The Effect of Mindfulness Training on Cognitive Flexibility in Sixth-grade Female Students

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Sakineh Heidari[1], Gholamhossein Maktabi[2*], Manijeh Shehni Yailagh[3], Nasser Behroozi[4]

Abstract: The study was conducted to determine the effect of mindfulness training on cognitive flexibility in sixth-grade female students. This research used a pretest-posttest study with control group. A multi-stage random sampling was used in 4 schools, among which 37 sixth-grade female students were randomly selected and assigned to two experimental (17 students) and control groups (20 students). Students in the experimental group participated in a mindfulness training course for 12 (120-minute) sessions for a month and a half. The study used Dennis and Vander Wal's Cognitive Flexibility Inventory (2010). The results of covariance analysis showed that there was a significant difference between the two groups in the scores of cognitive flexibility and due to the higher mean scores of the cognitive flexibility of the experimental group in the posttest ($p > 0.05$, $p = 10.25$), it can be stated that mindfulness training was effective in increasing students' cognitive flexibility.
Keywords: mindfulness training, cognitive flexibility, students

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Introduction

Each country's ministry of education plays a significant role in the individual and social behavior of the people in society. In fact, the educational activities of any country can be considered as the investment of a generation for other generations, the goal of which is human development. In other words, the purpose of educational activities is the growth of human awareness and potential (Arjomand Siahpoosh, Moghaddas Jafari, & Farboghlani, 2011). One of the important goals of education is to address the recognition of the students' personalities and help them to make academic progress in various subjects. Accordingly, in the research conducted in educational psychology, cognitive variables related to academic achievement have been widely studied (Deary, Strand, Smith, & Fernandes, 2007). Students' cognitive abilities, which are primarily a by-product of education, are practiced over time both in and out of the classroom and grow naturally (Moser-Mercer, 2010). In recent years, interest in the psychological effects of mindfulness training has increased significantly, and new evidence suggests that mindfulness has positive effects on cognitive (Chiesa & Malinowski, 2011) and emotional processes (Goldin & Gross, 2010). Mindfulness is a type of treatment that is increasingly being used. This treatment is a particular type of short-term and immediate treatment that motivates people who

1. Ph.D. student in Psychology, Faculty of Education and Psychology, Shahid Chamran University of Ahvaz, Ahvaz, Iran
2. Associate Professor, Department of Psychology, Faculty of Education and Psychology, Shahid Chamran University of Ahvaz, Ahvaz, Iran, *Corresponding author email: ghmaktabi@scu.ac.ir
3. Professor, Department of Psychology, Faculty of Education and Psychology, Shahid Chamran University of Ahvaz, Ahvaz, Iran
4. Associate Professor, Department of Psychology, Faculty of Education and Psychology, Shahid Chamran University of Ahvaz, Ahvaz, Iran

have recently entered the training process or those who are in being trained (Crane, 2017). The goal of mindfulness-based cognitive therapy is to make people aware of their thoughts, feelings, and physical sensations and to communicate with them differently. Through mindfulness and sitting-meditation exercises that focus on breathing as well as training cognitive skills, they are allowed to identify their dysfunctional cognitive processes, such as depression-related rumination, detachment from negative-thought content, and abandonment of these processes to re-focus on the ongoing experiences they have at that moment (Piet & Hougaard, 2011). Individuals who show higher levels of mindfulness show less negative automatic thoughts and believe that they can free themselves from such thoughts (Frewen, Evans, Maraj, Dozois, & Partridge, 2008).

In general, encountering an object or event, the individuals compare newly experienced information that is similar to previous knowledge. These representations or memory structures are called schema, and the process of searching for the schema that mostly resembles input data is called schema processing or automated processing. The ability to reduce and deactivate automatic cognitive processes depends on the individual's ability, which is called cognitive flexibility (Moore & Malinowski, 2009). According to Hayes, Strosahl, and Wilson (2011), three main processes in mindfulness can increase cognitive flexibility, namely acceptance of situation, communication with the present moment, and committed action. Unjudicial acceptance takes into account the non-judgmental aspect of the present moment. Contact with the present moment emphasizes the importance of observing and considering the complete diversity of external and internal stimuli, and committed action is essentially acting without carelessness and conventionality and based on individual values and consciousness. In their study, Moore and Malinowski (2009) examined the role of these three components (acceptance of situation, communication with the present moment, and committed action) in deterring irrelevant information and non-automating automated responses, and indicated the correlation among these three components and non-automatic cognitive processing and cognitive flexibility. Cognitive flexibility enables one to deal appropriately with pressures, challenges, and other emotional and social issues. The ability to change cognitive sets to adapt to changing environmental stimuli is a key element in defining cognitive flexibility. Some researchers define cognitive flexibility as an individual's evaluation scope on the controllability of the definition conditions, which changes in different situations (Zong et al., 2010).

