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Original Article

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Digital innovations for adolescent mental health: evaluating the impact of genziheal web-based education model

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ABSTRACT

Introduction: Mental health problems among adolescents remain a global public health concern, highlighting the need for accessible and innovative educational interventions. This study evaluated the effectiveness of a web-based mental health education model through the Genziheal platform in improving knowledge levels and reducing symptoms of mental health disorders among adolescent students.

Methods: A quasi-experimental, pretest-posttest control group design was employed involving 130 senior high school students (intervention group: n=80; control group: n=50). Data were collected using the Self-Reporting Questionnaire-29 (SRQ-29) and a validated mental health knowledge questionnaire. Paired t-test and Mann-Whitney tests were used for analysis.

Results: The intervention group demonstrated a significant increase in mental health knowledge (mean score improved from 11.0 ± 2.8 to 12.2 ± 3.2; p = 0.008), while no significant change was observed in the control group. However, no significant differences were found in mental health symptoms between pre- and post-test stages in both groups (p > 0.05).

Conclusions: The Genziheal platform effectively enhanced students' mental health literacy but did not significantly reduce symptoms of mental health disorders. These findings suggest that web-based educational tools can support mental health awareness among adolescents but should be complemented with parental involvement and professional support to address psychological symptoms. This study also highlights the potential integration of digital mental health interventions into school-based health promotion programs. The findings contribute to the development of scalable, culturally contextualized digital health promotion tools, particularly in resource-constrained settings such as Indonesia.

Keywords: adolescents, education, genziheal, mental health, website

Introduction

Adolescence is a transitional period between childhood and adulthood, typically occurring between the ages of 11 and 19, influenced by both biological development and the cultural norms of the time (Blakemore, 2019). In the digital era, this age group is referred to as Generation Z, a cohort of adolescents who are particularly vulnerable to unprecedented health challenges compared to previous generations (Brons *et al.*, 2023; Carey *et al.*, 2024; Upadhyay *et al.*, 2024).

Globally, the prevalence of mental health issues in adolescents is categorized as high, according to the World Health Organization (WHO) report. Nearly half of the mental health cases started from the age of 14 and are mostly not adequately treated, persisting into adulthood (WHO, 2021; Deng *et al.*, 2023). A large-scale survey in the UK involving 28,160 adolescents demonstrated that two

out of five adolescents suffer from mental health issues (Deighton *et al.*, 2019). In the United States, it is predicted that 34,5% of adolescents show mental health symptoms (Liu *et al.*, 2023). In Japan, approximately 39,7% of middle school students are reported to have poor mental health status (Itani *et al.*, 2018).

In Indonesia, according to the Indonesia-National Adolescent Mental Health Survey (I-NAMHS) in 2022, it was reported that 34.9% or around 15.5 million adolescents in Indonesia have at least one mental health issue. The most common mental health problems experienced by Indonesian adolescents are anxiety disorders, namely 26.7%, followed by attention deficit or hyperactivity disorder, reaching 10.6%, and depression, 5.3% (I-NAMHS, 2022). A significant challenge today is that mental health services for adolescents in Indonesia remain far below the targeted service level, even the latest study shows that only 2.6% of adolescents with psychological disorders have ever accessed counselling services (Pandia *et al.*, 2021; I-NAMHS, 2022).

Increasing incidents of mental health problems among adolescents indicate the urgency of developing an effective and targeted mental health education model for today's generation. Targeted and effective educational strategies are necessary to address this issue, particularly through innovative mental health promotion initiatives (Arango et al., 2018; Chicca & Shellenbarger, 2018; Lehtimäki et al., 2021). One promising solution is to integrate mental health education into school environments, involving teachers and students in interactive, peer-based discussions (Santre, 2022). Several studies have demonstrated that this approach improves students' understanding of mental health and encourages them to seek support when experiencing emotional distress (Mfidi, Thupayagale-Tshweneagae, and Akpor, 2018; Laurenzi et al., 2024).

