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FULL-LENGTH REPORT

Evaluation of a multicomponent positive psychology program to prevent gaming disorder and enhance mental wellness in primary pupils: A randomized controlled trial

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ABSTRACT

Background and Aims: Gaming disorder (GD) is a prevalent and complex issue that has recently been recognized as a condition that impairs mental health, underscoring the urgent need for early prevention measures. This evaluation study examined the effectiveness of the Digital Netizen Alliance (D.N.A.) program, a new multicomponent positive psychology program for preventing GD and bolstering mental wellness among Chinese children. *Methods:* Drawing on gamification and positive psychology principles, the program builds four key positive skills collectively referred to as the P-A-G-E framework: psychological resilience, active coping, growth mindset, and emotion regulation. A randomized controlled trial was conducted with 264 primary school pupils attending fourth, fifth, or sixth grade in Hong Kong (63% female; mean age = 10.83, *SD* = 1.18). *Results:* The findings revealed that participation in the program effectively promoted active coping, a growth mindset, and emotion regulation. Moreover, program participation alleviated GD symptoms and reduced negative affect. These desirable changes were fully explained by the P-A-G-E framework. *Discussion and Conclusions:* The new D.N.A. program, which cultivates the positive psychology skills specified in the P-A-G-E framework, facilitates favorable psychological changes among children. These results emphasize the importance of using multicomponent frameworks for interventions targeting GD prevention.

KEYWORDS

gaming addiction, gamification, problematic gaming, intervention, mental health, well-being

INTRODUCTION

The increasing popularity of video gaming, driven by the widespread use of smartphones and tablets (Hou et al., 2022; Syvertsen, Ortiz de Gortari, King, & Pallesen, 2022), has raised concerns about its potential adverse effects, particularly among children (e.g., Bender, Kim, & Gentile, 2020; Cheng, Cheung, & Wang, 2018). Research has shown that compared with adults, children tend to spend more time playing video games (González-González, Toledo-Delgado, Muñoz-Cruz, & Arnedo-Moreno, 2022; Wang, Sigerson, & Cheng, 2019). Over the past decade, concerns have grown about gaming disorder (GD), a psychiatric condition classified under "*disorders due to addictive behaviors*" in the ICD-11 and recognized in the DSM-5 as warranting further investigation (e.g., Jo et al., 2019; Wang & Cheng, 2020). GD is characterized by persistent or recurrent engagement in gaming behavior for prolonged

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periods, leading to a lack of control over gaming activities and the prioritization of gaming over other life domains, despite adverse consequences that impair personal, social, or occupational functioning (e.g., Bäcklund, Elbe, Gavelin, Sörman, & Ljungberg, 2022; Liu et al., 2022).

The global prevalence of GD has been estimated to range from 2% to 6% in the general population (Meng et al., 2022; Pan, Chiu, & Lin, 2020; Stevens, Dorstyn, Delfabbro, & King, 2020), with a higher prevalence of 5% to 10% observed among adolescents and young adults (e.g., Fam, 2018; Gao, Wang, & Dong, 2022). Studies on Chinese primary school pupils have reported GD prevalence rates ranging from 10% to 15% (Tsui & Cheng, 2021; Yang, Huang, & Wong, 2021). The present study was conducted in response to the World Health Organization's (2018) call for increased efforts to prevent GD amid growing public concern over the disorder.

With an awareness of the importance of early intervention, this study's primary objective was to develop and validate a new prevention program—the Digital Netizen Alliance (D.N.A.)—among children. A unique feature of this program is its use of gamification strategies in primary education, taking advantage of the popularity of gaming as a leisure activity for this vulnerable age group. Gamification refers to the strategic integration of game-like mechanics, dynamics, and aesthetics into serious non-gaming contexts (Cheng & Ebrahimi, 2023a). By incorporating gaming elements such as challenges, points, and rewards, this approach seeks to make learning and skill development interactive and enjoyable. Gamification has been found to positively influence affective states, attitudes, and cognitive processes, ultimately enhancing user motivation and engagement as well as the effective attainment of desired outcomes (Fotaris, Mastoras, Leinfellner, & Rosunally, 2016; Suh, Wagner, & Liu, 2018). Gamification has recently gained traction as a tool for promoting mental health and has shown promise in bolstering subjective well-being and alleviating psychological symptoms in various health contexts (Cheng & Ebrahimi, 2023b; Taghipour, Vizeshfar, & Zarifsanaiey, 2023), including GD prevention (Chau, Tsui, & Cheng, 2019; Lee & Huh, 2024).

Most program evaluation studies have focused on examining the overall effectiveness of programs, often overlooking their specific components and the underlying mechanisms that contribute to their effectiveness (Chen, Lu, Wang, & Gao, 2023). This approach may limit the understanding of how GD interventions work and hinder efforts to optimize their efficacy. To address these limitations, we devised a multicomponent framework for program development and evaluation, drawing on the Interaction of Person–Affect–Cognition–Execution (I-PACE) model (Brand et al., 2019). The major premise of this model is that the trajectory of GD symptom development is shaped by a multitude of factors, including both stable (personality dispositions) and changeable (cognitive, affective, and behavioral) aspects. Based on this model, our intervention focuses on cognitive (growth mindset), affective (psychological resilience and emotion regulation), and behavioral (active coping) factors because they are alterable through intervention efforts, and empirical evidence has demonstrated their protective function in alleviating GD symptoms (Ji, Yin, Zhang, & Wong, 2022; Tang, Ebrahimi, & Cheng, 2023; Warburton, Parkes, & Sweller, 2022).