Additionally, flexibility is the process whereby an individual's ability to cope with emotional, social, and physical challenges increases. Compensating for harm gives a person more power to deal with life's adversities. Cognitive flexibility is an individual's ability to adjust their cognitive process to deal with new and unpredictable situations. When a person does not have cognitive flexibility, he/she is inactive in dealing with environmental conditions and usually makes mistakes and procrastinates. Cognitive flexibility, then, can lead to fundamental changes in thinking (Cañas, Quesada, Antolí, & Fajardo, 2003).

In a study titled "The Effectiveness of Mindfulness Exercises on the Executive Functions of Elementary Students", 32 girls practiced mindfulness. Finally, the results showed that the experimental group had a significant increase in memory, cognitive flexibility, change of mental preparation, and attention compared to the control group (Abdi, Chalabianloo, & Jabari, 2016). In a study, Kurmi, Bhagyalakshmi, Kini, and Pai (2015) examined the effect of mindfulness meditation practice on attention and executive functions in the elderly. The results showed that mindfulness exercises affect the attentional abilities and executive functions in the said people. Pour Mohammadi and Bagheri (2015) in a study on female students in the fifth grade of primary schools in Tehran showed that there is a significant difference between the experimental and control

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groups in all three components of the number of correct inconsistent responses, inconsistent response time and interference. Thus, the results indicated the effect of mindfulness training on reducing automatic cognitive processing and the fact that automatic cognitive processing is the opposite of cognitive flexibility. In addition, Li, Liu, Zhang, Liu, and Wei (2018) investigated the effect of mindfulness training on preventive and reactive cognitive control. Their research showed that eight sessions of mindfulness training improved people's scores on preventive and reactive cognitive control. In their study, Hartkamp and Thornton (2017) also examined meditation, cognitive flexibility, and psychological well-being. The repetition of the results did not indicate a significant change in the cognitive function of the experimental group compared to the control group in the posttest stage. In a study, Murphy-Beiner and Soar (2020) also treated young people to reduce their depression and anxiety through mindfulness training with a focus on increasing cognitive flexibility. In another study aimed at teaching meditation and physical activity to increase cognitive flexibility and problem-solving ability among primary school children, the researcher combined these two methods for 8 sessions to increase these abilities in children (Yadav, 2019). Hence, due to the significance of cognitive flexibility in individuals' abilities, particularly children and adolescents in feedback and appropriate response to environmental changes and new environments with different elements, it is necessary to strengthen this feature in order to react to different situations in adulthood with flexible cognitive function. In order to achieve the desired goal, the question arises whether mindfulness training is effective on the cognitive flexibility of sixth-grade female students?

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Material and Method

This research conducted a quasi-experimental study and used pre-test-post-test-follow-up with the control group. The experimental group intervention was done in 12 sessions according to the instructions for the integrated educational package for general mindfulness and awareness training for children (Coholic, 2010) and the executive program for mindfulness training in primary schools in the United States (Galla, Kaiser-Greenland, & Black, 2016) and according to the protocol of cognitive therapy based on Baer's assessing mindfulness in children (Baer, 2010). During the said period, the control group did not receive any training. Finally, post-test was performed on both groups. The statistical population of this study included all sixth-grade female students in primary schools in Masjed Soleyman, Khuzestan Province, Iran in the academic year 2018-19. A multi-stage random sampling was used and 40 students were selected as samples. The 40 students were randomly assigned to two experimental (20 students) and control groups (20 students). After the start of the training course, 2 people were removed from the experimental group due to the absence of more than two sessions and one person due to the parents' discontent. Thus, the experimental and the control group included 17 and 20 students respectively. In the research, ethical considerations were observed with informed consent and timely referral, so that before training and conducting research objectives, sample selection criteria, the right to terminate the cooperation, data collection methods, and emphasis on disclosure were all explained. The study tools included Dennis and Vander Wal (2010) Cognitive Flexibility Inventory and the mindfulness training course, the specifications of which are provided below.

