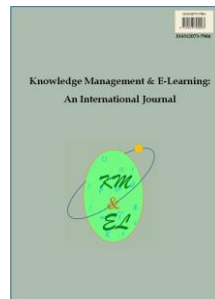

Applying emotion regulation strategies in complex tasks

Yuhan Liu
Minhong Wang
The University of Hong Kong, Hong Kong
Haoran Xie
Lingnan University, Hong Kong



Knowledge Management & E-Learning: An International Journal (KM&EL)
ISSN 2073-7904

Recommended citation:

Liu, Y., Wang, M., & Xie, H. (2026). Applying emotion regulation strategies in complex tasks. *Knowledge Management & E-Learning*, 18(3), 332–348. <https://doi.org/10.34105/j.kmel.2026.18.015>

Applying emotion regulation strategies in complex tasks

Yuhan Liu 

KM&EL Lab, Faculty of Education
The University of Hong Kong, Hong Kong
E-mail: yhliu19@connect.hku.hk

Minhong Wang* 

KM&EL Lab, Faculty of Education
The University of Hong Kong, Hong Kong
E-mail: magwang@hku.hk

Haoran Xie 

School of Data Science
Lingnan University, Hong Kong
E-mail: hrxie@ln.edu.hk

*Corresponding author

Abstract: Students often experience negative emotions, such as anxiety and frustration, when engaging in complex tasks, which may influence both their learning experiences and task performance. Although emotion regulation (ER) strategies have been shown to have positive effects on student learning, evidence regarding their effects in complex task situations remains underexplored. This study investigated students' use of ER strategies to support complex tasks and how their task performance and emotional experiences changed after applying these strategies. The participants were 24 ninth-grade students, who were learning English as a foreign language. They received instruction on applying three types of ER strategies (emotion-focused, task-focused, and regulation-focused) to support their cloze tasks. Results show that among the three types of ER strategies, students most frequently used task-focused strategies, followed by regulation-focused strategies, while emotion-focused strategies were used the least. Low-achieving students improved their task performance, whereas higher-achieving students did not show this change. Students' positive emotions increased and their negative emotions decreased after applying ER strategies. Many students reported that they still experienced negative emotions (such as anxiety and frustration) even when they applied ER strategies, mainly due to the challenging nature of tasks and the time pressure; these negative emotions distracted their attention and affected their performance. Implications of the findings are discussed.

Keywords: Emotion regulation; Complex task; Cloze task

Biographical notes: Dr. Yuhan Liu is a Postdoctoral Researcher at the Laboratory for Knowledge Management and E-Learning (KM&EL Lab), Faculty of Education, The University of Hong Kong. Her research interests include the learning sciences, educational psychology, and artificial intelligence in education, with a focus on emotion regulation in complex tasks.

Dr. Minhong (Maggie) Wang is Professor and Director of the Laboratory for Knowledge Management & E-Learning (KM&EL Lab), Faculty of Education, The University of Hong Kong. She is also Kuang-Piu Chair Professor at Zhejiang University, Eastern Scholar Chair Professor at East China Normal University, and Visiting Research Professor at Beijing Advanced Innovation Center for Future Education, Beijing Normal University. She is the Editor-in-Chief of Knowledge Management & E-Learning (indexed in Scopus & ESCI). Her expertise includes learning technologies, creative thinking, complex problem solving, knowledge management and visualization, and artificial intelligence applications. Based on Clarivate's Essential Science Indicators (ESI), she is recognized as a top 1% Scholar in (a) Social Sciences, General, and (b) Economics & Business.

Prof. Haoran Xie received a Ph.D. degree in Computer Science from City University of Hong Kong and an Ed.D degree in Digital Learning from the University of Bristol. He is currently a Professor and the Person-in-Charge at the Division of Artificial Intelligence, Director of LEO Dr David P. Chan Institute of Data Science, and the Associate Dean of the School of Data Science, Lingnan University, Hong Kong. He is the Editor-in-Chief of Natural Language Processing Journal, Computers & Education: X Reality, Computers & Education: Artificial Intelligence, and Artificial Intelligence in Language Education; and the Co-Editor-in-Chief of Knowledge Management & E-Learning. His research interests include natural language processing, large language models, language learning, and AI in education. He has published around 500 research publications, including more than 300 journal articles. His Google Scholar citation is more than 32,000 with the h-index of 70 and i10-index of 258. He has obtained 30 research awards including the World's Top 2% Scientists by Stanford University, Top 0.5% Highly Ranked Scholar, and Best Computer Science Scientists.

1. Introduction

In academic settings, students frequently experience a wide range of emotions when they engage with various tasks and contexts (Mänty et al., 2020). For instance, students may experience anxiety when performing a challenging task, or they may feel a sense of enjoyment upon successfully solving it. In online learning environments, students may feel online learning anxiety (Srisinthon, 2024). In educational contexts, emotions are regarded as a crucial factor influencing student learning and performance (Pekrun et al., 2002). Emotions can be categorized into two primary groups: positive emotions and negative emotions (Webster & Hadwin, 2015). Research shows that negative emotions like anxiety, anger, boredom, shame, and hopelessness tend to have detrimental effects on student performance (Ng & Lee, 2015). In contrast, positive emotions, such as enjoyment, relief, hope, and pride, can enhance student learning (Linnenbrink, 2007; Pekrun et al., 2002).