Considering these theoretical postulations and empirical findings, the D.N.A. program emphasizes the cultivation of four key positive skills collectively referred to as the P-A-G-E framework: psychological resilience, active coping, growth mindset, and emotion regulation (see Table 1 and Fig. 1). The present evaluation study aimed to examine their individual and conjoint effects on intervention outcomes as well as to unveil the underlying mechanisms that contribute to these effects. Thus, this approach provides a more nuanced understanding of how the intervention works, enabling the customization of the intervention program to cater to individual needs and the optimization of its effectiveness.

As few studies have used randomized controlled trials (RCTs) to evaluate GD interventions (Chen et al., 2023), we adopted this rigorous approach to evaluate the effectiveness of the D.N.A. program in cultivating the four P-A-G-E components. The RCT approach enables a systematic evaluation of a program's effectiveness and allows a direct comparison of outcomes between the intervention and the control groups (Nezu & Nezu, 2007). We tested the following hypotheses:

Table 1. Four modules of the D.N.A. program aligned with the P-A-G-E framework

Module	Aim and Hypothesis	Content and Relevant Skills
Module 1: Be a Super Resilience Hero: Unlock Your Superpowers!	To enhance psychological resilience *(Hypothesis 1)*	Development of resilience skills to overcome challenges, bounce back from setbacks, and cultivate optimism to strengthen participants' potential
Module 2: Be a Savvy Internet Explorer: Active Coping for a Balanced Life!	To increase the use of active coping strategies to confront real-life stressors *(Hypothesis 2)*	Acquisition of active coping strategies for managing participants' gaming time, setting boundaries, and practicing positive coping skills to maintain a balanced online–offline life
Module 3: Be a Growth Mindset Champion: Nurturing a Positive Mind for Growth!	To nurture a mindset of personal growth and continuous improvement *(Hypothesis 3)*	Cultivation of a growth mindset in participants, encouraging them to believe in their ability to learn and improve, thus fostering their personal and academic growth
Module 4: Be an Emotion Master: Manage Your Feelings with Confidence!	To develop skills to regulate emotions effectively *(Hypothesis 4)*	Training participants in a set of skills necessary for recognizing and expressing their feelings in a healthy way as well as techniques for self-regulation and emotional control

Fig. 1. Screenshots of the four modules of the P-A-G-E Framework in the D.N.A. program

Hypothesis 1: Participation in the D.N.A. program (vs. waitlist) would enhance psychological resilience.

Hypothesis 2: Participation in the D.N.A. program (vs. waitlist) would increase the use of active coping strategies.

Hypothesis 3: Participation in the D.N.A. program (vs. waitlist) would strengthen a growth mindset.

Hypothesis 4: Participation in the D.N.A. program (vs. waitlist) would improve emotion regulation.

In addition to its emphasis on skill development, the D.N.A. program aims to alleviate GD symptoms and enhance mental wellness. According to the "escape from self" theory of GD (Kwon, Chung, & Lee, 2011), individuals experiencing heightened stress and negative emotions may find gaming an appealing form of escapism. Ironically, excessive gaming can exacerbate problems in real life. In light of evidence indicating the effectiveness of incorporating positive psychology into preventive strategies (Benoit & Gabola, 2021; Kwok, Gu, & Kit, 2016), positive psychology interventions have emerged as a viable approach to preventing GD through the cultivation of personal strengths, effective coping skills, and positive emotions that empower individuals to face and cope with challenges and adversities encountered in daily life. We tested the following hypotheses pertaining to the amelioration of GD symptoms and bolstering subjective well-being:

Hypothesis 5: Participation in the D.N.A. program (vs. waitlist) would alleviate GD symptoms.

Hypothesis 6: Participation in the D.N.A. program (vs. waitlist) would bolster subjective well-being

(i.e., decrease negative affect and increase positive affect).

Hypothesis 7: An increase in the four skills outlined in the P-A-G-E framework would explain the negative association between participation in the D.N.A. program and GD symptoms.

Hypothesis 8: An increase in the four skills outlined in the P-A-G-E framework would explain the positive association between participation in the D.N.A. program and subjective well-being.

METHODS

Trial design and randomization

The RCT was conducted in adherence with the rigorous standards of the Consolidated Standards of Reporting Trials (CONSORT) guidelines (Schulz, Altman, Moher, & Consort Group, 2010). The trial comprised two conditions: an intervention condition, in which the participants were enrolled in the D.N.A. program during the study period; and a waitlist condition, in which the participants took part in the same program upon study completion. For the sequence generation process, an independent research assistant used a computer-generated randomization algorithm to assign half of the participants to the intervention condition and the other half to the waitlist condition. The randomization sequence was concealed from the entire research team involved in recruitment, data collection, and statistical analysis.

Power calculation and participants

An a priori power analysis with G*Power version 3.1.9.4 (Faul, Erdfelder, Buchner, & Lang, 2009) showed that a sample size of at least 106 participants per condition was required to detect a medium to large effect (Cohen's $d = 0.25$) with an alpha level of 0.05 and a power of 0.80 in a one-tailed test.

Four schools were selected on the basis of their location and willingness to participate in the project. Pupils were included if they were attending fourth, fifth, or sixth grade and could understand or communicate in Cantonese. Pupils were excluded if informed consent was not provided by them or their primary caregiver. We checked with the schools' social workers to ensure that none of the participants had a diagnosed psychiatric disorder or were currently undergoing treatment for mental health problems.

