

Effectiveness and User Experience of a Coloring-based Serious Game for Chinese College Students with Alexithymia: Mixed Methods Study

Shuzhan Liu, Haoyong Deng, Jing Chen, Qi Wang

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Abstract

Background: Alexithymia, characterized by difficulty identifying, describing, and expressing emotions, is prevalent among Chinese college students. Accessible, low-threshold digital tools are needed to help address this challenge. Coloring the Emoji, a coloring-based serious game, is such a tool designed to support emotion regulation for people with alexithymia.

Objective: This study aimed to explore the effectiveness of the Coloring the Emoji game as a digital art therapy for emotion regulation and to examine the user experience of the game among Chinese college students with alexithymia.

Methods: A mixed methods design was employed. The quantitative component included a 15-day intervention with 21 college students identified with elevated alexithymia. Pretest and posttest assessments used the 20-item Toronto Alexithymia Scale (TAS-20), with the Emotion Regulation Questionnaire (ERQ) and the Game Experience Questionnaire (GEQ) administered at posttest. The qualitative component consisted of semi-structured interviews conducted on day 1, day 7, and day 15, focusing on participants' emotional engagement and user experiences with the coloring-based serious game. Statistical analyses comprised paired t tests with effect sizes (Cohen's d), one-way ANOVAs, and linear regressions exploring demographic and behavioral predictors of changes in alexithymia, while qualitative data were thematically analyzed to provide complementary insights into intervention effectiveness and user experience.

Results: A total of 21 participants (47.6% male, 52.4% female; mean age 22.3 years) completed the study. Alexithymia decreased significantly from pretest to posttest, both on the TAS-20 total score ($M=2.90$; $P=0.009$) and on the Difficulty Identifying Feelings (DIF) subscale ($M=2.10$; $P=0.037$). ERQ results indicated the improvement in emotion regulation, with higher cognitive reappraisal and lower expressive suppression than normative levels. GEQ ratings suggested positive engagement with low stress. Regression analysis showed that the number of coloring works predicted improvements in identifying emotions, whereas demographics and total playtime did not. Qualitative interviews reinforced these findings: participants consistently described coloring as calming and focus-enhancing, helping them to recognize emotional states and release negative feelings. Daily engagement was said to heighten emotional awareness and gradually make expression more habitual. Additionally, participants noted limitations in template variety and color-emotion mapping and emphasized the need for greater personalization, expanded creative options, and social functions to maintain motivation and long-term use.

Conclusions: This study provides evidence that a coloring-based serious game can enhance emotion regulation in Chinese college students with alexithymia, showing a significant reduction in TAS-20 total scores alongside a positive, low-tension user experience. Findings highlight the potential of coloring-based digital art therapy to support emotion regulation in populations facing challenges in emotional barriers.

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Original Manuscript

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Results: A total of 21 participants (47.6% male, 52.4% female; mean age 22.3 years) completed the study. Alexithymia decreased significantly from pretest to posttest, both on the TAS-20 total score ($\Delta M=2.90$; $P=0.009$) and on the Difficulty Identifying Feelings (DIF) subscale ($\Delta M=2.10$; $P=0.037$). ERQ results indicated the improvement in emotion regulation, with higher cognitive reappraisal and lower expressive suppression than normative levels. GEQ ratings suggested positive engagement with low stress. Regression analysis showed that the number of coloring works predicted improvements in identifying emotions, whereas demographics and total playtime did not. Qualitative interviews reinforced these findings: participants consistently described coloring as calming and focus-enhancing, helping them to recognize emotional states and release negative feelings. Daily engagement was said to heighten emotional awareness and gradually make expression more habitual. Additionally, participants noted limitations in template variety and color-emotion mapping and emphasized the need for greater personalization, expanded creative options, and social functions to maintain motivation and long-term use.

Conclusions: This study provides evidence that a coloring-based serious game can enhance emotion regulation in Chinese college students with alexithymia, showing a significant reduction in TAS-20 total scores alongside a positive, low-tension user experience. Findings highlight the potential of coloring-based digital art therapy to support emotion regulation in populations facing challenges in emotional barriers.

Keywords: Alexithymia, Serious Game, Digital Art Therapy, Effectiveness, User Experience, Emotion Regulation

Introduction

Alexithymia, a concept introduced by psychiatrist Peter Sifneos in 1973 [1], refers to significant difficulties in identifying, describing, and expressing emotions, often accompanied by reduced imaginative capacity and limited symbolic thinking [2]. Alexithymia has broad implications for both

psychological and physiological health [3,4]. On the one hand, it is closely associated with various psychosomatic conditions, such as hypertension, asthma, and ulcerative colitis [5-7]. On the other hand, alexithymia undermines psychotherapy by weakening the therapeutic alliance, leading to higher dropout rates and reduced responsiveness to approaches that rely on emotional insight, such as psychodynamic therapy [8-10]. In recent years, alexithymia has attracted increasing attention in relation to the mental health of adolescents and college students, with Chinese college students in particular showing a notable prevalence and heightened psychological risks [11,12]. Our previous survey of Chinese college students ($n = 332$) underscores the severity of the issue: 12.05% of respondents exhibited clinically significant alexithymia ($TAS-20 \geq 70$) [13-15], with a mean score of 59.90 ± 8.15 , approaching the clinical threshold ($TAS-20 \geq 60$). These findings highlight the severity of alexithymia in this population and the need for targeted attention.

Coloring-based art therapy provides a simple, structured activity through which individuals can associate emotions with colors and express them in a low-pressure setting. This approach is particularly relevant for addressing two core features of alexithymia: difficulty in identifying feelings (DIF) and difficulty in describing feelings (DDF) [16]. Studies have suggested that coloring tasks can reduce anxiety, promote relaxation, and offer a manageable pathway for emotional expression [17,18], which may be especially beneficial for people who struggle with verbal articulation [19,20]. However, the broader applicability of coloring-based art therapy is limited by attitudinal barriers such as shame and embarrassment [21], reduced initiative due to emotional avoidance [22], and practical obstacles including time, spatial, and financial constraints [23]. These limitations underscore the need for delivery formats that increase feasibility and sustain engagement [24,25].