In today's digital era, the development of the internet and smartphones offers excellent opportunities to improve mental health literacy among adolescents. This technology can serve as an educational medium that is easily accessible to this age group (Arango *et al.*, 2018; Lehtimaki *et al.*, 2021). Recent research over the past five years indicates that mental health education models have been widely implemented in healthcare facilities, schools, and communities (Wang *et al.*, 2020; Karataş *et al.*, 2021; Taghadosi and Nouri, 2023). However, a gap remains in providing accessible digital educational models, particularly through web-based platforms.

To bridge this gap, this study introduces genziheal.com, a web-based mental health education platform specifically designed for adolescents. This application offers relevant and easily accessible content, including an AI-powered interactive chatbot to enhance user engagement. The urgency of utilizing digital solutions stems from the increasing prevalence of mental health issues among adolescents and their limited access to conventional mental health services. Digital interventions like Genziheal are particularly suited to the habits of *"Generation Z,"* a cohort born between the mid-1990s and early 2010s, who are highly familiar with and reliant on digital technologies. Therefore, this study aims to analyze the effectiveness of Genziheal in improving mental health literacy, increasing awareness, and reducing mental health symptoms among adolescents.

Materials and Methods

Study Design

A quasi-experimental, non-equivalent control group design was employed. Respondents were divided into two groups: an intervention group and a control group. In the intervention group, the respondents received the treatment so that the effect could be assessed, while the control group received none. The effectiveness of the intervention was evaluated by comparing the responses on pre- and post-intervention questionnaires from both groups.

Population and Sample

The study was conducted across five senior high schools in three districts of West Nusa Tenggara Province, selected based on demographic diversity, accessibility, and logistical feasibility to ensure a representative sample of the adolescent population targeted by the intervention. The research process began from September 2024 to November 2024. The selection of respondents was carried out in schools using research inclusion criteria. A purposive sampling strategy was employed within each participating school to ensure the inclusion of students from diverse socio-demographic backgrounds. The inclusion criteria included adolescent students aged 15 to 19 years; those who study in high school; have a smartphone device, either Android or iOS; do not have a history of severe mental health disorder that requires intensive medical care; and students who are not in a state of physical illness.

A total of 146 students were initially recruited and invited to participate by completing pre- and post-intervention questionnaires. However, only 130 students completed both assessments, resulting in 80 participants in the intervention group and 50 in the control group. The sample size was initially estimated using G*Power 3.1 software for a two-group comparison, with an effect size of 0.5, an alpha level of 0.05, and a power of 0.80. The minimum required sample was 128 participants. The final analyzed sample (n = 130) met this threshold, although group sizes were slightly unbalanced due to participant attrition.

Research Instrument

Two primary outcome variables were assessed: (1) adolescents' knowledge of mental health disorders and (2) self-reported mental health symptoms. Both variables

Table 1. Genziheal research stages

Intervention Group	Method
First meeting: Pre-test	Classical
Briefing induction stage two research guideline in explanation to respondents regarding research informed consent	
Explaining the use and creation of the web account genziheal.com	
Facilitating the questionnaire completion on adolescents' mental health via genziheal.com	
Facilitating the SRQ-29 questionnaire completion via genziheal.com	
Second meeting: Education 1	Focus Group Discussion
Providing mental health education regarding adolescents' emotional mental disorders; introduction to anxiety, depression, and stress on adolescents	
Third meeting: Education 2	Focus Group Discussion
Providing mental health education regarding self-harm, suicidal indication, and psychotropic substance abuse on adolescents	
Fourth meeting: Education 3	Online via ZOOM
Providing training on preventing and handling anxiety, stress, self-harm, and suicidal risk prevention by adolescents	
Fifth meeting: Post-test	Classical
Forming peer-group cadres of School Medical Room (UKS) students as "teenagers care about mental health"	
Conducting reevaluation and re-measurement on adolescents' mental health knowledge level via genziheal.com	
Re-facilitating SRQ-29 questionnaires via genziheal.com	
Control Group	
First meeting: pre-test	Classical
Explaining research instrument and informed consent to respondents	
Filling out mental health knowledge by respondents via genziheal.com	
Filling out SRQ-29 questionnaire via genziheal.com	
Second meeting: post-test	Classical
Conducting reevaluation and re-measurement on adolescents' mental health knowledge	
Facilitating questionnaire completion on adolescents' mental health knowledge via genziheal.com	
Facilitating SRQ-29 questionnaire completion via genziheal.com	

