


Investigating the effectiveness of emotional self-regulation skills on students' cognitive flexibility and working memory

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ABSTRACT

Objective: The current study was carried out to investigate the effectiveness of emotional self-regulation skill training on cognitive flexibility and working memory.

Methods and Materials: The research was conducted using a quasi-experimental method with pre-test, post-test, and follow-up design with a control group. The statistical population of the study consisted of all ninth-grade students in Jajarm city in the academic year of 2021-2022 who were studying in public and private girls and boys' schools, as well as state-sponsored, exemplary, and talented ones. Out of which, 60 participants were selected using cluster sampling and randomly assigned to two equal groups of 30 participants (an experimental group and a control group). To collect data, two questionnaires, the Daneman and Carpenter (1980) working memory test and the cognitive flexibility questionnaire by Dennis and Vanderwal (2010), were used. Multivariate covariance analysis tests and SPSS software were used for data analysis.

Findings: The results indicated that emotional self-regulation skill training had a significant effect on the cognitive flexibility and the working memory of experimental group subjects ($P < 0.05$).

Conclusion: Therefore, training in emotional self-regulation skills has a significant impact on students' cognitive flexibility.

Keywords: Emotional self-regulation skills, cognitive flexibility, working memory

1. Introduction

Many psychological injuries and behavioral abnormalities are associated with cognitive flexibility. Research has shown a relationship between cognitive flexibility and depression (Novakovic-Agopian et

al., 2021). The rigid cognitive style in depressed individuals, due to its impact on attentional bias towards self-referential and inefficient thoughts, disrupts the attentional system and exacerbates depression (Taghavi, Ebadi, & Kazemi, 2021). Therefore, enhancing cognitive flexibility in depressed individuals through challenging inefficient thoughts can

reduce depressive symptoms. In this regard, researchers have shown that individuals who are cognitively inflexible resort to rumination (a type of thinking style characterized by repetitive, intrusive, and uncontrollable thoughts) when distressed and focus their cognitive resources on rumination, which is a repetitive and unhelpful response (Sanagaoi Moharrar & Mir Shekari, 2019). Cognitive inflexibility provides a fertile ground for irrational thoughts, leading to distress, anxiety, and various life problems (Jafari & Mollaei, 2019). Furthermore, the relationship between cognitive flexibility and some mental health issues, such as obsessive-compulsive disorder (Hasani, Mehrinezhad, & Khodabakhsh Pirkalani, 2020), eating disorders, and family conflicts (Haqnezari, Nejati, & Pouretemad, 2022), has been investigated.

Additionally, researchers have confirmed the relationship between cognitive flexibility and problem-solving skills as well as resilience (Aghaziarati et al., 2020). Over the past decades, one of the concerns of various educational research has been identifying the cognitive mechanisms considered as the foundation of children's learning. One of these mechanisms is working memory, which is a limited-capacity system responsible for storing and manipulating information during complex and demanding activities (Azunny, Rahim, & Shalan, 2020).

These activities commonly occur in the classroom, such as following instructions while performing a task, writing while organizing the next section of a text, or engaging in mental calculations. Consequently, there is a high likelihood that children faced with insufficient working memory resources during a learning activity may experience failure (Chevalère et al., 2023). Working memory is now recognized as a significant factor in selective preventive intervention for children at risk of poor academic progress and recent research indicates that an important and modifiable factor for academic achievement is active working memory (da Silva et al., 2023). Studies on working memory have shown its relationship with performance among elementary school students (Deng et al., 2020), middle school students, and university students (Akbarzadeh & Zahraakar, 2022).

Working memory is crucial in learning as it acts as a unifying source for long-term memory and information in temporary storage, allowing for the integration of knowledge (Haqnezari, Nejati, & Pouretemad, 2022). A child with weak working memory capacity is limited in their ability to perform these operations in important classroom activities. Given the information presented and the conflicting results

obtained and the research gap on the topic, this study aims to investigate the impact of emotional self-regulation skills on cognitive flexibility and working memory of ninth-grade students in the schools of Jajarm city.