Tackling complex tasks or problems presents a considerable challenge for most students, during which they frequently encounter negative emotions that can affect their academic performance (Wang, 2024). Previous studies show that teaching students ER strategies can improve their academic performance and experience (Harley et al., 2019). However, the results on the effects of ER strategies on student performance remain inconsistent. Students who have learned ER strategies may not always effectively improve emotional experiences or task performance, especially in complex tasks.

1.1. Emotional experiences in complex tasks

Tackling complex tasks or problems is an essential part of the learning process, particularly in current educational practices, where students are encouraged to apply knowledge to solve real-world problems and authentic tasks. These tasks are often complex and characterized by dynamic situations and ill-defined solutions. Addressing such problems often involves a complex, situational process rather than a linear progression of clearly defined steps (Dörner & Funke, 2017). For instance, in the context of learning English as a foreign language, reading comprehension is widely recognized as a complex task as it necessitates the integration of diverse abilities, including prior knowledge, working memory, linguistic skills, and the use of effective strategies (Mckee, 2012). A variety of instructional tasks have been utilized to enhance students' reading comprehension, with multiple-choice cloze tasks emerging as a widely used and empirically supported approach. (Ajideh & Mozaffarzadeh, 2012; Jensen & Elbro, 2022). In a cloze task, students are provided with a passage or text of suitable length, with certain parts removed; they are required to fill in these gaps, typically by choosing the correct answers from a set of multiple-choice options (Ajideh et al., 2017). Differing from conventional fill-in-the-blank questions, cloze questions test students' deeper understanding ability beyond the understanding of a single sentence. The distractor design in the answer options further highlights the complexity of cloze tasks (Conoyer et al., 2017; Jensen & Elbro, 2022).

When tackling complex tasks, students often face difficult problems that, if unresolved, can lead to frustration, anxiety, or boredom, which negatively affect learning performance (Chin et al., 2017). For example, second language learners may experience anxiety when reading difficult texts, which can hinder their cognitive processing in reading (Rai et al., 2011). Likewise, students may struggle with anxiety in math problem-solving, which can overload their working memory and disrupt problem-solving progress (Dondio et al., 2023; Ramirez et al., 2016).

1.2. Emotion regulation and strategies

Emotion regulation (ER) refers to the ability to manage emotions effectively through various strategies to support goal achievement (Gross, 2015). In educational settings, ER helps students regulate their emotions to maintain a stable emotional foundation for task completion and enhance engagement, attention, and cognitive resource utilization (Boekaerts & Pekrun, 2015; Harley et al., 2017; Dewaele et al., 2019). While ER includes the regulation of both positive and negative emotions, ER in complex task situations focuses on managing challenging situations or negative feelings (Pascual et al., 2016).

ER in complex tasks involves the utilization of emotion-focused, task-focused, and regulation-focused strategies, with the first two more commonly discussed (Lazarus, 1991). Emotion-focused strategies focus on managing emotions, such as reducing tension, utilizing positive self-talk, and avoiding self-blame; cognitive appraisal and reappraisal are also commonly used emotion-focused strategies, which encourage people to view negative events in a positive light to reduce negative emotions (Webb et al., 2012). Task-focused strategies focus on addressing problems that cause negative emotions, for example, skimming the text before attempting a challenging text (Lazarus & Folkman, 1984). Task-focused strategies can shift emotions from negative to positive when effective in problem-solving (Folkman & Lazarus, 1988). Regulation-focused strategies involve self-regulation and metacognitive processes, for example, managing attention and

time during complex tasks (Bayat & Tarmizi, 2010; Muis et al., 2015; Schutz & Davis, 2000).

While ER has received growing attention in educational research (Gross, 2015), research on the application of ER strategies to support student learning in complex tasks remains limited and the findings have been inconsistent. For example, Brooks (2014) found that college students who used an emotion-focused strategy (i.e., reappraising anxiety through self-talk before a challenging task) improved their math task performance. Besides, Hanin et al. (2021) reported that teaching upper elementary students task- and emotion-focused strategies to engage them in confidence-boosting activities in math tasks led to improved emotional experiences, ER, and task performance. However, some studies argue that ER strategies are not significantly effective in enhancing student emotional experiences or learning performance in complex tasks. For instance, while reappraisal is typically linked to positive emotions and adaptive outcomes (Gross & John, 2003; Schutz et al., 2004), Burić et al. (2016) found that students utilizing reappraisal to regulate negative emotions actually experienced these emotions more intensely and achieved worse academic performance.

With the advancement of artificial intelligence (AI) technology, research on emotional AI in education has received increasing attention (Liu et al., 2024; Zhang et al., 2025). AI can detect learners' emotions and provide emotional support such as generating affective messages and emotional expressions (Zhang & Wang, 2024). However, students in these applications are often not encouraged to regulate their own emotions but simply received computer-generated emotional support.

1.3. The present study

The literature shows the potential of ER strategies to support student learning experience and performance. However, research findings on the effects of ER strategies on complex tasks remain underexplored. This study investigated students' use of ER strategies in complex tasks and how their task performance and emotional experience changed after applying these strategies.

The research questions (RQs) of the study are as follows.

RQ1: After students learn to apply ER strategies to support complex tasks, how often will they apply these strategies when performing complex tasks?

RQ2: How will students' performance on complex tasks change after they learn to apply ER strategies to support complex tasks?

RQ3: After students learn to apply ER strategies to support complex tasks, how will their emotional experiences change when performing complex tasks?

RQ4: Will students still experience negative emotions when they apply ER strategies to support complex tasks?

