–12 years old from earthquake-affected areas in Central Java, Indonesia. The inclusion criteria required participants to have experienced trauma from a recent earthquake within the past year. Children with pre-existing psychological disorders or without access to necessary digital devices were excluded. Additionally, four teachers and two child psychologists participated in interviews to provide insight into the children's behavioral and emotional changes, enriching the analysis with professional observations.

3.2 Game Design

The educational game for this research was developed based on trauma-informed principles, focusing on emotional safety and resilience. It featured supportive characters and comforting environments to avoid re-traumatization. The narrative centered on recovery and hope, guiding players through post-disaster scenarios with a focus on psychological healing. Mini-games addressed both disaster preparedness and emotional regulation, while a reward system offered positive reinforcement to enhance motivation and build self-confidence.

Table 1: Description of the material created in the game application

Segment	Visual/Setting	Source
I (Number symbol material)	a. Opening text <i>AYO BERHITUNG</i> – at the top there is the word START with a game segment symbol with a natural scenery background. b. Background music with cheerful tune. c. Picture of number symbols.	Elementary school mathematics material books
II (Addition of tens and units' material)	a. There is text "Use the button below to help Azmi find this number. Okay!", with a background of a road map that Azmi must go through to find the number in question. b. At the bottom there is a navigation button to help Azmi walk to the number in question. c. In the top left corner is the question.	Elementary school mathematics material books
III (Summation material)	a. Picture shows a pipe to drain water into the bucket until it is full. Water will flow if the answer is correct. b. The right side is the question.	Elementary school mathematics material books
IV (Subtraction material)	a. There are four balloons containing the answer numbers in the air with a bright blue-sky background. b. There is a sign in the form of a shooting point to shoot the balloons containing the correct answers. c. The bottom part is a question.	Elementary school mathematics material books
V (Result)	a. There is a text "Your Results". b. There is a text "Correct" and "Value" and "Repeat". c. If the player does not get the minimum value, the game can be repeated with questions that will be different each time the game starts from beginning. The minimum value is 75.	



Figure 1: Activity diagram main menu of the application



Figure 2: Game design

3.3 Research Instruments

To evaluate the effectiveness of the intervention, three primary instruments were used. First, the child PTSD symptom scale (CPSS) was administered before and after the intervention to measure the severity of PTSD symptoms, which may be flashbacks, nightmares, and anxiety. This standardized tool is widely validated for assessing trauma in children. Second, play engagement observation was conducted during game sessions to record levels of participation, emotional responses, and peer interaction. This observational method helped determine the game's ability to foster focus and emotional connection. Third, semi-structured interviews with four teachers and two child psychologists were used to gather qualitative data on the children's behavioral and emotional development, including improvements in adaptability, social skills, and emotional expression.

3.4 Procedure

The intervention was conducted over 10 consecutive days, with each session lasting 45 minutes. It included an educational game session followed by a short reflective discussion. The process began with a pre-test session, during which the children completed the CPSS and were observed for baseline engagement and emotional state. The game intervention phase followed, in which the children participated daily in trauma-informed educational game activities. Each session began with a brief orientation and was observed to capture emotional and social responses. After the intervention, a post-test session was conducted, repeating the CPSS to assess symptom changes. Finally, teachers and psychologists were interviewed to provide professional insight into the children's post-intervention behavior and recovery progress.

3.5 Data Analysis

This study employed both quantitative and qualitative methods to analyze the impact of the educational game intervention on children's trauma recovery. Quantitative data from the CPSS pre-test and post-test were analyzed to assess changes in PTSD symptoms. First, a normality test using either the Kolmogorov-Smirnov or Shapiro-Wilk method determined whether the data followed a normal distribution. If normality was confirmed, a paired sample t-test was conducted to examine the significance of differences in PTSD scores before and after the intervention. A p-value of less than 0.05 was considered statistically significant. To measure the strength of the intervention's impact, Cohen's d was calculated, with values of 0.2, 0.5, and 0.8 representing small, medium, and large effect sizes, respectively.

Qualitative data, including classroom observations and interviews with teachers and psychologists, were analyzed using thematic analysis. Interviews were first transcribed verbatim, followed by coding the transcripts and observation notes to identify recurring patterns related to children’s emotional and behavioral changes. The key themes that were expected to emerge included increased social interaction, improved emotional regulation, a restored sense of safety and control, and enhanced academic engagement. Data triangulation was employed to ensure credibility, comparing insights across interviews and observations. The final themes were presented in narrative form, supported by direct quotes, to capture the lived experiences of the children during the intervention.