2. Methods and Materials

2.1. Study Design and Participants

The present study employed a quasi-experimental research design with pre-test, post-test, and follow-up stages along with a control group, involving two experimental groups and one control group. Pre-tests, post-tests, and follow-up assessments were conducted for both experimental and control groups. The study population consisted of all ninth-grade students in the first year of high school in Jajarm city during the academic year 2022-23. The total number of these students was 593. To address the research questions and examine the effectiveness of emotional self-regulation skills on the dependent variables of the study, ninth-grade students from Jajarm city schools were randomly cluster-sampled. Six schools were randomly selected from the list of existing schools, and two classes from each school were randomly chosen. Finally, 60 students were randomly selected from this pool and divided into an experimental group (30 students) and a control group (30 students). The experimental group received training in emotional self-regulation skills, while the control group received no intervention. The inclusion criterion was being a ninth-grade student and attending schools in Jajarm city, while the exclusion criterion was absenteeism for more than three sessions.

2.2. Measures

2.2.1. Working Memory

The Daneman and Carpenter Working Memory Test, developed in 1980, is a widely used measure of working memory capacity. It was designed to evaluate a person's ability to hold and manipulate information in their mind. The test consists of a series of sentences that gradually increase in length and complexity. During the test, the participants read each sentence aloud, and then immediately recall the final word of the sentence. The number of correct words recalled is used as the measure of working memory capacity. The test takes approximately 20 minutes to complete and has two versions, each with 15 sentences. The test has been found to have high internal consistency, with reliability

coefficients ranging from .77 to .92. It also has good test-retest reliability, with scores remaining stable over time. The test has also demonstrated convergent validity with other measures of working memory and is widely used in research studies (Daneman & Carpenter, 1980).

2.2.2. *Cognitive Flexibility*

The Cognitive Flexibility Inventory (CFI) developed by Dennis and Vanderwaal (2010) is a self-report questionnaire designed to measure individual differences in cognitive flexibility. Cognitive flexibility is the ability to effectively switch between different ways of thinking, adapting to new situations and circumstances. The CFI consists of 20 items, which measure three dimensions of cognitive flexibility: cognitive shifting, attentional flexibility, and inhibitory control. Cognitive shifting refers to the ability to switch between different approaches to a problem or task. Attentional flexibility refers to the ability to shift attention between different stimuli or tasks. Inhibitory control refers to the ability to inhibit prepotent or automatic responses in order to achieve a goal. Each item on the CFI is rated on a 5-

point Likert scale, with responses ranging from 1 (strongly disagree) to 5 (strongly agree). Item scores are summed to produce a total score for the questionnaire, with higher scores indicating greater cognitive flexibility. The CFI has been shown to have good reliability and validity in measuring cognitive flexibility. Internal consistency reliability, as measured by Cronbach's alpha, has been reported to be high, ranging from .81 to .86 across different samples. Test-retest reliability has also been found to be good, with correlations ranging from .77 to .86 over a two-week period. Additionally, the CFI has been found to correlate positively with other measures of cognitive flexibility, such as the Wisconsin Card Sorting Test, as well as with measures of creativity and intelligence (Dennis & Vander Wal, 2010).

2.3. *Intervention*

2.3.1. *Emotional self-regulation*

This protocol is based on the guidelines of Allen, McHugh, and Barlow (2009), developed at Boston University (Ashori & Najafi, 2020).