Initially, 305 pupils were enrolled in the study. However, some of the participants did not complete all of the modules or were absent during the follow-up period, resulting in a final sample of 137 in the intervention group and 127 in the waitlist group. Figure 2 presents a flow chart summarizing the enrollment process. Despite the reduction in the sample size, the study had adequate statistical power to detect the expected effect size. The final sample consisted of 99 male and 165 female participants. The participants' ages ranged from 9 to 14 years, with a mean age of 10.83 ($SD = 1.18$) years. The participants in the two conditions had similar demographic characteristics (see Table 2).

Intervention program design and procedures

The D.N.A. program was implemented over a four-week period, during which all participants were instructed to complete each of the four modules within one week before proceeding to the next. The four modules aligned with the key components of the P-A-G-E framework: psychological resilience, active coping, growth mindset, and emotion regulation (see Table 1 and Fig. 1). Each module comprised an animated clip that provided psychoeducation on the module's topic, a set of mini-games that facilitated knowledge consolidation, badges and trophies that the participants could collect as reinforcement of their progress, and a collaborative pledge activity that encouraged the participants and their parents to set goals together to lead a balanced digital lifestyle. Specific details of the modules can be found in the "Intervention program design" section of the Supplementary Materials.

The modules were designed to be self-paced, enabling the participants to engage with the psychoeducational materials in accordance with their comfort and convenience. They could engage in the online gamified program using their computer or any digital device at home. A standardized schedule was implemented for all of the modules across all four schools. To promote adherence, a research assistant monitored the participants' progress and provided feedback on their achievements, and reminder emails were sent to those who did not complete a module during the assigned week. In addition, facilitators were available to provide support and guidance to the participants throughout the program.

Measures

Psychological resilience was measured using the Child and Youth Resilience Measure-12 (Liebenberg, Ungar, & LeBlanc, 2013). The active coping subscale of the Children's Coping Strategies Checklist—Revised (Ayers, Sandier, West, & Roosa, 1996) was used to measure active coping. The Growth Mindset Inventory (Dweck, 2006) was used to measure growth mindset. Emotion regulation was assessed using the Emotion Regulation Questionnaire for Children and Adolescents (Gullone & Taffe, 2012). GD symptoms were measured using an adapted version of the 15-item Korean Scale for Internet Addiction (K-Scale; Tsui & Cheng, 2021). The Positive and Negative Affect Scale for Children (Laurent et al., 1999) was used to assess both positive and negative affect. The Chinese-translated versions of all of these measures have been validated for use with Chinese youth (Gong, Wang, Zhang, Zeng, & Yang, 2022; Liu, Chen, & Tu, 2017; Mu & Hu, 2016; Pan et al., 2015; Tsui & Cheng, 2021; Zeng, Hou, & Peng, 2016; Zhang, Zhou, & Ho, 2022). More detailed information on each measure is provided in the "Measures" section of the Supplementary Materials.

Statistical analysis

All statistical analyses were performed using SPSS 28.0.1.0. Before hypothesis testing, we measured the prevalence of GD using composite scores derived from the adapted K-Scale.