were measured in the intervention and control groups to evaluate the effectiveness of the Genziheal platform. The variables consist of adolescents' knowledge level about mental health problems and mental disorder symptoms. The first variable refers to the definition of how basic knowledge is possessed by adolescents about mental health symptoms, mental health definition, anxiety problems, stress, and self-harm, including the impact of each symptom of psychological disorders. There are three categories for measuring the results of knowledge level, including sound knowledge, sufficient knowledge, and insufficient knowledge. The second variable, mental health symptoms, refers to problems that have occurred or are currently being experienced by adolescent students in the last 30 days. Mental health symptoms detected are anxiety, stress, psychotic symptoms, and drug abuse problems.

To measure the knowledge level of adolescent students, researchers used a questionnaire developed through general questions related to mental health, such as anxiety problems, stress, and self-harm, as well as the impact and how to handle mental health problems, comprising 16 questions. The knowledge assessment questionnaire underwent psychometric validation in a pilot study involving 34 adolescents. Construct validity was assessed using Pearson's correlation test, yielding a minimum value of 0.770. Reliability testing indicated strong internal consistency, with a Cronbach's alpha of 0.791. The instrument used to detect mental health symptoms was the Self-Reporting Questionnaire (SRQ-29), developed by the World Health Organization to assess self-reported mental health symptoms experienced over the past 30 days. The SRQ-29 includes subscales that allow categorization of symptom domains, such as neurotic symptoms (e.g., anxiety, stress), psychotic symptoms (e.g., hallucinations, delusions), and substance-related symptoms. These categorizations were based on item groupings adopted in previous national studies that utilized the SRQ-29 in Indonesia. It is important to note that the terms "psychotic symptoms" or "PTSD symptoms" in this study refer to self-reported experiences, not formal clinical diagnoses. The SRQ-29 has been validated and widely used in Indonesia and has been translated into Indonesian by the Ministry of Health as a standard tool for the early detection of psychological symptoms in psychiatric and community settings.

All outcome measurements were conducted by the research team in collaboration with designated school staff members. To minimize potential measurement bias, school personnel assisting with data collection were not involved in delivering the intervention and were instructed not to discuss the intervention content with students. The research team ensured that the same data collection procedures were consistently applied across both groups at both the pre-test and post-test stages.

Measurement and Data Collection

The Genziheal intervention was conducted over three months, from September to November 2024, across three districts in West Nusa Tenggara Province. The study involved five structured sessions for the intervention group and two assessment sessions for the control group. The main variables measured at both pre-test and post-test stages were adolescents' mental health knowledge and self-reported mental health symptoms. Participants consisted of high school students from Grades X to XII.

In the intervention group, participants participated in a structured mental health education program that combined four face-to-face sessions and one online session. Each session lasted approximately 60–90 minutes and included topics such as anxiety, depression, stress, self-harm, and coping strategies. These sessions employed interactive methods such as focus group discussions and were supported by digital materials accessed through the Genziheal platform (https://genziheal.com). During the final session, peer-group cadres, "students who care about mental health," were established in each intervention school to promote ongoing awareness activities.

Meanwhile, the control group participated in only two sessions: one pre-test and one post-test assessment, without receiving any structured intervention during the study period. After the final evaluation, control group participants were given access to the same educational materials via the Genziheal platform and modules. The detailed implementation timeline is presented in Table 1.

To avoid contamination between the intervention and control groups, schools were purposively selected and assigned to either group in different geographic areas, thereby minimizing interaction among students. Furthermore, all educational activities for the intervention group were conducted in separate sessions with limited access, and control group participants were not given access to the Genziheal platform until after the post-test was completed.