Table 1

The contents of therapy sessions

Session	Content
Session 1	Title: Introduction to Emotion Regulation Sessions and Pre-Assessment Introduction and Familiarization with Group Members Stating Group Rules and Objectives Introduction to the Course and the Necessity of Emotion Regulation Assignment: Group members should note down their objectives for participating in the sessions.
Session 2	Title: Expressing Normal Emotions and Problematic Emotions Emotional Awareness Session Instructions: Teaching and Introduction to Emotions Identifying and Labeling Emotions Distinguishing Between Different Emotions Identifying Emotions in Physical and Psychological States Factors Contributing to Emotional Regulation Success Assignment: Identify major emotions and feelings experienced in daily life.
Session 3	Title: Disease-Causing Emotions, the Necessity of Treatment, Emotional Disorder Symptoms, Appropriate Treatment, and the Causes of Emotional Disorders and Cognitive Errors Session Instructions: Cognitive Consequences of Emotional Reactions Physiological Consequences of Emotional Reactions Behavioral Consequences of Emotional Reactions and the Relationship between these Three Introducing Physical Symptoms, Behavioral Symptoms, and Cognitive Symptoms Introducing Psychological Treatment (Cognitive-Behavioral) Genetics and Environmental Influence on Individuals Introducing Emotion and Avoidance as Indicators of Emotional Disorders Assignment: Document significant negative emotions and complete the related form.

Session 4	Title: Interpretations Session Instructions: Understanding the Relationship between Emotions and Behavior, Emotions, and Thoughts Recognizing and Analyzing Automatic Thoughts, Interpretations, and Behaviors Flexibility in Interpretation and Considering a Range of Possibilities Reinterpreting and Modifying Interpretations Assignment: Complete a self-reflection questionnaire on how to change interpretations.
Session 5	Title: Behaviors Resulting from Emotions Session Instructions: Awareness of the Consequences of Emotional Avoidance Awareness and Experience of Emotion or Emotion Suppression Assignment: Complete a self-awareness questionnaire.
Session 6	Title: Assumptions, Core Beliefs, and Core Principles Session Instructions: Introduction to Beliefs Related to Rejection Introduction to Beliefs Related to Abandonment Identifying Core Beliefs Assignment: Identify several core beliefs.
Session 7	Title: Assumptions, Core Beliefs, and Core Principles Session Instructions: Introduction to Beliefs Related to Rejection Introduction to Beliefs Related to Abandonment Identifying Core Beliefs Assignment: Identify several core beliefs.
Session 8	Title: Changing Core Beliefs, Final Evaluation, and Conclusion of the Training Program Session Instructions: Challenging Problematic Core Beliefs and Replacing Them with New Beliefs Summarizing and Concluding the Topics Covered in the Sessions and Pre-Assessment Assignment: Summarize and complete the post-assessment questionnaire.

2.4. Data analysis

Multivariate covariance analysis tests and SPSS software were used for data analysis.

3. Findings and Results

The demographic characteristics were similar between two groups. The descriptive statistics findings are shown in the Table 2.

Table 2

Descriptive statistics findings (M: Mean, SD: Standard deviation)

Group	Variable	Index	Pre-test	Post-test	Follow-up
Exp.	Working memory	M	8.31	11.80	11.84
		SD	1.71	1.60	1.63
Control		M	8.44	8.62	8.55
		SD	1.89	1.99	1.90
Exp.	Cognitive Flexibility	M	51.32	57.44	57.62
		SD	4.39	4.11	4.99
Control		M	52.91	52.73	52.99
		SD	4.00	3.81	4.16

The results presented in Table 3 indicate that the univariate analysis of covariance (ANCOVA) in the post-

test (F=47.56, p=0.001) and follow-up (F=12.48, p=0.001) for the cognitive flexibility variable is statistically significant. To understand the nature of these differences, means adjusted for cognitive flexibility between the emotional self-regulation experimental group and the control group are compared in Table 4.

Table 3

The results of ANCOVA test for cognitive flexibility

Effect	Covariate	SS	d	MS	F	p	Effect size
Group	Pre-test scores	13.140	1	13.140	5.476	.001	0.50
	Post-test scores	12.301	1	12.301	4.128	.001	0.47

As observed in Table 4, in both the post-test and follow-up assessments, there is a statistically significant difference in cognitive flexibility between the experimental group and the control group (p<0.05). In other words, the experimental group exhibits significantly higher cognitive flexibility compared to the control group in both the post-test and follow-up assessments.