3.5 Data Interpretation

The integration of quantitative and qualitative findings provided a comprehensive picture of how educational games support trauma recovery in post-disaster children. The statistical outcomes indicated the degree of PTSD symptom reduction, while thematic insights revealed emotional, behavioral, and social developments facilitated by the game. Together, these findings demonstrated the dual function of educational games – as both pedagogical and therapeutic tools – highlighting their potential to support psychosocial recovery in disaster-affected children. The study contributes meaningful evidence for educators, mental health professionals, and policymakers in designing trauma-informed educational strategies that address both learning continuity and emotional resilience in emergency contexts.

4. Results

This study assessed the effectiveness of an educational game intervention in reducing PTSD symptoms among children who survived an earthquake in Central Java. After 10 days of implementation, both quantitative and qualitative data were collected to evaluate changes in the children’s psychological and behavioral conditions. The findings provided a comprehensive picture of the intervention’s impact on the emotional recovery and psychosocial well-being of the participants.



Figure 3: Children recovering from trauma

Quantitative results were obtained through the administration of the CPSS before and after the intervention. A total of 42 children were assessed, and the data showed a statistically significant reduction in PTSD symptoms following the intervention. The paired sample t-test revealed a p-value of 0.001 ($p < 0.05$), indicating a significant difference between pre-test and post-test scores. This result confirmed that the educational game had a meaningful effect in alleviating PTSD symptoms among the children. Furthermore, the calculated effect size using Cohen's d was 0.75, suggested a medium to large effect.

This not only emphasized the statistical significance of the intervention but also highlighted its practical impact on the children's psychological functioning. The average CPSS score decreased from 33.2 before the intervention, which indicated moderate to severe PTSD symptoms, to 20.7 after the intervention. This marked reduction reflected significant improvements in the children's emotional states, including reductions in anxiety, intrusive memories, and emotional distress.

The qualitative results, derived from classroom observations and interviews with teachers and child psychologists, further supported the quantitative findings. Several key themes emerged from the data. First, children displayed increased social engagement following the intervention. Observations indicated that they interacted more frequently with peers and teachers, showing signs of restored social confidence and connection. Second, improvements in emotional regulation were evident. Teachers and psychologists reported that children were better able to express their feelings and manage emotional reactions, a change attributed to the emotional-themed mini-games that formed part of the intervention.

Third, children reported a renewed sense of safety and control over their environment. This sense of security, as observed during gameplay and confirmed through interviews, was closely linked to the game's narrative of recovery and hope. Lastly, positive changes in academic behavior were noted. Post-intervention, children demonstrated greater focus, enthusiasm for learning, and classroom participation, suggesting that their emotional recovery contributed to improved academic engagement.



Figure 4: Visual representation of the intervention

Cumulatively, these results indicate that the trauma-informed educational game intervention was effective in supporting both emotional healing and behavioral development in children affected by the earthquake. The intervention not only reduced PTSD symptoms but also fostered emotional resilience, social reintegration, and educational motivation, making it a valuable tool for psychosocial recovery in post-disaster contexts.

The integration of quantitative and qualitative data in this study presents a compelling picture of the educational game intervention's effectiveness in supporting trauma recovery among children affected by the Central Java earthquake. Quantitatively, the intervention resulted in a statistically significant reduction in PTSD symptoms, with a marked decrease in CPSS scores and a medium to large effect size, indicating both clinical and practical relevance.

Complementing this, the qualitative findings offer rich insights into the emotional, social, and behavioral shifts experienced by the children. Together, these findings confirm that the educational game not only served as a therapeutic tool for reducing trauma symptoms but also played a vital role in rebuilding emotional resilience, enhancing social interaction, and restoring a sense of safety and agency.

Observational data and interviews with teachers and psychologists revealed several key themes that illustrate the broader psychosocial recovery facilitated by the intervention. First, the children demonstrated improved social engagement, becoming more communicative and collaborative with peers and teachers. Previously withdrawn behaviors gave way to active participation in group discussions and playful interactions, reflecting increased confidence and reduced anxiety.