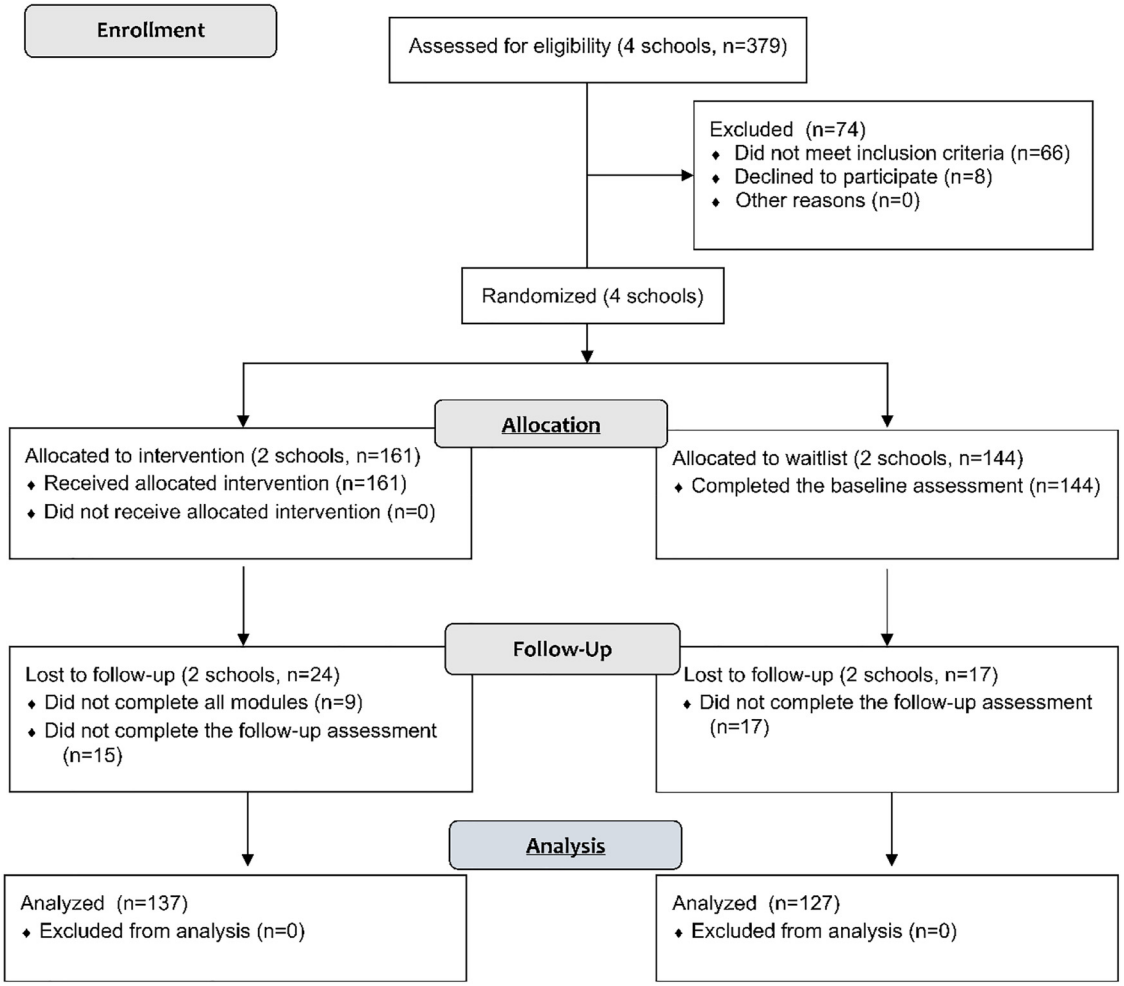

Fig. 2. CONSORT flow diagram of the randomized clinical trial of the D.N.A. program

Table 2. Descriptive statistics of the study variables for the intervention and waitlist (control) conditions

	Intervention (n = 137)		Waitlist (n = 127)			
	M	SD	M	SD	t	p
Age	10.86	1.20	10.79	1.17	0.51	0.306
Psychological resilience—T1	38.47	8.15	38.25	9.47	0.21	0.419
Active coping—T1	20.40	4.58	19.63	5.24	1.28	0.101
Growth mindset—T1	9.87	2.89	9.77	2.59	0.29	0.388
Emotion regulation—T1	31.72	9.96	30.71	9.37	0.84	0.200
GD symptoms—T1	31.90	6.29	32.52	7.42	−0.74	0.231
Positive affect—T1	34.34	8.33	34.52	8.78	−0.17	0.433
Negative affect—T1	31.51	9.09	32.64	9.49	−0.99	0.163
Psychological resilience—T2	39.75	8.07	37.60	8.51	2.51	0.006
Active coping—T2	22.75	4.01	20.17	4.59	4.87	<0.0001
Growth mindset—T2	10.69	2.73	9.51	2.52	3.64	<0.0001
Emotion regulation—T2	35.82	8.31	31.26	8.56	4.40	<0.0001
GD symptoms—T2	30.22	6.99	32.73	6.91	−2.93	0.002
Positive affect—T2	35.69	7.48	33.91	6.84	2.01	0.023
Negative affect—T2	28.05	7.93	32.29	9.13	−4.04	<0.0001

Note. GD = gaming disorder; T1 = Time 1 (baseline); T2 = Time 2 (follow-up).

The participants were classified into risk categories using a scoring scheme validated in Asia (Mak et al., 2017), including Hong Kong (Tsui & Cheng, 2021). Specifically, participants who scored 40 or less were categorized as being at no to low risk for GD, those scoring from 41 to 43 were categorized as being at moderate risk for GD, and those scoring 44 or above were categorized as being at high risk for GD.

To evaluate the program's effectiveness (Hypotheses 1–6), we used a mixed-design generalized linear model (GLM) to examine the effects of condition (intervention vs. waitlist) between participants and time (baseline vs. follow-up assessment) within participants, as well as their interaction.

To elucidate the psychological mechanisms underlying the program's effectiveness (Hypotheses 7–8), we performed mediation analysis using Model 4 of the Hayes PROCESS macro for SPSS version 4.2 (Hayes, 2022). The bias-corrected bootstrapping technique was used with 5,000 bootstraps to ensure the robustness of the findings (Hayes, 2018).

Ethics

The study protocol was preregistered on Open Science Framework (https://osf.io/uwapn/) and approved by the human research ethics committee of the first author's university prior to commencement. The study was conducted in accordance with the ethical principles outlined in the Helsinki Declaration. Before the assessments commenced, the participants and their primary caregivers gave their informed consent.

RESULTS

Changes in GD risk by group

Figure 3 illustrates the distribution of the participants across the three GD-risk groups at two time points. At baseline, the intervention and waitlist groups had similar GD-risk distributions. In the intervention group, 9% and 4% of the participants were classified as being at moderate and high risk, respectively. Similarly, in the waitlist group, 10% and 4% of the participants were classified as being at moderate and high risk, respectively. These findings indicated comparable levels of GD risk between the two groups at baseline.

At the follow-up assessment held one week upon program completion, the proportion of the participants at moderate risk of GD in the intervention group had decreased from 9% at the baseline to 6%, while no such change was observed for the waitlist group. Chi-square statistics showed that the change in the intervention group was significant, $\chi^2(4) = 179.26$, $p < 0.001$ (Cramer's $V = 0.80$). However, no temporal changes were found for the high-risk GD participants across the intervention and the waitlist groups. These initial findings indicated that the D.N.A. program was effective in reducing the prevalence of GD for individuals at moderate risk of GD but not for those at high risk. Table 2 presents the descriptive statistics for all of the study variables.