2. Method

The study was carried out with junior secondary students, who were encouraged to use ER strategies to enhance their cloze task performance in English language learning. As mentioned above, cloze tasks are complex tasks that require students to utilize a variety

of language strategies and knowledge to solve problems; the distractor design in the answer options increases the complexity of cloze tasks.

2.1. Participants

This study was carried out in a public secondary school in eastern China. The participants were 24 ninth-grade students from one class, including 11 males and 13 females, with a mean age of 14.79 years. They were non-native English speakers and had experience with cloze tasks prior to this study. An English teacher with more than five years of teaching experience and familiar with cloze tasks participated in this study to provide instructions and tutoring support to students. The study was approved by the Human Research Ethics Committee at the researchers' university, and all participants provided informed consent before taking part in the study.

2.2. Learning environment and learning materials

Considering that online learning environments have been widely used to provide students with flexible and personalized learning support, the online learning platform Teamviewer (<https://www.teamviewer.com>) was utilized in this study for one-to-one online tutoring. This platform allowed the teacher and the student to view and interact with each other in one-to-one online tutoring sessions. When engaging in a cloze task, the student's screen was shared with the teacher, allowing the teacher to observe the student's task process.

In this study, a set of passages was selected for cloze tasks, one passage for one task. Each passage contains around 280 words and includes 20 multiple-choice cloze items. Research suggests that passages ranging from 150 to 300 words are appropriate for cloze assessments because they provide sufficient content for evaluating language proficiency (Brown & Abeywickrama, 2004). Furthermore, Shahnazari-Dorcheh et al. (2012) reported that a cloze task with 20-25 blanks offers greater reliability in evaluating students' performance at the introductory and intermediate proficiency levels. The task materials were selected from past mock exam papers and were considered challenging by experienced teachers. The appropriateness of the selected materials was confirmed by the English teacher participating in the study.

Learning materials for ER strategies. An instructional video was used to teach students how to employ ER strategies to promote their cloze task performance. The instructions focused on three types of ER strategies. First, students were introduced to emotion-focused strategies, such as engaging in positive self-talk, and reappraising task importance. Second, task-focused strategies (e.g., rapidly skimming the text to obtain the general idea, and ignoring unfamiliar words) were introduced to help students enhance their task performance. Third, students were introduced to regulation-focused strategies, such as controlling attentional focus and allocating time efficiently. Illustrative examples were also provided in the instructions.

2.3. Measures and instruments

A pre-study survey was conducted to obtain participants' demographic information (gender and age).

Task performance. Participants' cloze task performance was evaluated in the pre-test and post-test. Each test comprised 20 multiple-choice cloze questions, with one point

assigned for each correct answer, resulting in a maximum score of 20. Student responses were scored based on reference answers verified by domain experts. While the two tests employed different questions, their difficulty levels were confirmed to be equivalent by two domain experts.

Emotional experiences. Participants' emotional experiences during tasks, including both positive and negative emotions, were assessed by employing the short version of Achievement Emotions Questionnaire (AEQ-S) developed by Bieleke et al. (2021). In the present study, the test-related emotions subscale from the AEQ-S was adopted as the measurement instrument. Minor adjustments were made to suit the research context. Specifically, references to "exam" were changed to "cloze task," and the temporal reference "after the exam" was adapted to "while performing the cloze task" to better reflect participants' in-task emotional experiences. The instrument included two dimensions of emotions. The positive emotion dimension comprised hope, enjoyment, pride, and relief, whereas the negative emotion dimension consisted of anxiety, boredom, anger, shame, and hopelessness. Sample items included statements such as "I enjoy doing the cloze task"; "I was optimistic that I could effectively deal with any difficulties during the cloze task"; "I felt a sense of pride while working on the cloze task"; "I experienced relaxation during the cloze task"; "I experienced anger while working on the cloze task"; "I experienced boredom while working on the cloze task"; "I experienced nervousness during the cloze task"; "I felt embarrassed when I could not answer the cloze questions"; and "I felt a sense of despair during the cloze task". Responses were collected by using a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The internal consistency reliability of the scales was satisfactory, with a Cronbach's α value of 0.88 for positive emotion and 0.87 for negative emotion.

Self-report. Students' self-reports on their use of ER strategies in complex tasks were collected at the end of each task. Students were required to give written responses to two questions. (1) Did you apply any ER strategies during the task? If yes, please specify them. (2) Did you experience negative emotions when applying ER strategies during the task? If yes, please specify the reasons and describe how the negative emotions affect your performance.

2.4. Procedure

The procedure of the study is as follows. In the first session, students signed a consent form to confirm their participation in the study. Next, they filled up a survey questionnaire to collect demographic information and complete the pre-test. After the test, they filled in a questionnaire about emotional experiences during the test. Next, students watched an instructional video on how to apply ER strategies to improve performance on complex tasks such as cloze tasks. After watching the video, students asked questions and received feedback and guidance from the teacher.

In the subsequent sessions (Sessions 2–4), students participated in one-to-one online tutoring sessions, one session per week. During each session, students were first reminded to apply ER strategies to support their task and then asked to perform a cloze task. After the task, the student was asked to give a self-report on using ER strategies during the task. Finally, the teacher checked the student's answers and provided explanations to the student, especially for those items that were answered incorrectly.

Finally, in Session 5, students completed a cloze task as the post-test, filled up surveys on their emotional experiences, and gave a self-report on their use of ER

strategies during the task. The teacher checked the students' answers and provided explanations, especially for incorrect ones.