Data Analysis

A total of 146 adolescent students initially participated in this study. However, only 130 respondents completed the questionnaire through to the post-test stage, comprising 80 students in the intervention group and 50 in the control group. The dropout of 16 students was due to incomplete attendance across the intervention sessions or failure to complete the post-test assessment. Group allocation was conducted at the school level using purposive sampling, whereby selected schools were assigned to either the intervention or control group based on logistical feasibility and geographic separation to minimize contamination.

Data analysis began with univariate analysis to present respondents' demographic characteristics, including gender, age, and grade level, using descriptive percentages. Bivariate analysis was then used to evaluate the impact of the Genziheal web-based mental health education model on students' knowledge levels and mental health symptoms.

The normality of data distribution was assessed using the Kolmogorov–Smirnov test. Results indicated that the variables of mental health symptoms in both the intervention and control groups, as well as the knowledge level variable in the control group, were not normally distributed. Consequently, differences between pre- and post-intervention scores for these variables were analyzed using the Wilcoxon Signed-Rank Test. The knowledge level variable in the intervention group, however, followed a normal distribution and was therefore analyzed using the Paired Sample T-Test. Additionally, between-group comparisons at the post-test stage were performed using the Mann–Whitney U test, as the key outcome variables did not meet the assumption of normality. All statistical analyses were conducted using IBM SPSS Statistics version 26.

Ethical Consideration

The study protocol was approved by the Health Research Ethics Committee of the Faculty of Medicine, University of Mataram (Approval No: 134/UN18.F8/ETIK/2024; Protocol No: UNRAM1390924). The research adhered to the principles of the Declaration of Helsinki (2013) and the International Ethical Guidelines for Health-Related Research Involving Humans (CIOMS, 2016). The present study strictly followed the ethical standards proposed in the Declaration of Helsinki (Revised 2013) and followed the International Ethical Guidelines for Human Research in Health (2016).

Participation was entirely voluntary, with respondents retaining the right to withdraw at any stage before data analysis without any consequences. Access to the target population and permission to carry out the study in five schools – SMA 1 Pujut, MA Qamarul Huda, SMA 1 Gerung, SMA 1 Narmada, SMK Kesehatan Yarsi Mataram were granted by the school authorities. The next step was for the researchers to ensure the confidentiality of the respondents' data by maintaining the anonymity of their names. They also got an information sheet before signing the informed consent form on the first page of the questionnaire. The respondent information sheet and the consent form comprehensively outline what is included in this study, including the research method, research duration, potential risks, and potential benefits. The respondents were informed that, as participants, they could withdraw at any time without any consequences. Then, the signature approval was obtained from all respondents before they could fill out and answer the questionnaire.

Results

Participant Characteristics

The demographic distribution of participants is presented in Table 2, categorized by gender, age, and grade level.

The sample was predominantly female (n = 98, 75.4%), with most respondents aged 17 years (42.3%). The majority were in Grade XII (n = 98, 75.4%).

Table 2. Demographic Characteristics of Respondents (n = 130)

	n (%)	(%)
Sex		
Male	32	24.6
Female	98	75.4
Ages		
Below 16	12	9.2
16	31	23.8
17	55	42.3
18	22	16.9
Over 18	10	7.7
Grades		
Grade X	13	10.0
Grade XI	19	14.6
Grade XII	98	75.4

Mental Health Symptoms and Knowledge Level

Table 3 summarizes the distribution of mental health symptoms, the number of symptoms per student, and knowledge levels before and after the intervention.

The results indicate that self-reported mental health symptoms were more frequently observed in the intervention group than in the control group at baseline. Following the intervention, there was a reduction in the number of students in the intervention group reporting multiple symptoms, with those experiencing three symptoms decreasing from 55.0% to 42.5%. In contrast, the control group showed only minimal variation. Knowledge levels improved substantially in the intervention group, with the proportion of students categorized as having good knowledge increasing from 20.0% to 41.3%. However, only a slight increase was observed in the control group for the same category.