Effectiveness of promoting psychoeducation based on the P-A-G-E framework

A GLM analysis was conducted for each of the four components of the proposed P-A-G-E framework. For psychological resilience, the Time × Condition interaction effect was nonsignificant, $F(1, 262) = 3.38$, $p = 0.07$ (partial $\eta^2 = 0.01$), indicating no significant change in resilience level for either the intervention or the waitlist group.

For active coping, the GLM results revealed that the Time × Condition interaction effect was significant, $F(1, 262) = 7.84$, $p = 0.005$ (partial $\eta^2 = 0.03$), indicating that after the intervention group had completed the program, they deployed more active coping strategies than did the waitlist group at the follow-up phase.

For growth mindset, there was a significant Time × Condition interaction effect, $F(1, 262) = 7.20$, $p = 0.008$ (partial $\eta^2 = 0.03$), indicating that the intervention group demonstrated a stronger growth mindset than did the waitlist group over time.

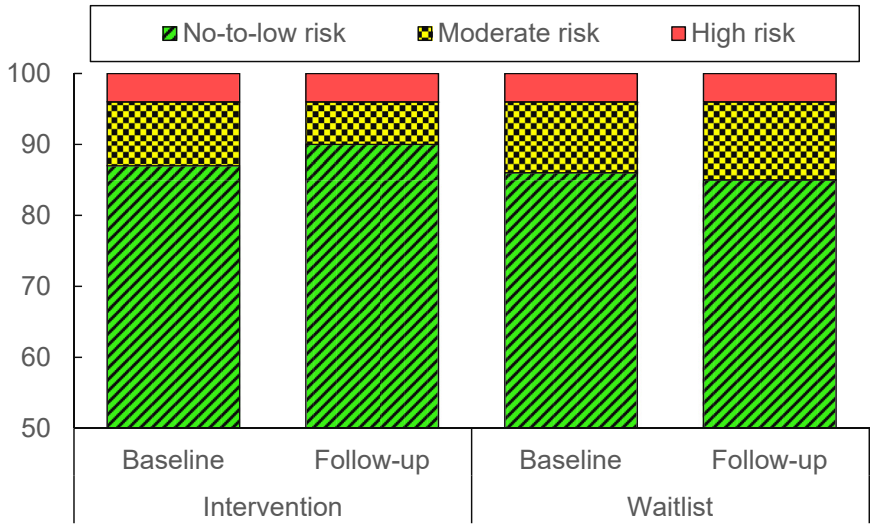

Fig. 3. Percentage of participants in each gaming disorder risk category in the intervention and waitlist (control) conditions

For emotion regulation, the Time × Condition interaction effect was significant, $F(1, 262) = 11.66$, $p < 0.001$ (partial $\eta^2 = 0.04$), indicating that the intervention group exhibited greater emotion regulation than did the waitlist group at the follow-up.

Effectiveness in improving psychological outcomes

For the primary outcome of GD symptom severity, the GLM analysis revealed a significant Time × Condition interaction effect, $F(1, 262) = 6.39$, $p = 0.01$ (partial $\eta^2 = 0.02$), indicating that after program completion, the intervention group reported lower levels of GD symptoms than did the waitlist group.

For the secondary outcome of negative affect, the Time × Condition interaction effect was significant, $F(1, 262) = 11.04$, $p = 0.001$ (partial $\eta^2 = 0.04$), indicating that the intervention group experienced less negative affect than did the waitlist group at the follow-up.

For the secondary outcome of positive affect, the Time × Condition interaction effect was nonsignificant $F(1, 262) = 3.61$, $p = 0.06$ (partial $\eta^2 = 0.01$), indicating no observed difference in positive affect changes between the intervention and the waitlist groups.

Psychological mechanisms underlying program effectiveness

In our mediation analysis, we first evaluated whether the P-A-G-E components accounted for the association between D.N.A. program participation and the reduction in GD symptoms. The results are summarized in the upper panel of Table 3 and Fig. 4. As revealed in Table 3, the indirect effects of the P-A-G-E components on GD symptoms were all significant, with the exception of growth mindset. These findings indicated that the D.N.A. program effectively alleviated GD symptoms by fostering positive changes in psychological resilience, active coping, and emotion regulation. The direct association between program participation and GD symptoms was not significant after controlling for the P-A-G-E components (see Fig. 4), indicating the presence of a full mediation effect.

Next, we repeated the mediation analysis as described above with negative affect as the outcome variable. The findings are shown in the middle panel of Table 3 and Fig. 5. Table 3 shows significant indirect effects of all of the P-A-G-E components on negative affect, with the exception of psychological resilience. These findings demonstrated the effectiveness of the D.N.A. program in relieving negative affect by facilitating positive changes in active coping, growth mindset, and emotion regulation. The direct association between program participation and negative affect was nonsignificant after controlling for the P-A-G-E components (see Fig. 5), indicating the presence of a full mediation effect.