2.5. Data analysis method

The data collected was analyzed as follows. First, descriptive statistics were used to describe the basic features of the data in the study. Second, a paired sample t-test was applied to compare students' task performance before and after applying ER strategies. Third, a median split was used to divide the students into low- and high-achieving groups according to their pre-test scores. Fourth, an independent t-test was applied to compare the pre-test scores between low- and high-achieving students. Fifth, the two-way mixed ANOVA with Time (pre-test vs. post-test) as the within-subject factor and Group (high-achieving vs. low-achieving) as the between-subject factor was applied to examine the differences between low- and high-achieving students in their post-test scores. Sixth, one-way repeated measures MANOVA with Time (pre-test vs. post-test) as the within-subject factor was used to compare the positive emotional experiences, and negative emotional experiences before and after applying ER strategies. Seventh, MANOVA was used to examine the differences in emotional experiences between low- and high-achieving students before and after applying ER strategies.

Finally, a thematic content analysis was conducted to identify key themes emerging from students' self-reports. Following an iterative coding procedure, themes and categories were developed in line with Krathwohl's (1993) guidelines. Initially, the first author and an experienced researcher independently coded approximately 30% of the dataset. Any inconsistencies in the identified categories were resolved through collaborative discussion and reference to the original data. After the categories were finalized and confirmed, the same two coders independently coded another 30% of the responses to examine inter-coder agreement, which was found to be high (Cohen's Kappa = 0.93). Following the resolution of remaining discrepancies through discussion, the first author applied the established coding scheme to analyze the rest of the dataset.

3. Results

3.1. Descriptive statistics

Table 1 presents the descriptive statistics of the students' pre- and post-test task performance, pre- and post-test emotional experiences.

Table 1
Descriptive statistics

Variable	<i>N</i>	Min	Max	Mean	<i>SD</i>
Task performance					
Pre-test score	24	2.00	17.00	10.21	3.59
Post-test score	24	7.00	17.00	10.46	2.69
Emotional experiences					
Pre-positive emotion	24	1.50	4.17	3.24	0.68
Post-positive emotion	24	2.50	4.50	3.51	0.59
Pre-negative emotion	24	1.27	3.20	2.06	0.58
Post-negative emotion	24	1.07	2.87	1.74	0.52

3.2. Task performance

Students' task performance before and after applying ER strategies was compared using a paired sample t-test. The results show no significant difference ($t = -0.435, p = 0.668$).

In further analysis, students were divided into low- and high-achieving groups by a median split according to their pre-test cloze test scores. The independent t-test results indicate a significant difference ($t(22) = -6.147, p < .001$) in the pre-test score between low-achieving students (Mean = 7.42, $SD = 2.58$) and high-achieving students (Mean = 13.00, $SD = 1.81$).

The differences in post-test scores between low- and high-achieving students were examined using the two-way mixed ANOVA with Time (pre-test vs. post-test) as the within-subject factor and Group (high-achieving vs. low-achieving) as the between-subject factor. As shown in Table 2, the effects of Group ($F(1,22) = 18.39, p < .001$) and Time*Group ($F(1,22) = 17.43, p < .001$) were significant, while the effect of Time ($F(1,46) = 0.01, p = .575$) was not significant. The results show that, compared with the high-achieving students, low-achieving students showed significant improvement in their task performance after applying ER strategies. In other words, applying ER strategies is more helpful for low-achieving students to improve task performance.

Table 2

Two-way mixed ANOVA of task performance in the post-test

Variable	High-achieving (N = 12)		Low-achieving (N = 12)		Time	Significance	
	Mean	SD	Mean	SD		Group	Time*Group
Pre-test	13.00	1.81	7.42	2.20	0.575	< 0.001***	< 0.001***
Post-test	11.42	2.88	9.50	2.69			

Note. *** $p < 0.001$

3.3. Emotional experiences

The students' emotional experiences before and after applying ER strategies were compared using one-way repeated measures MANOVA with Time (pre-test vs. post-test) as the within-subject factor. The results show a significant difference in the combined emotions (i.e., a combination of positive and negative emotions) before and after applying ER strategies ($F(2, 22) = 7.159, p = .004, Wilks' \Lambda = .606, \eta_p^2 = .394$). The results presented in Table 3 show significant improvement in students' positive emotions ($F(1,23) = 8.696, p = .007$) and reduction in negative emotions ($F(1,23) = 9.829, p = .005$) after applying ER strategies.

Table 3

ANOVA of emotional experiences before and after applying ER strategies

Variable	Before applying ER strategies		After applying ER strategies		Significance
	Mean	SD	Mean	SD	
Positive emotion	3.24	0.68	3.51	0.59	0.007**
Negative emotion	2.06	0.58	1.74	0.52	0.005**

Note. ** $p < 0.01$

In further analysis, students were divided into low- and high-achieving groups by a median split according to their pre-test cloze test scores. The MANOVA results show no significant difference in the combined emotions (i.e., a combination of positive and negative emotions) between low- and high-achieving students either before applying ER strategies ($F(2, 21) = 0.675, p = .520, Wilks' \Lambda = .940, \eta_p^2 = .035$) or after applying ER strategies ($F(2, 21) = 0.729, p = .494, Wilks' \Lambda = .069, \eta_p^2 = .065$).

