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AUGMENTED REALITY-BASED PSYCHOLOGICAL INTERVENTION TO ENHANCE STUDENT RESILIENCE IN HIGHER EDUCATION: A SCIENCE-TECHNOLOGY AND SUSTAINABLE DEVELOPMENT GOALS (SDGS)-ORIENTED APPROACH

ONNY FRANSINATA ANGGARA, DIANA RAHMASARI, ZAENAL ABIDIN, QURROTA A'YUNI FITRIANA, MUHAMMAD NURIL MUKMININ, ERIZZA FARIZAN ADANI

Universitas Negeri Surabaya, Surabaya, Indonesia
*Corresponding Author: onnyanggara@unesa.ac.id

Abstract

This study aimed to design and evaluate an augmented reality (AR)-based psychological intervention to enhance student resilience in higher education. Employing the ADDIE model, the intervention included need analysis, module design, development, implementation, and evaluation phases. Thirty students in the experimental group experienced the AR-based intervention, while a control group received standard services. Results indicated improved resilience in the experimental group. This occurred because the immersive and interactive nature of AR allowed students to simulate academic stressors and practice real-time coping strategies. The findings support integrating AR with psychological education as a science- and technology-driven approach aligned with sustainable development goals (SDGs), especially goal 3 on mental health. The AR method presents a promising solution for supporting student well-being and emotional strength in academic settings.

Keywords: Augmented reality, Higher education, Psychological resilience, SDGs, Technology integration.

1. Introduction

In the digital transformation era, university students face mounting challenges that impact their academic performance and emotional well-being. These include high academic expectations, social adaptation difficulties, and increased exposure to digital stressors. Resilience (defined as an individual's capacity to adapt positively to adversity) is now considered an essential psychological skill in navigating such pressures [1]. It influences self-regulation, persistence, and emotional flexibility, and is positively associated with subjective well-being and academic achievement [2]. Recent perspectives view resilience as a malleable capacity shaped by environmental input, including technological engagement [3]. Consequently, promoting resilience has become a priority for institutions committed to enhancing mental health as part of sustainable development goals (SDGs) [4, 5].

Technological tools, especially immersive platforms like Augmented Reality (AR), have emerged as innovative media in educational and psychological interventions [6-9]. Studies demonstrate that AR can enhance stress tolerance, emotional regulation, and learning motivation through experiential and personalized interactions [10, 11]. Within psychology, AR enables safe simulation of stress scenarios that allow users to explore adaptive strategies, making it ideal for emotional training and resilience development [12]. This aligns with the integrative model of resilience, where personalized, engaging, and context-specific interventions are more effective than static or didactic approaches. Furthermore, AR supports student-centred learning experiences that encourage cognitive engagement and real-time decision-making, addressing both psychological and educational needs.

This study integrates science and technology through the development of an AR-based intervention aimed at enhancing student resilience in higher education settings. Using the ADDIE instructional model [13], the intervention combines pedagogical planning, digital design, and psychological constructs to deliver immersive resilience training. The novelty of this research lies in its dual contribution: first, it positions AR not just as an educational support tool but as a direct mental health interventioN.; second, it aligns technological innovation with the SDGs, particularly Goal 3 (good health and well-being) and Goal 4 (quality education). The purpose of this study is to evaluate the effectiveness of this AR-based approach in strengthening psychological resilience among university students and to demonstrate its potential as a scalable solution for mental health challenges in academic environments. This will add new information regarding SDGs as reported elsewhere [14-19].

2. Literature Review

The integration of AR in mental health-related contexts has gained scholarly attention, highlighting its effectiveness in enhancing emotional resilience, reducing stress, and increasing engagement in therapeutic settings. These studies demonstrate the diversity of AR applications, from assisting individuals with cognitive impairments to reducing anxiety and supporting mindfulness in educational environments [20-22]. Such findings emphasize the potential of AR as a dynamic platform for developing context-specific, immersive strategies that support psychological well-being.