Finally, we performed a mediation analysis with positive affect as the outcome variable. The results are summarized in the lower panel of Table 3 and Fig. 6. As shown in Table 3, significant indirect effects of active coping and growth mindset were found. These results indicated that the D.N.A. program was effective in bolstering positive affect by

Table 3. Estimated indirect effects of the P-A-G-E components on primary and secondary outcomes after participation in the D.N.A. program ($n = 264$)

Indirect effect	Estimate	Boot *SE*	Boot LLCI	Boot ULCI
Primary intervention outcome: Gaming disorder symptoms				
Total	−2.0525	0.4218	−2.9472	−1.2702
D.N.A. program → PR → Outcome	−0.4332	0.1838	−0.8410	−0.1173
D.N.A. program → AC → Outcome	−0.6934	0.2515	−1.2339	−0.2532
D.N.A. program → GM → Outcome	−0.3196	0.2083	−0.7708	0.0334
D.N.A. program → ER → Outcome	−0.6062	0.3013	−1.2502	−0.0699
Secondary intervention outcome: Negative affect				
Total	−2.1255	0.5125	−3.1865	−1.1682
D.N.A. program → PR → Outcome	0.0890	0.1410	−0.1928	0.3972
D.N.A. program → AC → Outcome	−0.5231	0.2763	−1.1321	−0.0645
D.N.A. program → GM → Outcome	−0.3601	0.2045	−0.8163	−0.0159
D.N.A. program → ER → Outcome	−1.3312	0.3678	−2.0648	−0.6494
Secondary intervention outcome: Positive affect				
Total	1.8251	0.5038	0.8936	2.8843
D.N.A. program → PR → Outcome	0.2797	0.1898	−0.0116	0.7195
D.N.A. program → AC → Outcome	0.6812	0.2760	0.2008	1.2879
D.N.A. program → GM → Outcome	0.9213	0.2914	0.3899	1.5277
D.N.A. program → ER → Outcome	−0.0572	0.2432	−0.4956	0.4687

Note. The mediation analysis was conducted with 5,000 bootstrap samples, and all the P-A-G-E components were entered simultaneously as mediators. This mediation model included controls for the P-A-G-E components and the specific outcome assessed at baseline (Time 1). Estimates presented in this table are unstandardized coefficients derived from the follow-up (Time 2). Boot = bias-corrected bootstrap; *SE* = standard error; LLCI = lower limit confidence interval; ULCI = upper limit confidence interval; D.N.A. program = D.N.A. program participation (1: intervention, 0: waitlist); PR = psychological resilience; AC = active coping; GM = growth mindset; ER = emotion regulation.

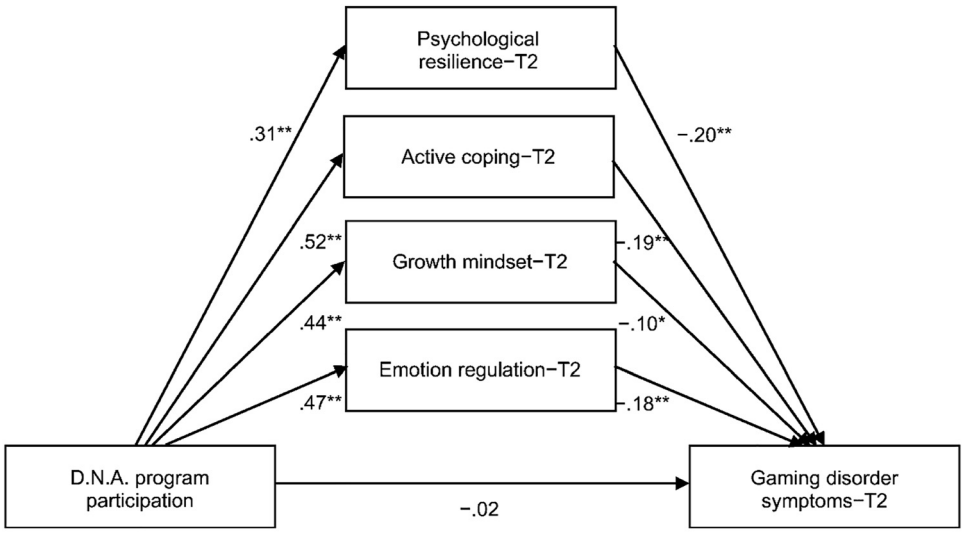

Fig. 4. Path diagram depicting the estimated indirect effects of the P-A-G-E components on the primary intervention outcome of gaming disorder symptoms (n = 264). The mediation analysis was conducted with 5,000 bootstrap samples, and all of the P-A-G-E components were entered simultaneously as mediators. This mediation model included controls for the P-A-G-E components and the specific outcome assessed at baseline (Time 1). Standardized coefficients derived from the follow-up (Time 2/T2) are presented in this figure. $^{*}p < 0.05$. $^{**}p < 0.01$