3.4. Frequency of student use of ER strategies in complex tasks

Table 4 shows the frequency of applying task-focused ER strategies among all students across all session. The most commonly used task-focused strategy was guessing and eliminating, followed by scanning. Table 5 shows the frequency of applying regulation-focused ER strategies among all students across all session. The most frequently applied regulation-focused strategy was sequencing and time management. Table 6 shows the frequency of applying emotion-focused ER strategies among all students across all session. The most frequently used emotion-focused strategy was positive self-talk, followed by quick tension reduction.

Table 4

Frequency of applying task-focused strategies among all students

Strategy	Illustrative Example	Frequency				Total
		S2	S3	S4	S5	
Skimming	<i>I read through the passage before answering the questions.</i>	11	7	6	11	35
Skipping	<i>I skipped over unfamiliar words that were not important.</i>	15	12	15	8	50
Scanning	<i>I tried to find clues in the article.</i>	19	21	22	22	84
Guessing and Eliminating	<i>I tried to guess the meaning of unfamiliar words based on the context of the passage.</i>	22	24	22	23	91
Repeating	<i>I tried to read the sentence I don't understand several times.</i>	13	16	12	15	56
Total		80	80	77	79	316

Table 5

Frequency of applying regulation-focused strategies among all students

Strategy	Illustrative Example	Frequency				Total
		S2	S3	S4	S5	
Sequencing and time management	<i>I tried to concentrate first on the easy questions.</i>	13	16	10	15	54
Checking	<i>I checked the correctness of the answers after finishing the task.</i>	5	4	5	4	18
Controlling attention	<i>I reminded myself to focus on the questions.</i>	3	5	7	4	19
Total		21	25	22	23	91

Table 7 summarizes the frequencies of student use of all ER strategies and presents the average frequency of each student's application of each strategy under each category. On average, each task-focused strategy was used by 2.63 students; each

regulation-focused strategy was used by 1.26 students; and each emotion-focused strategy was used by 0.76 student in this study.

Table 6

Frequency of applying emotion-focused strategies among all students

Strategy	Illustrative Example	Frequency				Total
		S2	S3	S4	S5	
Quick tension reduction techniques	<i>I took a deep breath.</i>	4	4	6	5	19
Positive self-talk	<i>I told myself I could solve the problem well.</i>	6	10	9	7	32
Importance reappraisal	<i>I adjusted the expectations on the score.</i>	1	3	0	0	4
Total		11	17	15	12	55

Table 7

Average frequency of each student's application of each strategy

Category	Number of strategies (N)	Number of students (M)	Frequency of using all strategies among all students (F)	Average frequency of using each strategy among each student (AF)
Task-focused	5	24	316	2.63
Regulation-focused	3	24	91	1.26
Emotion-focused	3	24	55	0.76

Note. AF = F/N/M

3.5. Experience of negative emotions in tasks

Most students (83%) mentioned that they experienced negative emotions during the tasks. Table 8 outlines the reasons students reported for experiencing negative emotions in tasks. The reported reasons include challenging tasks (frequency = 53), time-related issues such as insufficient time and improper time allocation (frequency = 31), and misaligned expectations such as concerns about poor performance and habitual stress during exams (frequency = 20), and the influence of the surrounding environment (frequency = 10). Misaligned expectations refer to discrepancies between students' anticipated outcomes and their actual performance. For example, students expected to perform well but were worried that they would not meet their own or others' expectations.

Table 9 summarizes students' self-reports on how negative emotions affected their task performance. The results show that the negative emotions students experienced while performing tasks could affect their performance by distracting their attention (frequency = 26), reducing their motivation (frequency = 8), affecting their understanding of task material (frequency = 6), and impairing their memory (frequency = 2).

Table 8
Reasons for experiencing negative emotions in tasks

Themes	Reasons	Illustrative example	Frequency				Total
			S2	S3	S4	S5	
Challenging task			18	13	13	9	53
	Task difficulty	<i>It made me upset that I could not work out a lot of problems.</i>	17	13	12	8	50
	Many task questions	<i>I felt impatient with many task questions.</i>	1	0	1	1	3
Time issue			11	9	5	6	31
	Insufficient time	<i>I felt nervous because I didn't have enough time to finish the task.</i>	8	8	5	3	24
	Improper time allocation	<i>I took a long time in the beginning, leading to insufficient time to complete the remaining questions.</i>	3	1	0	3	7
	Misaligned expectations		5	7	3	5	20
	Worries about task performance	<i>I worried that my task score might be low.</i>	4	4	2	4	14
	Habitual stress during exams	<i>I always feel nervous when I take an exam.</i>	1	3	1	1	6
Influence of the surrounding environment			2	3	4	1	10
		<i>The stability of the network environment, the influence of relatives outside the room, etc.</i>	2	3	4	1	10
Other reasons			1	2	3	4	10
	A lack of preparation	<i>I felt anxious for not having done enough preparation.</i>	1	0	0	1	2
	Self-mental state	<i>I'm very tired today.</i>	0	2	3	3	8

Table 9
The influence of negative emotions on task performance

Influence of negative emotions	Illustrative Example	Frequency				Total
		S2	S3	S4	S5	
Motivation	<i>My nervousness made me lose interest in reading the article.</i>	1	2	3	2	8
Concentration	<i>I can't calm down and think more about difficult problems.</i>	4	5	9	8	26
Memory	<i>I can't remember the meaning of the word I've seen before.</i>	0	1	0	1	2
Understanding	<i>I couldn't understand this article because I was nervous.</i>	2	2	1	1	6
Total		7	10	13	12	42

4. Discussion

4.1. After students learn to apply ER strategies to support complex tasks, how often will they apply these strategies when performing complex tasks?