In this context, digital adaptations of coloring-based art therapy have emerged as a promising alternative, integrating psychological principles with interactive design to create accessible platforms for emotion regulation [26,27]. Digital coloring games provide an intuitive medium that combines structured tasks with interactive feedback to promote consistent participation and overcome barriers associated with traditional approaches. Through real-time feedback and immersive experiences, these games encourage users to engage more deeply with their emotions [28,29]. Compared with traditional methods, coloring games also offer greater enjoyment and accessibility, can enhance user initiative, sustain long-term engagement, and support the transition from unconscious to conscious emotional expression [30,31].

Based on these considerations, we developed *Coloring the Emoji*, a serious game for emotional recognition and expression [32]. Drawing on expert interviews and psychological theory, the game incorporates the principles of color psychology [33], dimensional emotion models [34,35], and symbolic association [36,37] into a safe and intuitive interactive process, thereby addressing the core difficulties of alexithymia in identifying, associating, and expressing emotions [38-40]. This study evaluated the effectiveness and user experience of *Coloring the Emoji* among Chinese college students with alexithymia, examining its feasibility as a coloring-based digital art therapy for daily emotional situations. The findings are expected to inform the practical application of such tools and provide an empirical basis for the improvement and wider application of coloring-based digital art therapy in the future.

Methods

Study Design

This mixed methods study was conducted to evaluate the effectiveness and user experience of *Coloring the Emoji*, a coloring-based serious game designed as a digital art therapy for alexithymia. Based on findings from our previous survey of 332 Chinese college students, in which 12.05% showed clinically significant alexithymia, we recruited 21 participants with elevated alexithymia to take part in a 15-day experiment. Quantitative measures included pretest and posttest assessments of alexithymia using the Toronto Alexithymia Scale (TAS-20) and posttest assessments of emotion

regulation and game experience. In parallel, qualitative data were collected through semi-structured interviews conducted at day 1, day 7, and day 15 to gain insights into participants' emotional engagement and perceptions of the game.

Participants

Participant recruitment began in October 2024 using a combination of online and offline strategies. Announcements were made through university social media groups and student networks, and peer referrals were encouraged. To reduce stigma and expectancy bias, the recruitment materials deliberately avoided terms such as “mental illness” or “psychological counseling” and instead emphasized participation in a digital game study. A purposive sampling approach was used [41], drawing on respondents from our prior large-scale survey of 332 Chinese college students in which alexithymia prevalence was established, to identify individuals meeting the study criteria. Students aged 18 to 30 years, scoring 50 or above on the TAS-20, and able to operate a smartphone were eligible for inclusion. Exclusion criteria comprised ongoing psychotherapy, use of psychiatric medication, or inability to complete game tasks for any reason.

Ethical Considerations

This study was reviewed and approved by the Institutional Review Board of the authors' affiliated institution (Approval Number: TJDXHR076). Before study initiation, each participant received an institutionally approved electronic informed consent form that described the study's purpose, procedures, tasks, potential risks, and anticipated benefits. Written consent was obtained electronically to confirm voluntary participation. Participants were informed of their right to withdraw at any stage without penalty. To safeguard privacy, all data were anonymized and deidentified prior to analysis, and personal information was securely stored and accessible only to the research team. Confidentiality was strictly maintained throughout the study, and all results are reported at the group level to prevent individual identification.

Prototype

The primary instrument in this study was *Coloring the Emoji*, a coloring-based serious game developed to support users with alexithymia in recognizing, externalizing, and expressing their emotions through intuitive coloring tasks (Figure 1). Compatible with iOS and Android mobile platforms, the game includes three main interactive stages: color selection, pattern selection, and free coloring, aiming to create a non-verbal, low-pressure emotional exploration environment. The overall interface utilizes a clean visual design and pixel art aesthetic to enhance ease of use and minimize defensive reactions.

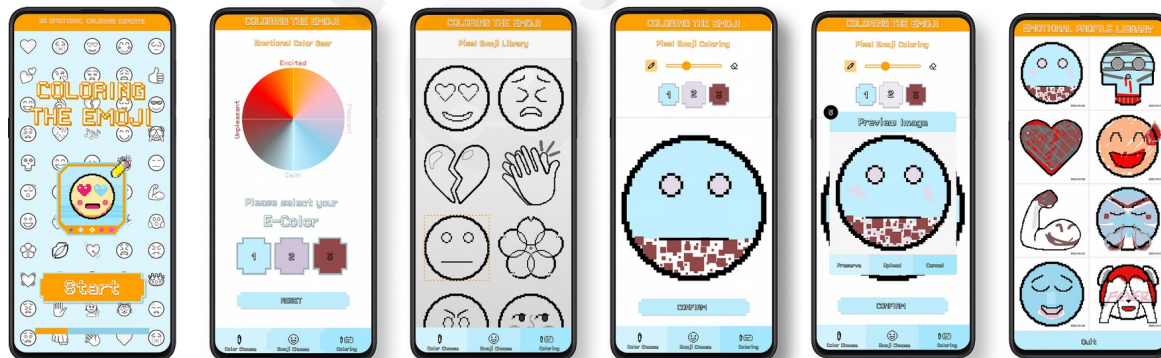


Figure 1. *Coloring the Emoji*: a coloring-based serious game.

In addition to the game itself, supplementary materials were prepared to facilitate participant onboarding and minimize technical barriers. These included an introduction video and a user manual

(Multimedia Appendix 1). The video provided background on the game's development, theoretical basis, and intended therapeutic goals, while the manual offered practical guidance on installation, interface navigation, and key features [42]. All participants received installation instructions in advance and were guided to install the game on their personal devices, and were also provided with an introduction video and user manual to ensure a clear understanding of the game before starting the experiment.

Procedures

After providing informed consent, participants were guided step by step through the study protocol. On the first day of the experiment (December 8, 2024), participants received instructions for installing and using *Coloring the Emoji* via an introduction video and user manual. They also completed a pretest assessment using the Toronto Alexithymia Scale (TAS-20) and a semi-structured interview (Multimedia Appendix 2) via Zoom regarding their use of emotion regulation tools. After completing the game setup, all participants began a 15-day intervention, during which they were instructed to engage with the game daily and use its core functions to record and reflect on their emotions.