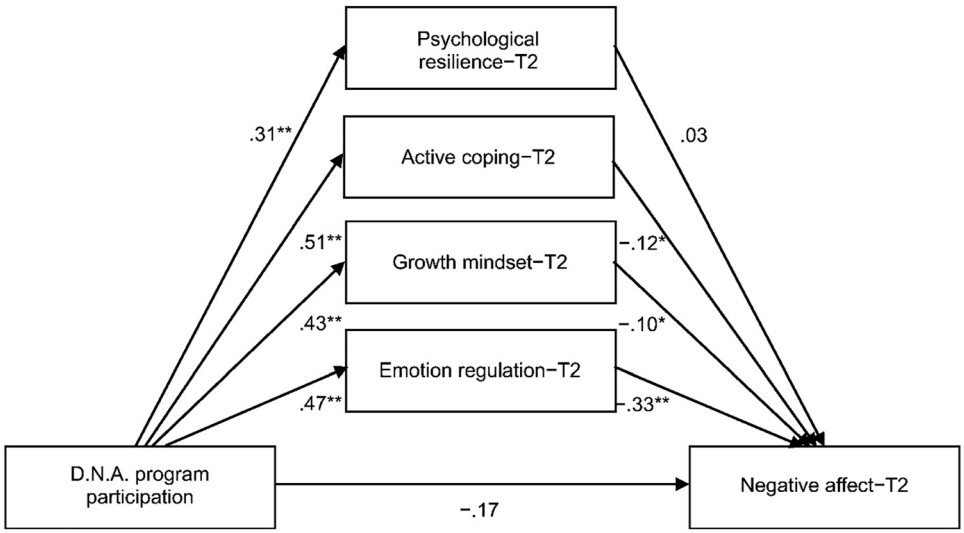

Fig. 5. Path diagram depicting the estimated indirect effects of the P-A-G-E components on the secondary intervention outcome of negative affect (n = 264). The mediation analysis was conducted with 5,000 bootstrap samples, and all of the P-A-G-E components were entered simultaneously as mediators. This mediation model included controls for the P-A-G-E components and the specific outcome assessed at baseline (Time 1). Standardized coefficients derived from the follow-up (Time 2/T2) are presented in this figure. $^{*}p < 0.05$. $^{**}p < 0.01$

fostering positive changes in active coping and growth mindset. The direct association between program participation and positive affect was nonsignificant after controlling for the P-A-G-E components (see Fig. 6), indicating the presence of a full mediation effect.

DISCUSSION

Our RCT assessed the efficacy of the new D.N.A. program in cultivating positive psychological skills and mitigating GD symptoms among primary school pupils. The program,

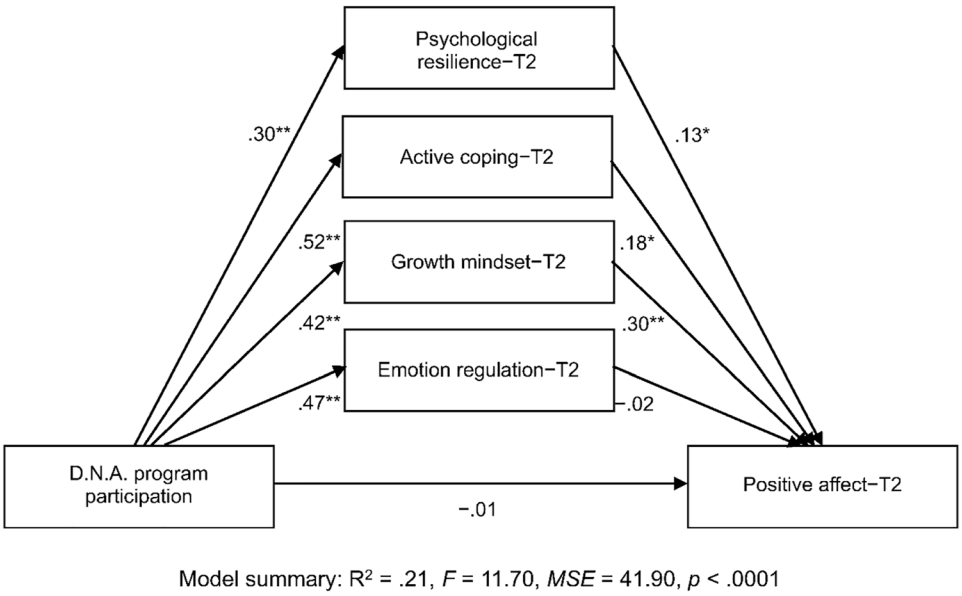

Fig. 6. Path diagram depicting the estimated indirect effects of the P-A-G-E components on the secondary intervention outcome of positive affect (n = 264). The mediation analysis was conducted with 5,000 bootstrap samples, and all of the P-A-G-E components were entered simultaneously as mediators. This mediation model included controls for the P-A-G-E components and the specific outcome assessed at baseline (Time 1). Standardized coefficients derived from the follow-up (Time 2/T2) are presented in this figure. $^{*}p < 0.05$. $^{**}p < 0.01$

based on the P-A-G-E framework, focuses on strengthening psychological resilience, active coping, growth mindset, and emotion regulation. The results indicate that the program generally promotes the development of these skills and reduces GD symptoms. The results of our mediation analysis demonstrate that the desirable effect on psychological outcomes can largely be attributed to the enhancement of the P-A-G-E components.

Differential impact on moderate- versus high-risk GD groups

The present findings indicate that the D.N.A. program effectively alleviates GD symptoms for participants at moderate risk but not for those at high risk. Completion of the program led to a decrease in the proportion of participants at moderate risk of GD, suggesting its potential use in GD prevention strategies. These findings align with research findings indicating a positive impact of preventive interventions on GD symptoms among Chinese youth, with broader societal implications for reducing healthcare costs associated with the diagnosis, treatment, and management of GD (Xiang et al., 2020).

In contrast, there was no reduction in the proportion of participants at high risk of GD, consistent with the findings of a study conducted in Germany (Lindenberg, Kindt, & Szász-Janocha, 2022), in which an intervention effectively alleviated symptoms of both GD and procrastination but did not lead to a significant change in the incidence rate of GD. In our study, the proportion of participants at high risk of GD was relatively low, and the self-report scale may not have adequately captured symptom changes for high-risk participants. Additional studies incorporating clinical interviews could provide deeper insights into our program's effectiveness for high-risk individuals. Overall, this study supports the incorporation of the D.N.A. program in GD prevention strategies, particularly for those at low to moderate risk.