Regarding the application of ER strategies during the task, students reported using a range of strategies, with a clear preference for task-focused and regulation-focused strategies. The results indicate that task-focused strategies were the most commonly used, followed by regulation-focused strategies, while emotion-focused strategies were applied the least. This suggests that students tended to prioritize strategies directly related to managing the task itself, such as “Guessing and Eliminating” and “Sequencing and Time Management,” which were the most frequently used task-focused and regulation-focused strategies, respectively. Although emotion-focused strategies, like positive self-talk and quick tension reduction techniques, were less used by students when performing complex tasks, the use of task-focused and regulation-focused strategies appeared to help them alleviate negative emotions and foster positive emotional experiences, ultimately benefiting students’ task performance.

4.2. How will students’ performance on complex tasks change after they learn to apply ER strategies to support complex tasks?

The results indicate that students made no significant improvement in task performance after applying ER strategies. This finding echoes the finding from previous research, which suggests that merely providing instruction on relevant strategies is often not enough to enable students to effectively apply these strategies in complex situations (Wüstenberg et al., 2014).

Further analysis shows that low-achieving students, but not high-achieving students, improved their task performance after applying ER strategies. The results suggest that ER strategies are beneficial for students with lower levels of task proficiency. This finding is supported by previous research that high-achieving students tend to master more learning strategies than low-achieving students (Holschuh, 2000). It is possible that high-achieving students had already mastered some ER strategies before participating in this study. Therefore, it is difficult for them to improve their task performance by participating in this study.

4.3. After students learn to apply ER strategies to support complex tasks, how will their emotional experiences change when performing complex tasks?

The results suggest that applying ER strategies had a significant impact on students’ emotional experiences when performing complex tasks, that is, a reduction in negative emotions and an increase in positive emotions. This finding aligns with previous studies showing that ER strategies can improve students’ emotional experiences (Hanin et al., 2021; Schutz et al., 2004). Furthermore, the impact was not influenced by students’ task proficiency level. This suggests that the ER strategies that students learned in this study were universally applicable, enabling students with different levels of task proficiency to regulate their emotions effectively. These ER strategies can improve emotional experiences on a fundamental level, such as reducing anxiety and boosting confidence in a complex task, benefiting all students regardless of their initial task proficiency. The

findings demonstrate a clear impact of applying ER strategies on improving students' emotional experiences in complex tasks.

4.4. Will students still experience negative emotions when they apply ER strategies to support complex tasks?

Many students mentioned that they experienced negative emotions during the tasks. This finding echoes previous research that students who used cognitive reappraisal to regulate negative emotions actually experienced more intense negative emotions (Burić et al., 2016).

Regarding the reasons for negative emotions despite the application of ER strategies, students reported three key factors: challenging tasks, time-related issues, and misaligned expectations. Many students mentioned challenging tasks (e.g., the difficulty and volume of questions) as a source of anxiety and frustration. Time-related issues (such as insufficient time and improper time allocation) were another major factor contributing to negative emotions. Students also mentioned misaligned expectations (i.e., discrepancies between anticipated outcomes and actual performance) that caused negative emotions.

Further, students noted that these negative emotions affected their performance by distracting their attention, reducing their motivation, and affecting their understanding of task material. The most common effect of negative emotions noted by students is distraction. Students tended to focus on a difficult problem and become anxious when they were unable to solve it quickly. This could disrupt them from other problems, leading to slower problem solving, poor time management, and ultimately lower overall performance. The findings reveal the severe impact of emotional interference on cognitive processes, highlighting the importance of dealing with negative emotions to improve performance in complex task situations. Therefore, teachers should encourage students to actively use ER strategies to manage negative emotions in the classroom.

4.5. Limitations and future work

This study has several limitations. First, the findings from the context of performing complex cloze tasks in English language learning may not be directly generalizable to other contexts. Future work can explore the application of ER strategies in other complex task situations. Second, in addition to task proficiency, the progress made by learners after using ER strategies in complex tasks can be influenced by other learner characteristics, which can be explored in future studies. Third, this study focused on the short-term effects of applying ER strategies in complex task situations. Students in this study had limited time to practice using ER strategies before applying them to the post-test task. Future research can investigate the long-term effects of ER strategies on student performance and experience.

5. Conclusion

Students often encounter negative emotions when performing complex tasks. Prior studies reported inconclusive findings on the effects of ER strategies on student learning and performance. This study investigated students' use of ER strategies to support

complex tasks and how their task performance and emotional experience may change after applying these strategies. The results show that among three types of ER strategies, students most frequently used task-focused strategies, followed by regulation-focused strategies, while emotion-focused strategies were used the least. Low-achieving students improved their task performance, whereas higher-achieving students did not show this change. Students' positive emotions increased and their negative emotions decreased after applying ER strategies. Many students reported that they still experienced negative emotions (such as anxiety and frustration) even when they applied ER strategies, mainly due to the challenging nature of tasks and the time pressure; these negative emotions distracted their attention and affected their performance.

The findings have implications for educational researchers and practitioners. First, it is important to teach students ER strategies to improve their emotional experiences when performing complex tasks. Second, compared with high-achieving students, low-achieving students are more encouraged to apply ER strategies to improve their performance on complex tasks. Third, compared to other two types of ER strategies, students need additional guidance and practice in applying emotion-focused strategies; otherwise, they may still experience negative emotions when performing challenging tasks under time pressure.