Cognitive Flexibility Inventory (CFI): The Cognitive Flexibility Inventory was designed by Dennis and Vander Wal (2010). This scale is a 20-question short self-report tool used to measure the type of cognitive flexibility required for an individual's success in challenges and replaces dysfunctional thoughts with effi-

cient ones. The scoring method is based on a 7-point Likert scale from 1 (I strongly disagree) to 7 (I strongly agree) and measures 3 aspects of cognitive flexibility: A. The perception of alternative solutions, b. the perception of controlling difficult situations, and c. the perception of alternative justifications. Dennis and Vander Wal (2010) showed in a study that this inventory has an appropriate factorial structure, convergent validity, and simultaneous validity. In the present study, the reliability coefficients for the whole scale were obtained by Cronbach's alpha as 0.56 and the Spearman-Brown bisection was 0.61, which were in a good range. Moreover, the reliability coefficients of the subscales using Cronbach's alpha for the perception of different options, the controllability perception, and perception of justification of behavior were 0.60, 0.54, and 0.49 respectively, and were 0.46, 0.62 and 0.75 using the Spearman-Brown bisection.

Mindfulness Training Course

The course is a combination of general mindfulness training for children and the executive program for mindfulness training in primary schools in the United States and based on Baer's mindfulness-based cognitive therapy in children. This program is used in each session in a practical and participatory way for children to perform mindfulness exercises. A description of the training sessions is as follows:

Table 1. Description of mindfulness training sessions

First	A brief introduction to mindfulness training, review of the performance of the autopilot and its differences with mindfulness training, mindfulness breathing training in two ways: teddy bear and breathing with the pinwheel, and cloud-and-wind game.
Second	Mindfulness breathing with the pinwheel, focusing on the sense of taste, practicing mindful eating, pointing out the difference between describing and judging and playing the seed-and-butterfly game.
Third	Playing with the teddy bear, teaching the three concepts of emotions, physical senses, and thoughts.
Fourth	3-minute breathing training, water glass practice, invisible ball game, and bubble meditation training.
Fifth	Playing with the teddy bear, focus on the sense of hearing, mindfulness-listening training (acceptor voice), and cat-and-cow game (mirroring).
Sixth	Teaching mindful breathing with flowers and candles, focusing on the sense of hearing, mindfulness-listening training, physical scanning training, and jumping game.
Seventh	Mindful breathing (3-minute breathing), focus on the sense of sight, mindful seeing training, the first part (painting), the practice of distinguishing judgment from a description by examining an object from different angles, and curious-mind game.
Eighth	Conscious breathing with a teddy bear, focusing on the sense of sight, mindful seeing training, the second part (painting), examining perceptual errors, romantic kindness meditating, and memory game.
Ninth	Mindful breathing (3-minute breathing), focusing on the sense of touch, mindful touching training, the practice of distinguishing judgment from a description by examining a few objects with different roughness and softness, and the sun and ice cream game.
Tenth	Mindful breathing (3-minute breathing), focus on the sense of smell, mindful smelling training, bubble meditation practice, and two exercises of the mountain and the baby.
Eleventh	Mindful breathing (3-minute breathing), awareness of the moving body, taking steps mindfully, and pendulum movement exercise.
Twelfth	Mindful breathing (3-minute breathing), a review of all mindful-training exercises, and a review of the use of mindfulness in everyday life.

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Data Analysis: In this research, inferential statistics were used to analyze the data and evaluate the effect of mindfulness training course, which included Kolmogorov–Smirnov test to check the normal distribution of data, Levene's test to check the homogeneity of variances, Regression Slope Test and analysis of covariance to test the research question.

Results

In order to investigate the normal distribution of data, the Kolmogorov–Smirnov test was used, whose results are reported in Table 2. As Table 2 shows, the assumption of normality in the cognitive flexibility variable was confirmed in two groups with a significant level of ($p > 0.05$).

Table 2. The Kolmogorov–Smirnov test to test the assumption of normality in cognitive flexibility

Stage	Mean	Standard deviation	Z Kolmogorov-Smirnov	P
Pre-test	76.21	9.77	0.48	0.53
Post-test	84.62	10.23	0.53	0.93

Levene's test was used to check the homogeneity of the variances, whose results are reported in Table 3. Table 3 shows the results of Levene's test to check the homogeneity assumption of error variances. Based on the results, the assumption of homogeneity of variances in the variable of cognitive flexibility with a significant level greater than 0.05 is confirmed.