Research and practical implications

This program evaluation study provides preliminary evidence of the viability of a comprehensive, multicomponent approach to addressing the complex nature of GD. By simultaneously strengthening protective factors and promoting diverse skills, this approach is found to reduce GD symptoms and improve well-being. The D.N.A. program emphasizes cognitive, affective, and behavioral strategies (the P-A-G-E components) to cultivate a positive self-image and healthier gaming habits. The present findings indicate that the program reduces GD symptom severity and negative affect, demonstrating its efficacy in GD prevention and treatment.

The results of our mediation analysis reveal that the P-A-G-E components contribute to the program's benefits. The use of the RCT approach further supports the effectiveness of the P-A-G-E framework, suggesting a theoretical focus for future interventions to promote subjective well-being and healthy gaming behaviors among youngsters. Nonetheless, it is important to note the different roles of each component of the P-A-G-E framework in mitigating GD symptoms and bolstering subjective well-being. Although the overall results show that the P-A-G-E framework yields desirable psychological effects on children who has completed the D.N.A. program, these effects vary by the component and intervention outcome. For instance, our findings revealed that strengthening participants' growth mindset enhanced subjective well-being but did not mitigate GD symptoms.

These intricate findings align with a recent meta-analytic review on growth mindset interventions (Burnette et al., 2022), which highlights the heterogeneous nature of the effects of such interventions on a range of outcomes. Specifically, our data indicate that the D.N.A. program is effective in fostering a growth mindset, consistent with Burnette et al.'s (2022) meta-analytic findings demonstrating that intervention effects tend to be pronounced for proximal target outcomes, such as the mindset itself. However, the lack of significant intervention effects of a growth mindset on GD symptoms aligns with their findings that growth mindset interventions often yield weaker effects on more distal outcome measures. These discrepancies in findings may be attributable to the complex and multifaceted cognitive aspects of GD, which involve deficits in executive functioning, context-specific decision-making processes, and gaming-specific cognitive biases (Billieux et al., 2020). To effectively address these intricate cognitive dimensions of GD, it is crucial for practitioners to ensure that the growth mindset targeted in their intervention is appropriately tailored and specific.

In contrast, robust findings have revealed the benefits of a growth mindset for bolstering subjective well-being (Burnette et al., 2022; Lam & Zhou, 2020), which is regarded as a relatively distal outcome in studies evaluating growth mindset interventions. This desirable intervention effect is probably attributable to the increased ability to deploy effective coping strategies and to positive interpretative mechanisms underpinned by a growth mindset (Dweck & Leggett, 1988), as these function as cognitive resources for affective well-being, even in the face of adversity (Dweck, 2013). The present findings underscore the importance of fostering a growth mindset during the early stages of children's development. This study also extends the generalizability of prior growth mindset research, which has primarily focused on adolescents and adults. These nuanced insights into the heterogeneous effects of growth mindset interventions highlight the value of using a multicomponent framework in intervention design and conducting program evaluations using an array of outcomes to address complex GD-related issues effectively.

Caveats and directions for future research

This study has some limitations that are noteworthy. First, there was a relatively short interval between the baseline and follow-up assessments, which may have prevented us from capturing long-term psychological changes. The COVID-19 pandemic caused delays and modifications to the program, including the cancellation of a second follow-up assessment. A recent meta-analysis on gamified interventions showed that longer follow-up periods identify more substantial mental health benefits (Cheng & Ebrahimi, 2023b). To comprehensively evaluate the program, a longer follow-up period with multiple time points is recommended.

Second, there was no active control group in the study. Owing to the school closures during the COVID-19 pandemic, the gamified program was implemented remotely in response to requests from our partner schools, allowing their pupils to participate in the intervention during the closure period. This prevented us from administering other offline control intervention programs or alternative GD programs as part of the trial. Nevertheless, our evaluation of the effectiveness of the new gamified program remains valuable for informing future interventions and program development.

Third, our sample of Chinese primary school pupils limits the generalizability of the results to other cultural contexts. Cultural diversity can influence intervention effectiveness because of differences in language, attitudes toward mental health, and healthcare utilization (Kirmayer, 2012). Culture-specific factors have been found to influence the causes and mechanisms of GD (Cheng et al., 2018). In addition, the motivation for gaming as an escape is more strongly associated with GD symptoms in individualistic societies than in collectivistic societies (Wang & Cheng, 2022). Further studies are needed to examine the program's effectiveness in various cultural contexts and to identify culture-specific factors that affect interventions for GD.

CONCLUSION

This RCT provides empirical support for the effectiveness of the D.N.A. program in alleviating GD symptoms and fostering well-being in Chinese primary school pupils. The program's emphasis on specific positive psychological skills, encapsulated in the P-A-G-E framework, effectively improved these skills and mitigated GD symptoms. However, the components have diverse impact on positive and negative mental health outcomes. These intricate findings highlight the importance of a multicomponent approach to GD prevention and the need for interventions targeting specific positive psychological skills. Future interventions should aim to both reduce risk and enhance wellness to optimize effectiveness and promote children's mental wellness.

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Conflict of interest: The gamified program described in this study was designed and implemented without any intention for future commercial or any other use that might present a potential conflict of interest. The authors declare that there are no financial or non-financial relationships that could be perceived as a potential conflict of interest in relation to this study.

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SUPPLEMENTARY MATERIALS

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