Author Statement

The authors declare that there is no conflict of interest.

Acknowledgements

The authors would thank Professor Haijing Jiang for his valuable guidance and support for this study.

ORCID

Yuhan Liu  <https://orcid.org/0009-0000-0300-040X>

Minhong Wang  <https://orcid.org/0000-0002-1084-6814>

Haoran Xie  <https://orcid.org/0000-0003-0965-3617>

References

- Ajideh, P., & Mozaffarzadeh, S. (2012). C-test vs. multiple-choice cloze test as tests of reading comprehension in Iranian EFL context: Learners' perspective. *English Language Teaching*, 5(11), 143–150. <http://doi.org/10.5539/elt.v5n11p143>
- Ajideh, P., Yaghoubi-Notash, M., & Khalili, A. (2017). An investigation of the learning strategies as bias factors in second language cloze tests. *Advances in Language and Literary Studies*, 8(2), 91–100.
- Bayat, S., & Tarmizi, R. A. (2010). Assessing cognitive and metacognitive strategies during algebra problem solving among university students. *Procedia - Social and Behavioral Sciences*, 8, 403–410. <https://doi.org/10.1016/j.sbspro.2010.12.056>
- Bieleke, M., Gogol, K., Goetz, T., Daniels, L., & Pekrun, R. (2021). The AEQ-S: A short

- version of the achievement emotions questionnaire. *Contemporary Educational Psychology*, 65: 101940. <https://doi.org/10.1016/j.cedpsych.2020.101940>
- Boekaerts, M., & Pekrun, R. (2015). Emotions and emotion regulation in academic settings. In L. Corno & E. M. Anderman (Eds.), *Handbook of Educational Psychology* (pp. 90–104). Routledge.
- Brooks, A. W. (2014). Get excited: Reappraising pre-performance anxiety as excitement. *Journal of Experimental Psychology: General*, 143(3), 1144–1158. <https://doi.org/10.1037/a0035325>
- Brown, H. D., & Abeywickrama, P. (2004). *Language assessment: Principles and classroom practices*. Pearson Education.
- Burić, I., Sorić, I., & Penezić, Z. (2016). Emotion regulation in academic domain: Development and validation of the academic emotion regulation questionnaire (AERQ). *Personality and Individual Differences*, 96, 138–147. <https://doi.org/10.1016/j.paid.2016.02.074>
- Chin, E. C., Williams, M. W., Taylor, J. E., & Harvey, S. T. (2017). The influence of negative affect on test anxiety and academic performance: An examination of the tripartite model of emotions. *Learning and Individual Differences*, 54, 1–8. <https://doi.org/10.1016/j.lindif.2017.01.002>
- Conoyer, S. J., Lembke, E. S., Hosp, J. L., Espin, C. A., Hosp, M. K., & Poch, A. L. (2017). Getting more from your maze: Examining differences in distractors. *Reading & Writing Quarterly*, 33(2), 141–154. <https://doi.org/10.1080/10573569.2016.1142913>
- Dewaele, J.-M., Chen, X., Padilla, A. M., & Lake, J. (2019). The flowering of positive psychology in foreign language teaching and acquisition research. *Frontiers in Psychology*, 10: 2128. <https://doi.org/10.3389/fpsyg.2019.02128>
- Dondio, P., Gusev, V., & Rocha, M. (2023). Do games reduce maths anxiety? A meta-analysis. *Computers & Education*, 194: 104650. <https://doi.org/10.1016/j.compedu.2022.104650>
- Dörner, D., & Funke, J. (2017). Complex problem solving: What it is and what it is not. *Frontiers in Psychology*, 8: 1153. <https://doi.org/10.3389/fpsyg.2017.01153>
- Folkman, S., & Lazarus, R. S. (1988). Coping as a mediator of emotion. *Journal of Personality and Social Psychology*, 54(3), 466–475. <https://doi.org/10.1037/0022-3514.54.3.466>
- Gross, J. J. (2015). Emotion regulation: Current status and future prospects. *Psychological Inquiry*, 26(1), 1–26. <https://doi.org/10.1080/1047840X.2014.940781>
- Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, 85(2), 348–362. <https://doi.org/10.1037/0022-3514.85.2.348>
- Hanin, V., Colognesi, S., & Van Nieuwenhoven, C. (2021). From perceived competence to emotion regulation: assessment of the effectiveness of an intervention among upper elementary students. *European Journal of Psychology of Education*, 36, 287–317. <https://doi.org/10.1007/s10212-020-00481-6>
- Harley, J. M., Lajoie, S. P., Frasson, C., & Hall, N. C. (2017). Developing emotion-aware, advanced learning technologies: A taxonomy of approaches and features. *International Journal of Artificial Intelligence in Education*, 27(2), 268–297. <https://doi.org/10.1007/s40593-016-0126-8>
- Harley, J. M., Pekrun, R., Taxer, J. L., & Gross, J. J. (2019). Emotion regulation in achievement situations: An integrated model. *Educational Psychologist*, 54(2), 106–126. <https://doi.org/10.1080/00461520.2019.1587297>
- Holschuh, J. P. (2000). Do as I say, not as I do: High, average, and low-performing students' strategy use in biology. *Journal of College Reading and Learning*, 31(1),