During the experiment, participants participated in two subsequent semi-structured interviews via Zoom on day 8 and day 15 to provide feedback on their experiences and perceptions of the game. Each interview was conducted by one of the researchers, with a separate team member taking detailed notes. All interviews were audio-recorded, transcribed verbatim, and checked for accuracy before being anonymized. At the end of the experiment (December 23, 2024), participants completed posttest assessments, including the TAS-20, the Emotion Regulation Questionnaire (ERQ) [43], and the Game Experience Questionnaire (GEQ) [44]. All procedures were standardized across participants, and both qualitative and quantitative datasets were anonymized, securely stored, and archived for subsequent reporting.

Measures

Effectiveness

The primary effectiveness measure was change in alexithymia scores, assessed pretest and posttest using the 20-item Toronto Alexithymia Scale (TAS-20). This scale comprises three subscales: Difficulty Identifying Emotions (DIF), Difficulty Describing Emotions (DDF), and Extraverted Thinking (EOT), rated on a 5-point Likert scale, with higher scores indicating greater alexithymia. In addition, the 10-item Emotion Regulation Questionnaire (ERQ) was administered at posttest to evaluate participants' habitual use of two distinct emotion regulation strategies: cognitive reappraisal and expressive suppression. Together, these measures provided a quantitative assessment of whether the game improved participants' emotional awareness and regulation abilities. To complement the quantitative data, qualitative insights were obtained through semi-structured interviews to explore participants' experiences with emotional expression, their engagement with the intervention, and perceived changes in emotion regulation.

User Experience

User experience was assessed at posttest using the 33-item Game Experience Questionnaire (GEQ), a validated instrument for digital games that covers Competence, Sensory and Imaginative Immersion, Flow, Tension/Annoyance, Challenge, Negative Affect, and Positive Affect. In this study, the GEQ captured participants' perceived enjoyment, engagement, and usability of *Coloring the Emoji*. Qualitative data were also obtained from semi-structured interviews conducted during the experiment, which probed ease of use, motivation, barriers to engagement, and suggestions for

improvement.

Statistical Analysis

All quantitative data were analyzed using SPSS Statistics (version 27; IBM Corp). Descriptive statistics were first computed for demographic variables, game activity measures, and all questionnaire scores, including means, standard deviations, and frequency distributions. To assess intervention effectiveness, paired-sample *t* tests were conducted to compare TAS-20 scores between pretest and posttest. Effect sizes were calculated using Cohen's *d* with conventional thresholds (small <0.20, medium 0.20-0.50, large >0.80). For ERQ and GEQ outcomes, which were collected only at posttest, descriptive analyses were supplemented with comparisons to established normative values to aid interpretation. In addition, one-way ANOVAs were used to examine potential differences in TAS-20, ERQ, and GEQ scores across demographic categories and pretest alexithymia severity groups. Linear regression analyses were further performed to explore whether participant characteristics or game behaviors predicted changes in alexithymia scores. Statistical significance was set at $p < 0.05$ for all tests. Qualitative interview data were analyzed using NVivo 15 (QSR International) following Colaizzi's method. After repeated reading of the transcripts for familiarization, key statements were identified, extracted, and condensed into codes while retaining their original meaning. Two independent coders conducted open coding, and the codes were iteratively refined into categories, subthemes, and overarching themes. Coding discrepancies were resolved through discussion to ensure reliability. Finally, qualitative themes were integrated with quantitative outcomes to provide a comprehensive understanding of the intervention's effectiveness and user experience.

Results

Demographic Data and Descriptive Statistics

A total of 21 participants were included in the study (Table 1). The majority of participants (61.91%) were between 23 and 25 years old, 23.81% were 20–22 years old, 4.76% were 26–29 years old, and 9.52% were aged 30 years or above, indicating that the sample was concentrated in the early twenties. The sex distribution was relatively balanced, with 47.61% male and 52.38% female, suggesting no marked gender bias. In terms of alexithymia severity assessed by the TAS-20 at pretest, over half of the participants (52.38%) scored in the range of 60–69, and 14.29% scored 70 or above, indicating that the sample was mainly characterized by moderate to severe alexithymia. Additionally, 47.61% of participants reported prior experience with mobile psychological interventions, indicating varying levels of familiarity with digital health tools. Regarding behavioral performance during the experiment, the mean total gaming time was 1821.43 seconds ($SD = 1605.05$), and the mean number of coloring works was 15.1 ($SD = 10.32$). Both indicators showed significant variability, indicating differences in participant engagement and creativity.

Table 1. Participant characteristic.

Variables	characteristics
Age, n (%)	
20-22	5 (23.81)
23-25	13 (61.91)
26-29	1 (4.76)
≥30	2 (9.52)
Sex, n (%)	
Male	10 (47.61)

Female	11 (52.38)
TAS-20^a Pretest Degree, n (%)	
<50	1 (4.76)
50-60	6 (28.57)
60-69	11 (52.38)
≥70	3 (14.29)
Do you have experience using mobile psychological interventions? n (%)	
Yes	10 (47.61)
No	11 (52.38)
User Behavior Data in This Experiment, mean (SD)	
Total Playtime (s)	1821.43 (1605.05)
Total Coloring Works	15.1 (10.32)

^aTAS-20: 20-item Toronto Alexithymia Scale.

^bTotal Playtime: Cumulative playtime recorded during the experiment.

^cTotal Coloring Works: Number of coloring works completed during the experiment.

Results of TAS-20, ERQ, and GEQ

The TAS-20 total score showed a significant reduction from pretest ($M = 62.71$, $SD = 6.28$) to posttest ($M = 59.81$, $SD = 6.68$) (Table 2 and Figure 2), with a mean difference of 2.90 ($t = 2.885$, $P = 0.009$), corresponding to a moderate effect size (Cohen's $d = 0.63$, 95% CI [0.804, 5.005]). At the subscale level, Difficulty Identifying Feelings (DIF) decreased significantly from 20.19 ($SD = 4.26$) to 18.10 ($SD = 4.77$), yielding a mean difference of 2.10 ($t = 2.239$, $P = 0.037$, $d = 0.49$, 95% CI [0.143, 4.047]). In contrast, no significant differences were observed for Difficulty Describing Feelings (DDF) ($\Delta M = 0.52$, $t = 1.000$, $P = 0.329$, $d = 0.22$, 95% CI [-0.569, 1.616]) or Externally Oriented Thinking (EOT) ($\Delta M = 0.29$, $t = 0.422$, $P = 0.677$, $d = 0.09$, 95% CI [-1.126, 1.697]). This suggests that the intervention was particularly effective in improving participants' ability to identify their feelings (DIF) but did not significantly impact their ability to describe feelings (DDF) or externally oriented thinking (EOT).