Statistical Analysis of Differences

To assess the effectiveness of the intervention, three statistical tests were applied: the Wilcoxon Signed-Rank Test for within-group comparisons of non-normally distributed data, the Paired Sample T-Test for normally distributed data in the intervention group, and the Mann–Whitney U Test for between-group comparisons (Tables 4–6).

The Wilcoxon test showed no statistically significant differences in mental health symptoms between the pre- and post-test stages in both the intervention ($p = 0.056$) and control groups ($p = 0.450$). Similarly, no significant difference was found in knowledge level within the control group ($p = 0.199$).

A paired t-test revealed a statistically significant improvement in knowledge level in the intervention group ($p = 0.008$), demonstrating the effectiveness of the Genziheal web-based intervention.

The Mann-Whitney test indicated no statistically significant differences between the intervention and control groups for both mental health symptoms ($p = 0.784$) and knowledge level ($p = 0.257$) at the post-test stage.

Although the intervention effectively improved knowledge levels in the intervention group, no significant changes were observed in mental health symptoms compared to the control group. Further research is recommended to explore the long-term effects of such

Table 3. Distribution of Self-reported Mental Health Symptoms and Knowledge Level

	Pre-test		Post-test	
	n	(%)	n	(%)
Mental health symptoms (Intervention n=80)				
Anxiety symptoms	61	76.3	59	73.8
PTSD symptoms	72	90.0	64	80.0
Psychotic symptoms	62	77.5	41	51.3
Psychoactive substance	5	6.3	6	7.5
Mental health symptoms (Control n=50)				
Anxiety symptoms	36	72.0	34	68.0
PTSD symptoms	42	84.0	42	84.0
Psychotic symptoms	30	60.0	27	54.0
Psychoactive substance	3	6.0	2	4.0
Number of mental health symptoms (Intervention n=80)				
No symptoms	3	3.8	7	8.8
One symptom	8	10.0	16	20.0
Two symptoms	20	25.0	20	25.0
Three symptoms	44	55.0	34	42.5
Four symptoms	5	6.3	3	3.8
Number of mental health symptoms (Control n=50)				
No symptoms	4	8.0	1	2.0
One symptom	8	16.0	14	28.0
Two symptoms	14	28.0	15	30.0
Three symptoms	21	42.0	18	36.0
Four symptoms	3	6.0	2	4.0
Knowledge level (Intervention n=80)				
Good	16	20.0	33	41.3
Sufficient	41	51.3	33	41.3
Limited	23	28.7	14	17.4
Knowledge level (Control n=50)				
Good	11	22.0	15	30.0
Sufficient	29	58.0	30	60.0
Limited	10	20.0	5	10.0

Table 4. Wilcoxon Test for Mental Health Symptoms and Knowledge Level (Control and Intervention Groups)

Variable	n	Mean Rank	Z	p
Mental Health Symptoms (Intervention, Pre-Post)				
Decrease	24	22.79	-1.912	0.056
Increase	16	17.06		
No Change	40	-		
Mental Health Symptoms (Control, Pre-Post)				
Decrease	18	15.83	-0.755	0.450
Increase	13	16.23		
No Change	19	-		
Knowledge Level (Control, Pre-Post)				
Decrease	18	22.47	-1.284	0.199
Increase	27	23.35		
No Change	5	-		

interventions and examine the role of external support systems that may enhance psychological outcomes.

Discussions

The study has found that a web-based mental health education intervention model via the Genziheal platform has a different impact on both variables, namely, knowledge level and adolescent students' mental health symptoms. A significant increase was observed in the intervention group's knowledge level (pre-test = 11.0±2.8, post-test = 12.2 ± 3.2), indicating that this platform is effective as a medium for mental health education ($p<0.05$). On the other hand, the mental health symptoms variable shows no significant changes in either the intervention group or the control group ($p>0.05$). This finding suggests that Genziheal-based intervention is more effective in improving adolescent students' knowledge compared to directly influencing mental health symptoms.