Table 4

The results of Bonferroni's post-hoc test for cognitive flexibility

Stage	Groups	Mean diff.	SD	p
Post-test	Control and Experimental	8.80	0.52	0.001
Follow-up	Control and Experimental	8.50	0.45	0.001

The results presented in Table 5 indicate that the univariate analysis of covariance (ANCOVA) in the post-test ($F=5.52, p=0.001$) and follow-up ($F=24.49, p=0.001$) for the working memory variable is statistically significant. To understand the nature of these differences, means adjusted for working memory between the emotional self-regulation experimental group and the control group were compared in Table 6.

Table 5

The results of ANCOVA test for working memory

Effect	Covariate	SS	df	MS	F	p	Effect size
Group	Pre-test scores	12.17	1	12.17	5.05	.001	0.46
	Post-test scores	12.12	1	12.12	4.24	.001	0.44
		8	8	2	0	0	
		5	5	9	0	0	

As observed in Table 6, in both the post-test and follow-up assessments, there is a statistically significant difference in working memory between the experimental group and the control group ($p<0.05$). In other words, the experimental group exhibits significantly higher working memory compared to the control group in both the post-test and follow-up assessments.

Table 6

The results of Bonferroni's post-hoc test for working memory

Stage	Groups	Mean diff.	SD	p
Post-test	Control and Experimental	2.55	0.32	0.001
Follow-up	Control and Experimental	2.40	0.26	0.001

4. Discussion and Conclusion

The aim of the present research is to investigate the effectiveness of emotional self-regulation skills training on cognitive flexibility and working memory. The results showed that in the post-test and follow-up, the experimental group exhibited greater cognitive flexibility compared to the control group. Therefore, training in emotional self-regulation skills has a significant impact on students'

cognitive flexibility. Additionally, the research results have sufficient empirical support, and in the post-test and follow-up, the experimental group demonstrated higher working memory compared to the control group. This indicates that emotional self-regulation intervention had a significant effect on increasing students' working memory.

The findings of this research are consistent with the results of previous studies (Ashori & Najafi, 2020; Faraj Zadeh et al., 2020; Homer et al., 2018; Sosa & Lagana, 2019; Zarenezhad, Soltanikouhbanani, & Karshki, 2019; Zhou, Liu, & Deng, 2020). In interpreting the results, it can be stated that emotional structures help us predict, explain, respond to, and control our lives. Emotions are not stored in our memory; rather, they are revived through the evaluation of situations that trigger specific emotional frameworks, leading to specific behaviors. In this way, they influence the improvement of students' cognitive flexibility. Emotional self-regulation skills, such as recognizing and labeling emotions, accepting negative emotions when necessary, and facing them instead of avoiding, contribute to improving psychological flexibility (Ashori & Najafi, 2020).

The use of emotional self-regulation skills helps students accurately identify their emotions and examine each emotion without being overwhelmed by it, with the goal of regulating emotions without reactive and destructive behaviors. The ability to be aware of emotions, identify and label them, accept negative emotions when necessary, and confront them helps improve students' psychological flexibility and reduces ineffective coping strategies such as catastrophizing, rumination, self-blame, and blaming others. Furthermore, in this research, a strong emphasis was placed on raising awareness and identifying both positive and negative emotions, which helped students have a clearer perception of their emotions and cognitive and psychological processes. This, in turn, enabled them to manage and reduce emotional behaviors, such as negative emotions related to their academic performance, and focus more on their learning process, contributing to the improvement of students' working memory.

Moreover, emotional self-regulation training instills the belief in individuals that they can manage their emotional and psychological self-regulation and self-efficacy. This is particularly important as academic underachievement and decreased academic motivation can lead students to have low expectations of their ability to regulate their academic emotions. In this process, students may lose problem-solving skills and psychological and emotional flexibility.

Therefore, emotional self-regulation training helps students perceive their high ability to improve their working memory.

5. Suggestions and Limitations

One of the limitations of this research is that the sampling was only conducted among ninth-grade students in the first cycle of secondary education in the city of Jajarm. This limitation may restrict the generalizability of the research findings. Therefore, it is recommended that, based on the above results, this method can be applied to diverse student and student populations.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Ethics principles

In this research, ethical principles including obtaining informed consent, ensuring privacy, and confidentiality were observed.

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