Table 2. Results of TAS-20 total score and subscale scores.

Variable	Pretest	Posttest	ΔM	t-ratio	P value	Cohen's d	95% CI
TAS-20	62.71±6.28	59.81±6.68	2.90	2.885	0.009	0.63	[0.804, 5.005]
DIF	20.19 ±4.26	18.10±4.77	2.1	2.239	0.037	0.49	[0.143, 4.047]
DDF	12.52 ±3.06	12.00±3.01	0.52	1.000	0.329	0.22	[-0.569, 1.616]
EOT	20.86 ±3.95	20.57±4.22	0.29	0.422	0.677	0.09	[-1.126, 1.697]

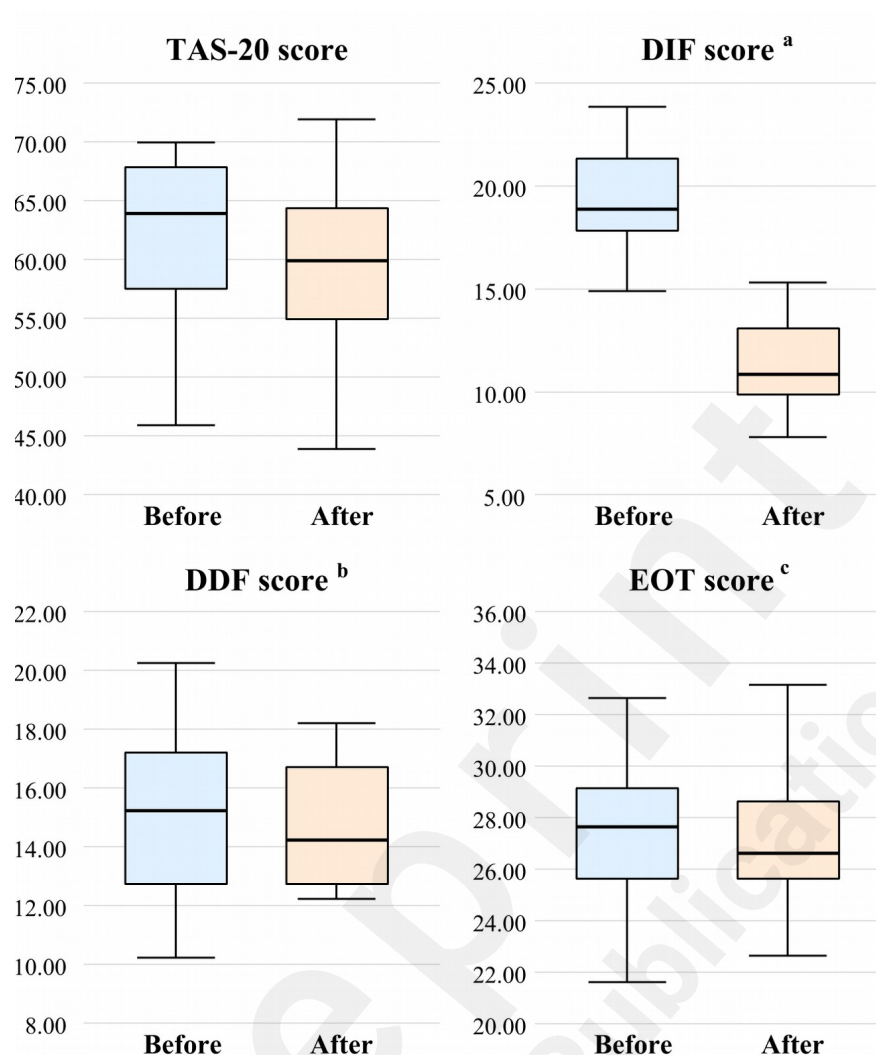


Figure 2. Boxplots of changes in TAS-20 total score and subscale scores. The y-axis represents score changes. The x-axis shows the pretest and posttest for the TAS-20 total score, Difficulty Identifying Feelings (DIF), Difficulty Describing Feelings (DDF), and Externally Oriented Thinking (EOT).

^aDIF score: Items 1, 3, 6, 7, 9, 13, and 14.

^bDDF score: Items 2, 4, 11, 12, and 17.

^cEOT score: Items 5, 8, 10, 15, 16, 18, 19, and 20.

On the ERQ, participants scored a mean of 5.15 (SD = 0.62) on Cognitive Reappraisal. Compared to the typical adult norm for Cognitive Reappraisal (≈ 4.5 -5.0), this study's results suggest that participants used cognitive reappraisal strategies at a higher rate. Regarding Expressive Suppression, participants scored a mean of 2.77 (SD = 0.88), lower than the adult norm for Expressive Suppression (≈ 3.0 -3.5) (Table 3 and Figure 3). Cognitive Reappraisal refers to the ability to reinterpret a situation from a more positive or neutral perspective, helping individuals regulate their emotional responses. Expressive Suppression refers to inhibiting outward emotional expressions, often used to control emotional reactions in social situations. Higher levels of Cognitive Reappraisal are generally considered beneficial to mental health because they promote more adaptive emotion regulation.

Table 3. Results of ERQ subscale scores.

Variable	Posttest	95% CI

Cognitive Reappraisal	5.15±0.62	[4.884, 5.411]
Expressive Suppression	2.77±0.88	[2.389, 3.144]

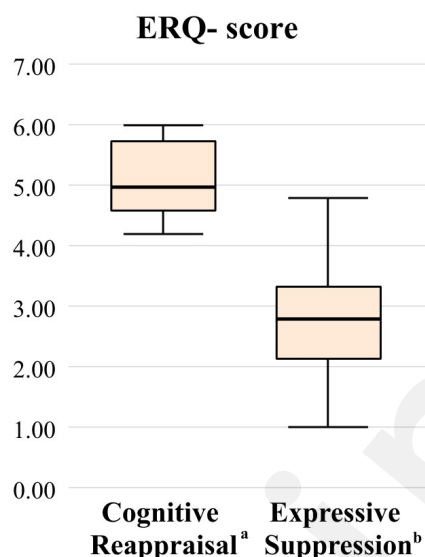


Figure 3. Boxplots of changes in ERQ subscale scores. The y-axis represents the ERQ subscale scores. The x-axis shows the two subscales: Cognitive Reappraisal and Expressive Suppression.