Despite the increase in knowledge levels, the statistical comparison between the intervention and control groups revealed no significant differences in mental health symptoms. This outcome may be influenced by individual variability in mental health conditions and unmeasured external factors rather than the duration of the intervention. The Genziheal intervention was conducted over three months comprising five structured sessions, which aligns with the duration used in similar digital mental health interventions (Lattie *et al.*, 2019; Shelemy, Harvey and Waite, 2020; Wang, Zhang and An, 2023). Another possible explanation for the limited effect on symptom reduction is the absence of external support mechanisms during the intervention. Factors such as parental involvement, peer support, and teacher engagement were not integrated into the model, despite their known influence on adolescents' emotional well-being and behavior change (Das *et al.*, 2016; Feiss *et al.*, 2019; Basu and Banerjee, 2020). Future versions of the Genziheal program may benefit from incorporating these supportive elements to enhance its overall effectiveness.

The increase in students' mental health knowledge in this study can be explained using the Health Belief Model (HBM) and the Health Promotion Model (HPM). According to the Health Belief Model (HBM), individuals are more likely to change their behavior if they believe a health problem is severe, feel at risk, and perceive clear benefits from acting (Nobiling and Maykrantz, 2017; Barkhordari-Sharifabad, Vaziri-Yazdi, and Barkhordari-Sharifabad, 2020; Fadaei et al., 2020). The Genziheal platform provided information about the risks of poor mental health and the benefits of early awareness and self-care. This may have increased students' understanding and encouraged them to learn more about mental health.

The HPM also supports this result. This model emphasizes the significance of personal motivation, self-confidence, and support from the learning environment (Palmer *et al.*, 2020; Wiguna and Suhamdani, 2022; Ren and Li, 2023). Genziheal was designed to be interactive and user-friendly, allowing students to access information independently and engage actively with the content. These features are crucial in enabling adolescents to learn more effectively. Web-based learning is also in line with the habits of Gen Z and offers a practical solution for promoting mental health at scale (Khoshnood, Rayyani, and Tirgari, 2018; Wang, Zhang, and An, 2023).

However, even though these models help explain the improvement in knowledge, they may not be enough to reduce mental health symptoms. Future interventions should include emotional and social support, such as involving parents, peer groups, or school counselors, to strengthen the impact of educational efforts.

The findings of this study are consistent with previous research, which shows that web-based interventions are effective in improving mental health knowledge among adolescents and adults (Anttila *et al.*, 2019; Iglhaut *et al.*, 2024). Like our study, those interventions successfully increased participants' awareness and understanding of mental health issues through accessible, technology-based platforms.

Table 5. Paired t-Test for Knowledge Level in the Intervention Group (n = 80)

Variable	Pre-test Mean ± SD	Post-test Mean ± SD	p
Knowledge Level	11.0 ± 2.8 (1.0–15.0)	12.2 ± 3.2 (5.0–16.0)	0.008

Table 6. Mann-Whitney Test for Post-Test Differences Between Intervention and Control Groups (n = 130)

Variable	Group	N	Mean Rank	Z	p
Mental health symptoms	Intervention	80	64.41	-0.274	0.784
	Control	50	66.18		
Knowledge level	Intervention	80	60.82	-1.134	0.257
	Control	50	68.43		

However, consistent with the findings of Mfidi et al. (2018), Heizomi et al. (2020), and de Sousa et al. (2022), this study did not observe significant short-term improvements in symptoms of mental health disorders. These studies emphasize that symptom reduction often requires more extended intervention periods, higher engagement levels, and additional psychosocial support. Likewise, Lattie et al. (2019) reported that digital interventions can reduce anxiety and depressive symptoms. Still, their effectiveness is enhanced when combined with interpersonal interaction, such as peer support or professional counseling. Therefore, while this study supports the efficacy of web-based interventions for increasing knowledge, it also reinforces the argument that symptom-level changes may require more comprehensive, multi-component approaches.

In a more specific context, several studies have also supported the use of digital platforms to enhance adolescent mental health literacy and coping skills. The present research shares similarities with the findings of Tian et al. (2024), which reported that web-based interventions or smartphone applications can effectively improve students' mental health literacy. Similarly, Khajavi et al. (2024) found that online health education programs have a positive influence on adolescents' ability to manage stress. These findings reinforce the relevance of web-based interventions as accessible and scalable tools for mental health education among adolescents.