Table 3. Levene's F test to investigate the uniformity assumption of error variances in the cognitive flexibility variable in the two groups studied

Variables	Statistical indicators			
	Degree of freedom 1	Degree of freedom 2	F	Significance level
Cognitive flexibility	1	35	0.38	0.54

A regression slope test was used to investigate group variance error, the results of which are presented in Table 4. As shown in Table 4, the variance test on regression slope in cognitive flexibility variable variance test was confirmed with a significance level greater than 0.05.

Table 4. Variance test on regression slope in cognitive flexibility variable

Source of changes	Total of squares	Degree of freedom	F	Significance level
Pre-test	89.32	2	5.09	0.07

Based on the results of Table 5, the assumption of equivalence of variance-covariance matrices in the cognitive flexibility variable was confirmed with a significance level of 0.32.

Table 5. Box's M test results to check the assumption of equivalence of variance-covariance matrices

Box's M test	F	Degree of freedom 1	Degree of freedom 2	Significance level
7.73	1.16	6	8220.22	0.32

The results of the multivariate covariance test to compare the mean scores of the two subject groups in the components of cognitive flexibility are presented in Table 6.

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Table 6. Multivariate covariance test of the comparison of the mean scores of the two subject groups in the components of cognitive flexibility

Sources	Value	F	Assumption DF	Error DF	Sig	Effect size
Pillais Trace	0.71	25.10	3	30	0.001	0.71
Wilks Lambda	0.28	25.10	3	30	0.001	0.71
Hotelling's Trace	2.51	25.10	3	30	0.001	0.71
Roy's Largest Root	2.51	25.10	3	30	0.001	0.71

The results of multivariate analysis of covariance for comparison between the experimental and control groups in the components of cognitive flexibility show that there is a between the experimental and control groups with a significant level of less than 0.01. That is, the effect of mindfulness training intervention on the linear composition of 3 cognitive flexibility components was significant. In order to determine which of the 3 components there was a significant difference between the two study groups, the results of univariate covariance analysis are presented in the following tables.

Table 7. The results of univariate covariance analysis of the comparison of the two groups studied in the component of the increased tendency to understand the controllability of difficult situations

Source of changes	SS	DF	F	Sig.	Effect size	Test power
Pretest	241.37	1	36.77	0.001	0.53	1.00
Group	262.10	1	39.93	0.001	0.55	1.00
Error	210.03	32				
Total	42695.00	37				

According to the results of the table 7, ($F = 39.93$ $P < 0.01$), after adjusting the pre-test scores, the difference between the two experimental and control groups in the tendency to understand the controllability of difficult situations was significant at the alpha level of 0.01. The adjusted mean of the experimental group in this variable was 36.56 and the adjusted mean of the control group was 31.66. Therefore, it can be concluded that mindfulness training intervention was effective in increasing the tendency to understand the controllability of difficult situations of sixth-grade elementary school girls in Masjed Soleyman, Khuzestan Province, Iran. Given the value of the effect of the mindfulness intervention, 55% of variance predicted an increase in the controllability of difficult situations.

Table 8. Results of univariate covariance analysis of the comparison of the two groups studied in the component of the tendency to perceive several alternative explanations for life and behavioral events

Source of changes	SS	DF	F	Sig.	Effect size	Test power
Pretest	63.71	1	56.23	0.001	0.63	1.00
Group	15.53	1	13.71	0.001	0.30	0.94
Error	36.25	32				
Total	2940.00	37				

According to the results of Table 8, after adjusting the pre-test scores, the difference between the two experimental and control groups in the component of the tendency to perceive several alternative explanations for life and behavioral events was significant at the alpha level of 0.01. The adjusted mean of the experimental

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group in this variable was 9.41 and the adjusted mean of the control group was 8.09. Therefore, it can be concluded that mindfulness training intervention was effective in increasing the tendency to perceive several alternative explanations for life behavioral events of sixth-grade elementary school girls in Masjed Soleyman, Khuzestan Province, Iran. Given the value of the effect of the mindfulness training, 30% of variance predicted the tendency to perceive several alternative explanations for life and behavioral events.

Table 9. Results of univariate covariance analysis of the comparison of the two groups studied in the component of the ability to produce several alternative solutions in difficult situations.