^aCognitive Reappraisal score: Items 1, 3, 5, 7, 8, and 10.

^bExpressive Suppression score: Items 2, 4, 6, and 9.

Regarding the GEQ dimensions, participants reported acceptable levels across most subscales (Table 4 and Figure 4). Competence ($M = 2.64$, $SD = 0.36$), Positive Affect ($M = 2.48$, $SD = 0.41$) and Negative Affect ($M = 1.75$, $SD = 0.42$) was comparable to the norm (≈ 2.5 – 2.7 , ≈ 2.5 – 2.7 , and ≈ 1.7 – 1.9), while Sensory and Imaginative Immersion ($M = 2.27$, $SD = 0.40$) and Flow ($M = 2.11$, $SD = 0.53$) were slightly below the norm (≈ 2.4 – 2.6 , and ≈ 2.3 – 2.5). Tension/Annoyance ($M = 1.27$, $SD = 0.57$) and Challenge ($M = 1.25$, $SD = 0.44$) were clearly lower than norm (≈ 1.6 – 1.8 , and ≈ 1.7 – 1.9). These findings suggest that the game provides acceptable positive emotions, but with reduced challenge and tension, consistent with a relatively supportive and non-stressful gaming environment.

Table 4. Results of GEQ subscale scores.

Variable	Posttest	95% CI
Competence	2.64±0.36	[2.484, 2.793]
Sensory and Imaginative Immersion	2.27±0.40	[2.096, 2.437]
Tension/Annoyance	1.27±0.57	[1.027, 1.516]
Challenge	1.25±0.44	[1.058, 1.437]
Flow	2.11±0.53	[1.880, 2.330]
Positive Affect	2.48±0.41	[2.299, 2.653]
Negative Affect	1.75±0.42	[1.574, 1.931]

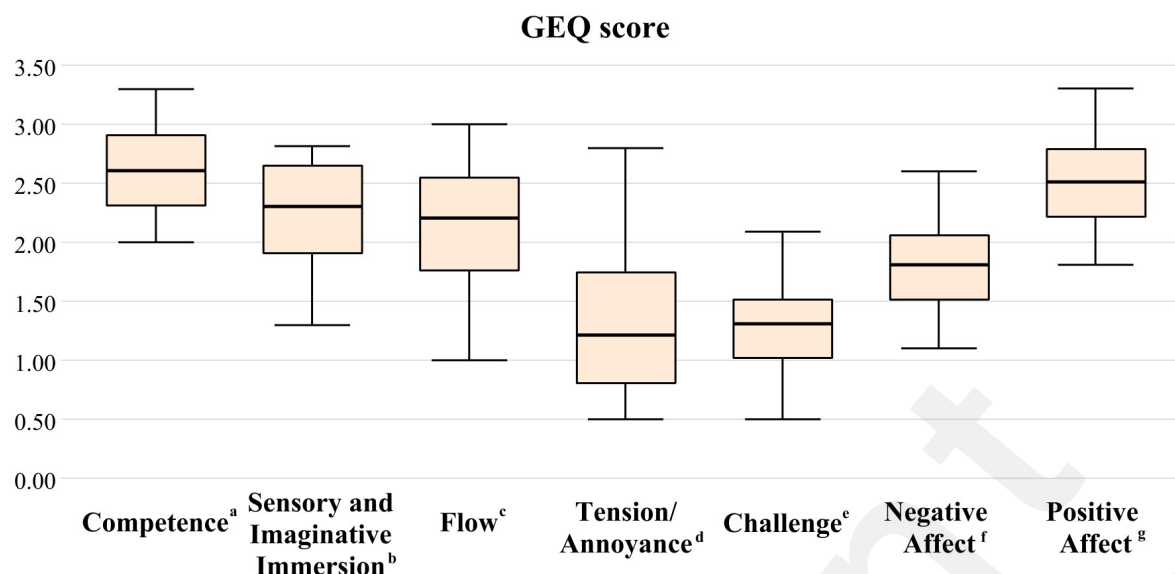


Figure 4. Boxplots of changes in GEQ subscale scores. The y-axis represents the GEQ subscale scores. The x-axis shows the seven subscales: Competence, Sensory and Imaginative Immersion, Flow, Tension/Annoyance, Challenge, Negative Affect, and Positive Affect.

^aCompetence score: Items 2, 10, 15, 17, and 21.

^bSensory and Imaginative Immersion score: Items 3, 12, 18, 19, 27, and 30.

^cFlow score: Items 5, 13, 25, 28, and 31.

^dTension/Annoyance score: Items 22, 24, and 29.

^eChallenge score: Items 11, 23, 26, 32, and 33.

^fNegative Affect score: Items 7, 8, 9, and 16.

^gPositive Affect score: Items 1, 4, 6, 14, and 20.

Demographic Factors and Questionnaire Scores

Analyses of demographic variables showed that gender, age, and profession were not associated with statistically significant differences in TAS-20, ERQ, or GEQ scores (all P s > 0.05). For example, TAS-20 total scores did not differ significantly between males ($M = 57.80$, $SD = 6.75$) and females ($M = 61.64$, $SD = 6.38$; $F = 1.795$, $P = 0.196$), nor were there reliable effects of age group or profession on any of the three measures. In contrast, alexithymia severity, as indexed by TAS-20 pretest groupings (<50, 50-59, 60-69, ≥70), was significantly associated with ERQ scores ($F = 3.527$, $P = 0.003$) (Table 5). Participants in the high-severity group ($M = 4.54$, $SD = 0.25$) reported greater use of cognitive reappraisal strategies than those in the moderate-severity group ($M = 3.86$, $SD = 0.46$). In contrast, the severity of alexithymia was not related to changes in TAS-20 scores from pretest to posttest ($F = 0.872$, $P = 0.475$) or GEQ scores ($F = 0.803$, $P = 0.509$). Taken together, these findings suggest that while gender, age, and profession did not significantly differentiate symptom or behavioral outcomes, alexithymia severity exerted a measurable effect on emotion regulation as assessed by the ERQ, highlighting the relevance of alexithymia severity in using emotion regulation strategies.