While traditional resilience training typically relies on cognitive-behavioural methods or didactic psychoeducation, recent frameworks advocate for the use of interactive digital environments. Resilience is no longer perceived as a fixed trait but as a dynamic, learnable skill influenced by neuroplasticity and environmental stimuli [23, 24]. AR contributes to this process by stimulating multisensory engagement and experiential learning, which are known to enhance adaptive coping mechanisms and emotional self-regulation [25]. AR applications enable learners to engage in simulations that mimic high-pressure scenarios, such as academic deadlines or social conflicts, thereby facilitating real-time practice of problem-solving and emotional control strategies. These immersive environments enhance students' readiness to respond flexibly under stress and improve their long-term retention of behavioural change [26]. Moreover, AR's personalization features make it particularly suitable for psychological interventions. Students can choose coping techniques that align with their emotional styles, such as guided mindfulness, narrative visualizations, or interactive affirmations. These user-driven features foster agency and ownership in the resilience-building process, supporting a constructivist approach to psychological development [27]. Integrating AR into educational psychology also contributes to the digital transformation goals under SDG 4 (quality education) and the mental health targets of SDG 3 (good health and well-being), positioning it as both a pedagogical and humanitarian innovation. Thus, AR is not merely an instructional aid but a technologically advanced medium for enhancing emotional resilience and mental readiness among students.

3. Research Method

A quasi-experimental design was used to test the intervention's effectiveness. Detailed information is explained elsewhere [28, 29]. Sixty students were divided into control and experimental groups. The experimental group received the AR-based psychological training, while the control group accessed standard counselling services. Data were analysed using descriptive and inferential statistics. Reliability of the questionnaire was confirmed prior to analysis using established metrics. Detailed information on how to analyse using statistical analysis is reported elsewhere [30].

Figures 1 and 2 illustrate the AR development process following the ADDIE model: analysis, design, development, implementation, and evaluation [13].

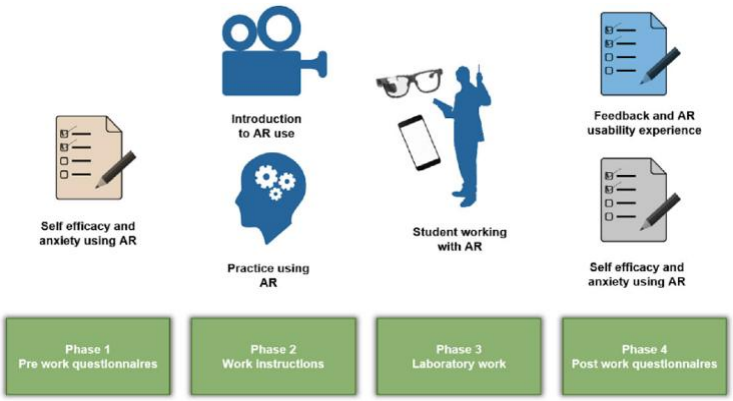

Fig. 1. AR development phase based on the ADDIE model.

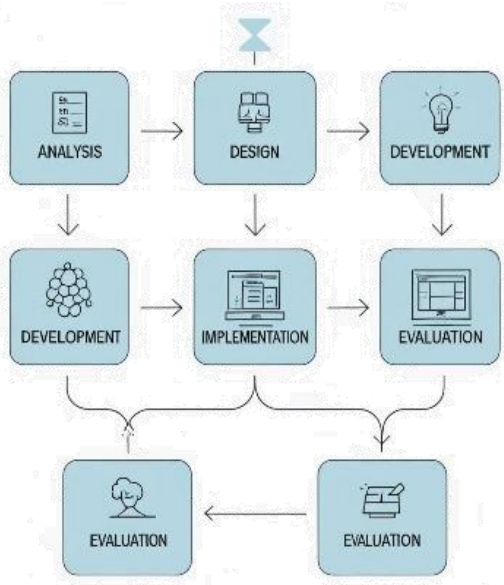

Fig. 2. ADDIE instructional model.

4. Results and Discussion

Figure 3 shows the flowchart of the AR application process. It begins when students scan a marker using their mobile device, triggering a 3D animation and audio overlay. If the marker is not detected, the system provides a retry prompt. This flow ensures that users are guided smoothly and can interact dynamically with the AR content. The sequential process not only supports intuitive navigation but also builds engagement, crucial in sustaining emotional attention and immersion during psychological training [25].