Second, there was noticeable progress in emotional regulation. Children began to express their emotions more constructively and showed greater calmness when facing challenges, a shift supported by the game's emotional awareness components and modeled coping strategies. Third, many children reported feeling a renewed sense of safety and control, a crucial aspect of trauma recovery. Through interactive gameplay that allowed them to make decisions and navigate post-disaster scenarios, the children regained a sense of autonomy and self-assurance, which had been disrupted by the traumatic experience.

Finally, the intervention had a positive impact on academic behaviors. Teachers observed enhanced focus and participation in classroom activities, as children demonstrated improved concentration and greater enthusiasm for learning. The thematic content of the game appeared to help bridge the gap between emotional recovery and academic engagement, enabling children to relate their experiences to learning materials in meaningful ways.

Overall, the qualitative data reinforced the statistical outcomes, offering a holistic view of the children's progress. The educational game not only reduced PTSD symptoms but also supported the development of healthier emotional responses,

social confidence, and academic motivation, making it a promising model for post-disaster educational and psychosocial interventions.

5. Discussion

Recent technological advancements, such as virtual reality, have contributed to the evolution of digital media art, transforming traditional artistic expression into immersive, interactive experiences (Li & Li, 2022; Zheng & An, 2023; Le Roux & Cobham, 2022). Early identification and intervention are crucial. Programs that provide daily necessities, recreation, school resumption, and empathetic adult support can facilitate recovery and resilience (Olness, 2021). This study reinforces the value of trauma-informed, game-based interventions by demonstrating that educational games can significantly reduce PTSD symptoms and foster emotional recovery among children impacted by the Central Java earthquake.

These findings are consistent with previous research highlighting the heightened vulnerability of children exposed to trauma and the need for targeted support to rebuild emotional and cognitive functioning (Graham et al., 2017). Children exposed to disasters are at significant risk for PTSD and other psychological issues. Effective intervention requires early identification, continuous support, and targeted psychological therapies. Further research is needed to refine intervention strategies and understand the long-term trajectories of PTSD in children.

Further research validated the theoretical and empirical feasibility of these games, which were specifically designed for trauma reduction in disaster-affected areas (Kusumandari & Wibawa, 2019). Empirical studies conducted in Klahang village, Indonesia, demonstrated the effectiveness of Android-based learning games in helping children recover from trauma following a fire. These games successfully reduced trauma levels across categories of mild, moderate, and severe trauma (Kusumandari et al., 2019). Beyond symptom reduction, the interventions also contributed to improved social engagement. Children showed increased openness in peer interactions and greater participation in classroom activities – both essential components of post-trauma recovery.

Rebuilding social connections in safe, supportive settings enhances emotional resilience and fosters a sense of belonging, particularly in children who previously exhibited withdrawal or social isolation (Mayer et al., 2019). Additionally, interactive educational games are designed to teach disaster preparedness and response. These tools prove effective in empowering children from resource-limited communities, strengthening their ability to respond to emergencies and enhancing their confidence (Marahatta et al., 2024).

Fundamentally, this study highlights the effectiveness of integrating trauma-responsive educational games into post-disaster educational settings. These interventions not only help alleviate PTSD symptoms but also promote emotional regulation, social reintegration, and academic engagement. As a holistic approach, GBL serves both therapeutic and developmental functions, offering critical support for children recovering from traumatic experiences.

A pressing need exists to expand and refine the use of game-based interventions in disaster-affected educational contexts. By harnessing the strengths of GBL, educators and policymakers can foster resilient learning environments that support the comprehensive recovery of trauma-affected children. This study contributes to the growing body of evidence showing that educational games are not only effective learning tools but also powerful instruments for healing.

6. Conclusion

This study highlights the potential of educational games as effective, trauma-sensitive tools for supporting children's emotional and cognitive recovery following disasters. By significantly reducing PTSD symptoms, the intervention demonstrates that GBL can promote healing within a safe and interactive environment.

Educational games offer more than just academic benefits; they also provide therapeutic support that fosters emotional regulation, resilience, and social engagement. As part of a trauma-informed educational framework, they present a promising strategy for post-disaster recovery.

Future research should focus on adapting these interventions to various disaster contexts and diverse child populations, including children with special needs. Additionally, long-term studies are needed to evaluate their sustained impact on emotional well-being and resilience.

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