Table 5. Comparison of ERQ Scores Across Different Alexithymia Severity.

Variable	Pretest Degree<50	Pretest Degree in 50-60	Pretest Degree in 60-69	Pretest Degree≥70	F	P value
ERQ Score	3.10 ± Null	4.00 ± 0.37	3.86 ± 0.46	4.54 ± 0.25	3.527	0.003

Demographic Factors and User Behavior Data

Analysis of demographic factors showed that gender, age, and severity of alexithymia had no significant effects on game activity indicators (all P s > 0.05). However, there were significant differences in the number of coloring works across professions ($F = 4.239$, $P = 0.021$) (Table 6). Specifically, the average number of coloring works differed significantly across professional groups ($P = 0.021$), ranging from 10.15 in Design to 26.00 in other disciplines. Students in Architecture ($M = 23.67$) and Computer Science ($M = 18.00$) also demonstrated relatively higher numbers of coloring works compared with those in Design.

Table 6. Comparison of Total Playtime and Coloring Works Across Different Professions.

Variable	Architecture	Computer Science	Design	Others	F	P -value
Behaviors						
Total Playtime	1565.00 ± 1272.28	1514.50 ± 504.17	1444.54 ± 1160.15	3915.67±2 871.54	2.413	0.102
Total Coloring works	23.67 ± 11.06	18.00 ± 1.41	10.15 ± 3.72	26.00± 20.07	4.239	0.021*

Predictors of Changes in Alexithymia Scores

Table 7 reports the regression coefficients for predictors of the reduction in Difficulty Identifying Feelings (DIF). Results indicated that demographic factors such as age, gender, profession, alexithymia severity, and total playtime were not significant predictors (all P s > 0.12). By contrast, the total number of coloring works during the experiment showed a positive association with the reduction in DIF ($\beta = 0.67$, $P = 0.05$), suggesting that participants who engaged in more creative activity experienced greater reductions in DIF. Importantly, no comparable predictive effects were observed for changes in the TAS-20 total score or the other two subscales (DDF and EOT), suggesting that the impact of creative engagement is limited to the DIF dimension.

Table 7. Multiple regression analysis prediction.

Demographics and game behaviors	Unstandardized coefficients, B(SE)	Standardized coefficients(95%CI)	t-ratio	P -value
Constant	-26.748	Null	-1.157	0.268
Demographics				
Age	0.079	0.070	0.308	0.763
Gender	-3.522	-0.420	-1.666	0.120
Degree	--2.964	-0.531	-0.883	0.393
profession	0.456	0.170	0.708	0.491
Alexithymia Severity	0.571	0.836	1.360	0.197
Behaviors				
Total Playtime	-0.001	-0.372	-1.425	0.178
Total Coloring Works	0.280	0.674	2.217	0.045*

Thematic Patterns of Qualitative Interview Data

Thematic analysis of the semi-structured interviews yielded important insights into both the effectiveness and user experience of *Coloring the Emoji* for individuals with alexithymia. Two major themes and eight subthemes were identified, along with the covered codes (Table 8).

Table 8. Themes and subthemes from qualitative analysis.

Theme and Subthemes	Codes
Effectiveness	
Record Daily Emotions	• Immediate recording, emotionally salient moments, daily reflection, emotional release, reframing past experiences, sense of lightness
Identify Emotional State	• Color emotion association, self-reflection, positive feedback, expressing inner emotions, new opportunity for awareness
Express Through Coloring	• Emotional release, catharsis, relief after expression, symbolic representation of anger, satisfaction through coloring
Share Coloring Works	• Casual sharing, positive emotions for sharing, balancing openness and privacy, minimal sharing tendency, curiosity about others' expressions
Enhance Emotional Awareness	• Recognizing emotional patterns, forced expression leading to awareness, improved self-expression, greater ability to articulate feelings, linking emotions to daily events, accumulated reflection
User Experiences	
Usability	• Color emotion mismatch, limited forms and options, abstract images, difficulty mapping emojis to emotions, need for guidance vs. freedom, consistency concerns, technical issues such as pixel brush usability, daily check-in incentive, positive feedback mechanisms
Enjoyment	• Calming effect, focus through simple tasks, soothe emotions, sense of achievement, emotional release through completion, aesthetic dissatisfaction about coloring works, lack of variety
Suggestions for Improvement	• Avoid rigid templates, customizable color emotion mapping, free drawing options, custom emojis, meme-based creativity, balance between freedom and usability, statistical tracking features, emotional sticker wall, need for social interaction features, social engagement opportunities

Theme 1: Emotion Regulation

Sub-theme: Record Daily Emotions

Over three-quarters of participants (16/21) described the act of recording as a daily practice for revisiting and releasing emotions. They viewed it not simply as a tool for recording events, but also as a valuable way to reconstruct their immediate mental state and capture the emotionally salient moments. Importantly, many participants emphasized that this process also fostered reflection, allowing them to revisit past experiences from a different perspective.

Writing down the emotions of that moment, especially those tied to recent events that left a strong impression. (E10)

If something particularly upsetting or striking happened during the day, I would record the emotions of that specific moment; if the day ended on a relatively ordinary note, I would reflect on the overall mood of the day. (E16)

I felt some sentimentality. The problems that once troubled me no longer seem important; they have already passed, leaving me with a sense of lightness, as if I had crossed mountains with ease. (E7)

Sub-theme: Identify Emotional State

The majority of participants (15/21) found the method of selecting colors and patterns to represent emotions novel and engaging. For many, it transformed a simple activity into an opportunity to process emotions and gain self-understanding.