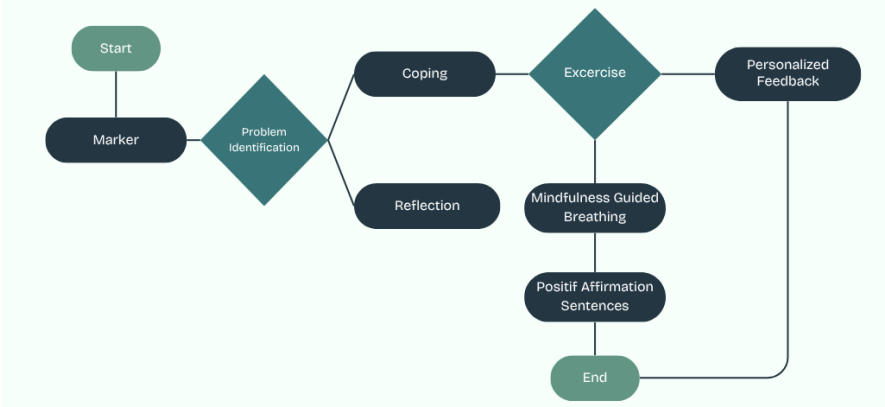

Fig. 3. Flowchart of AR application process.

Figure 4 presents the interface design of the AR system. Panel (a) displays a psychologist-themed dashboard, while panel (b) guides users through activation steps. Panels (c) to (h) show interactive objects such as affirmation texts, 3D visuals of books, and digital tools for emotional regulation. These personalized components

allow users to actively engage with resilience content, aligning with findings that immersive visuals can stimulate reflective and emotional learning [12].

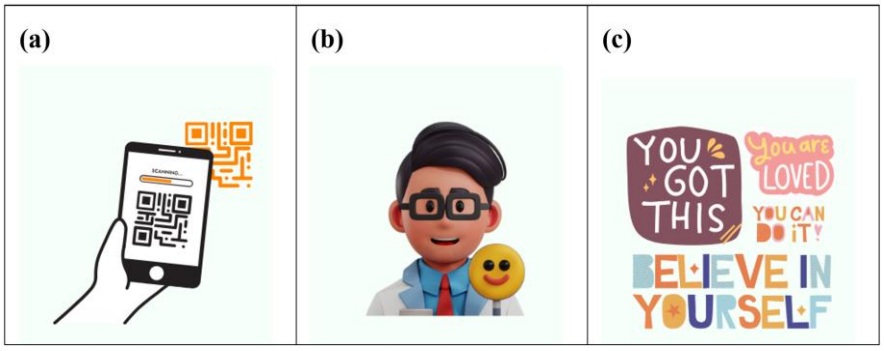

Fig. 4. Positive affirmation and interactive AR interface.

Figure 5 illustrates the Mindfulness Breathing Framework integrated into the application. The three-step process scanning a QR code, following guided breathing, and engaging with visual breathing cues ("inhale" and "exhale") offers real-time physiological regulation. This digital-physical combination reinforces awareness and relaxation, two critical components of psychological resilience [11]. Integrating such techniques within AR creates a layered experience that enhances mental preparedness through repeated practice.

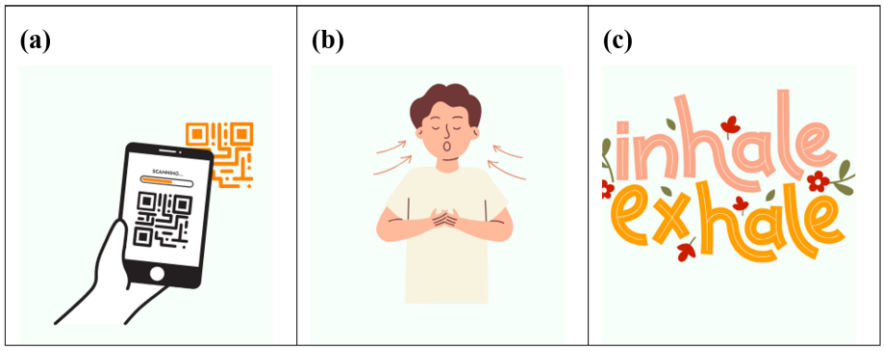

Fig. 5. Mindfulness breathing framework steps.

The experimental group demonstrated a marked increase in resilience, while the control group remained stable. This supports evidence from prior meta-analyses on the efficacy of interactive digital interventions for mental well-being [31]. The significant difference ($t(29) = 6.82$, $p < 0.001$) highlights that the immersive AR experience offers more than knowledge, it facilitates emotional adaptation. The use of narrative, simulation, and personalization appears to be central in enabling students to translate cognitive insights into behavioural change. These results confirm the alignment of AR technology with digital health and SDG targets, offering a scalable, science-based alternative to traditional services. The ability to

simulate academic stress and practice coping strategies interactively provides a novel mechanism for building resilience in higher education contexts.

5. Conclusions

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