- 94–108. <https://doi.org/10.1080/10790195.2000.10850105>
- Jensen, K. L., & Elbro, C. (2022). Clozing in on reading comprehension: A deep cloze test of global inference making. *Reading and Writing*, 35(5), 1221–1237. <https://doi.org/10.1007/s11145-021-10230-w>
- Krathwohl, D. R. (1993). *Methods of educational and social science research: An integrated approach*. Longman/Addison Wesley Longman.
- Lazarus, R. S. (1991). *Emotion and adaptation*. Oxford University Press.
- Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. Springer publishing.
- Linnenbrink, E. A. (2007). The role of affect in student learning: A multi-dimensional approach to considering the interaction of affect, motivation, and engagement. In P. A. Schutz & R. Pekrun (Eds.), *Emotion in Education* (pp. 107–124). Elsevier. <https://doi.org/10.1016/B978-012372545-5/50008-3>
- Liu, Y., Zhang, H., Jiang, M., Chen, J., & Wang, M. (2024). A systematic review of research on emotional artificial intelligence in English language education. *System*, 126: 103478. <https://doi.org/10.1016/j.system.2024.103478>
- Mänty, K., Järvenoja, H., & Törmänen, T. (2020). Socio-emotional interaction in collaborative learning: Combining individual emotional experiences and group-level emotion regulation. *International Journal of Educational Research*, 102: 101589. <https://doi.org/10.1016/j.ijer.2020.101589>
- McKee, S. (2012). Reading comprehension, what we know: A review of research 1995 to 2011. *Language Testing in Asia*, 2(1): 45. <https://doi.org/10.1186/2229-0443-2-1-45>
- Muis, K. R., Psaradellis, C., Lajoie, S. P., Di Leo, I., & Chevrier, M. (2015). The role of epistemic emotions in mathematics problem solving. *Contemporary Educational Psychology*, 42, 172–185. <https://doi.org/10.1016/j.cedpsych.2015.06.003>
- Ng, E., & Lee, K. (2015). Effects of trait test anxiety and state anxiety on children's working memory task performance. *Learning and Individual Differences*, 40, 141–148. <https://doi.org/10.1016/j.lindif.2015.04.007>
- Pascual, A., Conejero, S., & Etxebarria, I. (2016). Coping strategies and emotion regulation in adolescents: Adequacy and gender differences. *Ansiedad y Estrés*, 22(1), 1–4. <https://doi.org/10.1016/j.anyes.2016.04.002>
- Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research. *Educational Psychologist*, 37(2), 91–105. https://doi.org/10.1207/S15326985EP3702_4
- Rai, M. K., Loschky, L. C., Harris, R. J., Peck, N. R., & Cook, L. G. (2011). Effects of stress and working memory capacity on foreign language readers' inferential processing during comprehension. *Language Learning*, 61(1), 187–218. <https://doi.org/10.1111/j.1467-9922.2010.00592.x>
- Ramirez, G., Chang, H., Maloney, E. A., Levine, S. C., & Beilock, S. L. (2016). On the relationship between math anxiety and math achievement in early elementary school: The role of problem solving strategies. *Journal of Experimental Child Psychology*, 141, 83–100. <https://doi.org/10.1016/j.jecp.2015.07.014>
- Schutz, P. A., & Davis, H. A. (2000). Emotions and self-regulation during test taking. *Educational Psychologist*, 35(4), 243–256. https://doi.org/10.1207/S15326985EP3504_03
- Schutz, P. A., Distefano, C., Benson, J., & Davis, H. A. (2004). The emotional regulation during test-taking scale. *Anxiety, Stress & Coping*, 17(3), 253–269. <https://doi.org/10.1080/10615800410001710861>
- Shahnazari-Dorcheh, M., Roshan, S., & Hesabi, A. (2012). What is the optimum length of a cloze test. *International Journal of English Linguistics*, 2(5): 2012.
- Srisinthon, P. (2024). Anxiety and engagement in the online classroom: A case study of Thai learners of Chinese as a foreign language. *Knowledge Management & E-*

- Learning*, 16(4), 716–735. <https://doi.org/10.34105/j.kmel.2024.16.033>
- Wang, M. (2024). Rethinking how people learn: A holistic framework for effective learning design. *Knowledge Management & E-Learning*, 16(2), 208–216. <https://doi.org/10.34105/j.kmel.2024.16.010>
- Webb, T. L., Miles, E., & Sheeran, P. (2012). Dealing with feeling: A meta-analysis of the effectiveness of strategies derived from the process model of emotion regulation. *Psychological Bulletin*, 138(4), 775–808. <https://doi.org/10.1037/a0027600>
- Webster, E. A., & Hadwin, A. F. (2015). Emotions and emotion regulation in undergraduate studying: Examining students' reports from a self-regulated learning perspective. *Educational Psychology*, 35(7), 794–818. <https://doi.org/10.1080/01443410.2014.895292>
- Wüstenberg, S., Stadler, M., Hautamäki, J., & Greiff, S. (2014). The role of strategy knowledge for the application of strategies in complex problem solving tasks. *Technology, Knowledge and Learning*, 19, 127–146. <https://doi.org/10.1007/s10758-014-9222-8>
- Zhang, H., Liu, Y., Jiang, M., Chen, J., Wang, M., & Paas, F. (2025). Emotional artificial intelligence in education: A systematic review and meta-analysis. *Educational Psychology Review*, 37: 106. <https://doi.org/10.1007/s10648-025-10086-4>
- Zhang, H. & Wang, M. (2024). A novel deep learning model to improve the recognition of students' facial expressions in online learning environments. *Knowledge Management & E-Learning*, 16(1), 134–150. <https://doi.org/10.34105/j.kmel.2024.16.006>