I choose different colors based on my mood of the day, and then I select different expressions or patterns to draw. (E4)

When I pick a color, I realize that I am reflecting on my current mental state..... Even though what I create might not be very beautiful, the process itself gives me positive feedback. (E11)

One good thing about it is that it provides some tools, which give me an opportunity I didn't realize before. I can express my inner emotions through this kind of doodling. (E12)

Sub-theme: Express Through Coloring

Some participants (4/21) viewed coloring as a way to release and transform emotions. For these participants, coloring provides an outlet to release suppressed emotions and gain a sense of relief.

For example, when I record my bad moods, I feel a slight sense of release after I finish..... It's like having someone to talk to, or like texting a good friend after we argued, which leaves me feeling a little better. (E15)

For instance, when I'm angry, I select a punching or some other muscular expression, and then I pair it with a 'strong punch' phrase. It actually feels kind of satisfying. (E16)

Sub-theme: Share Coloring Works

The participants displayed a conflicting attitude toward sharing their coloring works. On one hand, they expressed a desire to share their coloring works as a form of self-expression, driven by the need to connect with others (3/21). On the other hand, they were hesitant to share too much, as they struggled to find the right balance and were concerned about social boundaries and appropriateness (4/21). This ambivalence reflected a tension between wanting to share positive emotions and the difficulty of determining the right amount to share in social contexts.

I feel like, when I draw, I might as well share it. There's no harm in sharing, so I just do it. Actually, I haven't really thought too much about it. (E13)

I feel that positive emotions can be shared with others, but I think the difficult part about sharing is knowing the right balance. It's hard to gauge the appropriate level, so I tend to share less, keeping it to a minimum. (E13)

Sometimes, I get curious about what others want to express, especially when I see something intriguing, but I'm not sure what they are trying to communicate. (E7)

Sub-theme: Enhance Emotional Awareness

A significant number of participants (8/21) indicated that consistent drawing practice helped improve their emotional awareness and their ability to express it. Over time, many participants developed a habit of recording their emotions, with some even noting that the process had become an essential part of their daily lives.

Well, if you don't draw, you might not realize what's going on. But once you start drawing,

you realize, wow, it's like I've been drawing the same thing every day. (E3)

It's like there's something that forces me to express what I'm feeling now. It's this feeling where you don't want to express it, but you must. Since I'm doing this, I must express it. (E6)

I'm naturally someone who doesn't talk much, and I might have some sort of expressive difficulty. But recently, they told me that I've been talking more, expressing myself more. (E8)

I can relate the expression of the day to what happened to me that day, and the more I accumulate, the more interesting it becomes. (E16)

Theme 2: User Experiences

Sub-theme: Usability

In terms of usability, participants expressed concerns about several aspects, including the alignment between colors and emotions (8/21), the variety of coloring options (6/21), the technical smoothness of the tool (3/21), and the feedback mechanism (2/21). These concerns highlighted the participants' need for both an intuitive emotional expression tool and flexible functionality in the coloring process. While some participants found the tool useful, they also noted challenges in how well it supported their emotional expression, the limited variety of coloring choices, and the ease of use.

The intuitive connection between color and emotion doesn't match. For example, the color I like corresponds to an emotion I don't like. The images aren't aesthetically pleasing and are too abstract. (E1)

It doesn't seem too difficult, but it's more about consistency. The form feels a bit limited, and there are a few shapes to choose from. (E2)

For some emojis, I found it difficult to connect them to my feelings that day. I just picked one that seemed okay to me and colored it in, but that no longer really reflected my emotional expression. (E5)

But if you just give me a blank sheet, I wouldn't know what to draw. I think guidance is necessary, but I'm not sure how much guidance or restrictions should be in place. (E12)

I feel like the pixel brush isn't very easy to use. (E7)

After checking in every day, there's an incentive, and there's some positive feedback. (E7)

Sub-theme: Enjoyment

Coloring activities were reported to foster focus and calmness (7/21), while also providing users with a sense of accomplishment (3/21). However, the overly standardized forms of expression were perceived as diminishing the activity's enjoyment and beauty.

I feel that simply focusing on a simple task, doing it calmly, naturally helps to soothe my mood. (E10)

When it goes well, playing this feels like a small achievement, If it doesn't turn out well, it still feels like a way to release some emotions, and completing it gives a sense of accomplishment. (E10)

I think the ugliness definitely affects me, but the ugliness is just a result. The issue is that this activity, combining the mosaic-style blocks with the predefined emojis, is quite uniform. Most

of the outcomes are very similar. (E5)

Sub-theme: Suggestions for Improvement

In terms of suggestions for improvement, participants highlighted two main directions. First, they wanted greater freedom and personalization (5/21), such as defining their own color emotion associations, creating personal palettes, and avoiding rigid templates. They also emphasized the need for a balance between freedom and usability, noting that too much complexity could discourage engagement. Second, participants expressed interest in adding more data-driven and social features (4/21), including visual progress tracking, interactive tools like sticker walls, and enhanced community functions such as messaging, commenting, and content sharing to increase long-term appeal.

I don't want to use templates. I like to define my own colors for emotions. I'd also like the subsequent images to follow my personal color palette. I hope the interface allows for free drawing and simplifies the background template. (E1)

One really appealing way is creating custom emoji packs, like making fun emojis that could include text, or using popular meme images. You could take these memes and add your own creative touches. (E8)

There's a balance here. If the freedom is great but it becomes too complicated to draw, that could drive some people away. We need a middle ground where there's a certain degree of freedom. (E10)

I'd like to see something like a statistical graph, such as a line chart that shows how many times I logged in today, tomorrow, and the day after. (E5)

Could there be an emotional sticker wall where I can place emojis I've created? These stickers could overlap, be resized, and placed freely. (E12)

I really hope the platform develops into a real social community, not just a platform for display. Right now, it lacks interactive features like messages and comments, so it doesn't feel like a true social platform. (E1)

Discussion

Principal Results

This mixed methods study evaluated the effectiveness and user experience of *Coloring the Emoji*, a coloring-based serious game designed as a digital art therapy for alexithymia. Twenty-one college students with elevated alexithymia were recruited to participate in a 15-day experiment that combined pre-post questionnaire assessments with three qualitative interviews. The findings indicated that the intervention fostered improvements in emotion regulation, with participants reporting enhanced ability to identify and express emotions. The game was generally experienced as engaging and calming, while interviews also highlighted the need for greater personalization, creative variety, and social interaction features. Together, these results provide initial support for the feasibility of coloring-based digital art therapy and point to directions for future refinement.