These findings underscore the growing potential of digital platforms in addressing adolescent mental health needs. Building on this evidence, the present study contributes to the development of future online-based mental health promotion initiatives. Through its real-time chatbot feature, Genziheal offers an interactive and user-friendly experience that is highly accessible for adolescents, particularly as they belong to the "digital native" generation—individuals who have grown up immersed in digital technologies and the internet (Fitryasari, Tristiana, and Yusuf, 2021; Haddock et al., 2022; Ricoy, Martínez-Carrera, and Martínez-Carrera, 2022). As such, the Genziheal platform holds promise as a prototype for scalable, low-cost mental health education tools and may serve as a model for similar applications aimed at expanding access to mental health services and health promotion in broader community settings.

This study has several limitations. First, the unequal sample sizes between the intervention and control groups may have affected statistical power. Second, the three-month intervention period may not be sufficient to capture long-term effects on mental health symptoms. Third, external factors such as parental involvement, peer relationships, and school-based support were not measured, which may have influenced outcomes. Nevertheless, this study offers valuable insights into the potential of web-based education platforms in promoting adolescent mental health. The findings contribute to existing evidence supporting digital interventions to improve mental health literacy, emphasizing the need for more comprehensive strategies that integrate parental engagement, social support, and institutional involvement to enhance intervention outcomes.

Conclusion

The Genziheal platform, a web-based mental health education tool that integrates both online and offline learning approaches, proved effective in enhancing mental health literacy among adolescents. Participants in the intervention group demonstrated improved understanding and awareness of mental health issues compared to those in the control group. Moreover, this study addresses a significant gap in the existing literature by evaluating a locally developed digital intervention designed explicitly for Indonesian adolescents. In this area, few culturally contextualized tools currently exist. Compared to other generic digital health platforms, Genziheal offers an interactive, chatbot-assisted experience that aligns with the needs and habits of the digital native generation.

These results highlight the potential of Genziheal and similar platforms to provide accessible, scalable mental health education, especially in settings with limited access to conventional mental health services. Future development should focus on integrating such tools into formal school curricula and youth outreach programs to enhance sustainability and reach. This is particularly relevant in the context of Indonesia's growing youth population and limited mental health infrastructure.

However, this study is not without limitations. The relatively short intervention duration, unequal group sizes, and exclusion of social support variables may have influenced the outcomes. Future research should explore longer-term interventions with more diverse samples and examine the impact of integrating family and peer support mechanisms into digital platforms to optimize mental health outcomes.

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Availability of data and materials

The data and materials supporting the findings of this study are not publicly available due to participant privacy and ethical considerations. However, data may be obtained from the corresponding author upon reasonable request. Educational materials used in this study, including the guidebook module and video resources, are accessible through the Genziheal web platform at https://www.genziheal.com. Specific requests regarding these materials can also be directed to the authors.

Authors' contributions

Reza Indra Wiguna: as the head of the research team and research coordinator from the implementation of data collection to the final reporting of the research, study conception and design, and as the research data analyst.

Valian Yoga Pudya Ardhana: as a programmer and designer of the Genziheal web application and online web hosting. Orientation training of the e-GenziHeal application to adolescent students in 5 schools.

Rias Pratiwi Safitri: is a psychologist who provides counseling for handling adolescent mental health problems online through the Genziheal website. Coordinator for the preparation of mental health education materials on the Genziheal web application.

Baiq Fitria Frisma lita: Coordinator of data processing and collection at school, references, data analysis.

D Mustamu Qamal Pa'ni: Coordinator of data processing and collection at school, references, and data analysis.

Lia Arian Apriani: as a translator, data collection, manuscript writing, and references.

Declaration of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper. This research was conducted independently, and no personal relationships influenced the study design, data collection, analysis, or interpretation of results. The authors have no affiliations with any organizations, institutions, or companies that could have influenced the outcomes of this study. All authors have reviewed and approved the final manuscript, and the research was conducted according to ethical standards.

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