Effectiveness

The game produced measurable improvements in emotion regulation. On the TAS-20, the total score decreased significantly from pretest to posttest ($\Delta M = 2.90$, $P = 0.009$, $d = 0.63$). At the subscale

level, a significant reduction was observed in Difficulty Identifying Feelings (DIF) ($\Delta M = 2.10$, $P = 0.037$, $d = 0.49$), suggesting enhanced ability to recognize emotional states. Consistent with these results, the ERQ results showed a relatively high level of Cognitive Reappraisal ($M = 5.15$) and slightly lower level of Expressive Suppression ($M = 2.77$) compared with normative data. This regulatory profile is generally considered favorable, as greater reliance on reappraisal and reduced use of suppression are linked to healthier emotion regulation [45].

To further explore mechanisms of change, regression analyses were conducted. Demographic variables such as age, gender, alexithymia severity, and total playtime were not significant predictors (all P s > 0.12). By contrast, the total number of coloring works during the experiment positively predicted reductions in DIF ($\beta = 0.67$, $P = 0.05$), suggesting that greater creative engagement was associated with larger improvements in recognizing emotions [46]. This predictive effect was specific to the DIF subscale, indicating that creative activity played a unique role in facilitating emotional identification.

Qualitative interviews provided converging evidence for these quantitative findings. Participants described emotion recording as a meaningful daily activity that enabled them to revisit daily emotions, reconstruct emotionally salient moments, and gain emotional release through reflection. [47] Many emphasized that the act of selecting colors and patterns improved their ability to identify and differentiate between emotional states,[48] which is consistent with the quantitative improvements in DIF. Coloring was also perceived as a channel for emotional expression and catharsis, helping participants externalize negative emotions and improve their emotional states. Additionally, sharing coloring work triggered ambivalence, with participants expressing difficulty balancing self-expression with social concern.[49] Over time, daily participation improved both emotional awareness and emotional expression, with some participants reporting that recording emotions had become habitual.

User Experience

Participants demonstrated an overall satisfactory experience across the different dimensions of the GEQ. Competence ($M = 2.64$, $SD = 0.36$) and Positive Affect ($M = 2.48$, $SD = 0.41$) were close to normative values, indicating that users generally felt capable and derived enjoyment from the activity. Scores for Tension/Annoyance ($M = 1.27$, $SD = 0.57$) and Challenge ($M = 1.25$, $SD = 0.44$) were notably below typical levels, pointing to a low-pressure and non-stressful environment [50]. Qualitative feedback aligned with these results: participants frequently described the coloring activity as calming and conducive to concentration, and many reported a sense of satisfaction upon completing their coloring works [51]. At the same time, they raised concerns about the stereotypical association of colors with emotions, limited creative options, and insufficient feedback, which reduced overall enjoyment.

Analyses of in-game user behavior further demonstrated that gender, age, and alexithymia severity were not significantly associated with either total playtime or the total number of coloring works (all P s > 0.05). In contrast, profession had a significant effect on the total number of coloring works ($F = 4.239$, $P = 0.021$). These findings suggest that professional background influences the level of creative output, which is further supported by the qualitative interview data.

Suggestions for improvement emphasized increasing freedom and personalization while maintaining ease of use [52], such as customizable color gears and flexible pattern templates. Participants also highlighted the value of progress tracking and social features to enhance motivation and support long-term engagement [53]. Taken together, these findings suggest that while the game successfully fosters a low-stress and engaging environment, its long-term appeal will depend on greater personalization and richer creative options.

Comparison with Prior Work

This study extends prior alexithymia research by demonstrating the feasibility of a serious game designed as a coloring-based digital art therapy. Traditional art therapy approaches have shown benefits in supporting emotional awareness and expression [16], yet their broader application has been limited by practical barriers such as time, space, and accessibility [21-23]. Building on this foundation, *Coloring the Emoji* provides a more accessible and engaging pathway for emotion regulation, fostering emotional awareness and expression through creative activity in a supportive environment.

Findings from this study are consistent with the expanding evidence on gamification in digital health. Previous studies have demonstrated that rewards, feedback, and interactive elements effectively enhance engagement in physical activity and cognitive training [54]. This study extends the insights to the domain of emotion regulation, indicating that even simple coloring tasks, when gamified, can foster immersion and positive affect while maintaining a low-stress experience [55].

This study provides quantitative support for the link between creativity and emotion regulation. Prior work has suggested that creative activities promote reflection and stress reduction [55]. Regression analysis in this study showed that greater creative engagement predicted improvements in recognizing emotions, underscoring creativity's role in enhancing emotional awareness [57].

This work also contributes to research on culturally sensitive digital interventions. Most digital art therapy studies have been conducted in Western contexts [58]; Findings in Chinese college students illustrate both the promise and the challenges of adapting such tools in Asian culture. Usability concerns, personalization needs, and ambivalence about sharing point to the importance of cultural adaptation in global digital mental health [59,60].

Limitations

This study has several limitations. First, some participants engaged for a relatively short time or completed fewer coloring works, which may have reduced the stability and interpretability of the game's effects. Second, the sample consisted exclusively of college students, limiting the generalizability of the findings to a wider range of age groups and professional backgrounds. Finally, as a coloring-based serious game designed primarily for Chinese college students, its design and user experience may be influenced by cultural background, so its effectiveness and acceptability need to be further verified among different cultural populations.

Conclusions

This study provides evidence that a serious game, *Coloring the Emoji*, is an effective digital art therapy for Chinese college students with alexithymia. The game improves emotion regulation, especially the ability to identify emotions, and promotes healthier regulation strategies. Participants also reported a generally positive and calming user experience, characterized by competence, low tension, and a sense of accomplishment. Further studies with larger and more diverse samples are necessary to explore its feasibility across varied populations. The findings demonstrate the potential of coloring-based digital art therapy in supporting emotion regulation, providing an accessible and engaging approach for emotional support.

Data Availability

The data sets generated or analyzed during this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Instruments of the experiment.

Multimedia Appendix 2

Interview guide.

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Supplementary Files

Multimedia Appendixes

Instruments of the experiment.

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Interview guide.

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