Source of changes	SS	DF	F	Sig.	Effect size	Test power
Pretest	572.68	1	51.91	0.001	0.62	1.00
Group	518.61	1	47.01	0.001	0.59	1.00
Error	352.98	32				
Total	37742.00	37				

According to the results of the table 9, after adjusting the pre-test scores, the difference between the two experimental and control groups in the component of the ability to produce several alternative solutions in difficult situations was significant at the alpha level of 0.01. The adjusted mean of the experimental group in this variable was 46.37 and the adjusted mean of the control group was 38.78. Therefore, it can be concluded that mindfulness training intervention was effective in increasing the ability to produce several alternative solutions in difficult situations of sixth-grade elementary school girls in Masjed Soleyman, Khuzestan Province, Iran. Given the value of the effect of the mindfulness training intervention, 59% of variance predicted the ability to produce several alternative solutions in difficult situations.

Discussion

The study was conducted to determine the effect of mindfulness training on increasing cognitive flexibility. The results showed that there was a significant difference in post-test scores between the experimental and control groups in the scores related to cognitive flexibility, and considering the higher mean scores of the cognitive flexibility of the experimental group in the post-test, it can be stated that mindfulness training was effective in increasing students' cognitive flexibility. The results were in line with similar studies conducted Abdi et al. (2016), (Kurmi et al., 2015), Pour Mohammadi and Bagheri (2015), Li et al. (2018), Hartkamp and Thornton (2017), Murphy-Beiner and Soar (2020), and (Yadav, 2019).

Explaining the results, it can be asserted that cognitive flexibility is focused on the nature of learning in highly complex environments, and a person has the flexibility to be able to organize his/her previous knowledge promptly and easily in response to various environmental needs. Individuals can go beyond their framework of thoughts and subsequent behaviors and experience more options using minute stop-and-breath techniques and exit their previous thoughts and usual frameworks. By training mindfulness, with an emphasis on the present moment, and increasing problem-solving ability, individuals can assume difficult situations controllable by analyzing them into simpler elements, and control each part by changing cognitive sets to adapt to the changing situations. Dennis and Vander Wal (2010) state that individuals who perceive life situations as controllable are more likely to be motivated to solve problematic situations through cognitive strategies. These individuals use less cognitive methods such as wishful thinking and self-deprecating rumination, which are methods

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of cognitive avoidance. In addition, these individuals may not be constantly seeking social support when faced with problematic situations and may resolve such situations with sufficient self-confidence without seeking social support. Burton, Pakenham, and Brown (2010) showed that mindfulness training provides people with more opportunities to think and allows them to let go of unhealthy automatic thoughts, habits, and patterns of behavior. Mindfulness is the focus on a specific, intentional, moment-to-moment approach, independent of prejudice and judgment that can monitor non-automated cognitive processes. Therefore, it can be expected that if mindfulness training improves the individual's ability to invest attention in the present moment, as a result of practice, he/she can increase cognitive flexibility and re-control processes that become automatic (Pour Mohammadi & Bagheri, 2015). This approach reduces over-generalization in historical memory and self-critical evaluation and increases useful cognitive processes such as non-judgmental observation of mental content. In this approach, clients are encouraged to process experience without judgment as it is formed and to change and deal with challenging thoughts and feelings. Mindfulness training helps subjects change their relationship with painful thoughts and feelings, thereby reducing their impact on their lives and thus increasing their flexibility because based on what is deduced from theories, behaviors are selected based on conscious motivations. Therefore, individuals select the consequences that respond to their most conscious motivations according to the obstacles in a situation. Mindfulness is the awareness of consciousness and attention that is dedicated to examining the type and amount of knowledge a person has about him/herself. Although mindfulness involves self-attention, the goal is to provide insight into one's mental events that allow one to observe these events without regarding them as parts of him/herself. The ability to observe without judging external events adds to the flexibility of individuals.

Mindfulness, on the other hand, creates the ability in an individual to replace alternative thoughts with previous ones in situations that require flexibility and change and to adapt to the new environmental conditions and respond accordingly. This is the very cognitive flexibility. In fact, an individual with mindfulness uses the metacognitive method of mental processing and increases his/her flexibility in response to environmental changes and environments with problems. In so doing, one needs to use one's metacognitive abilities to have mindfulness in relationships with environmental changes to be able to have alternative thoughts and explanations accordingly. This is achieved in mindfulness training according to the exercises provided to individuals. In interpreting this finding, it should be noted that mindfulness exercises allow a person to distance him/herself from automatic mental processing and gradually increase his/her inner views and insights and have more perception toward unchangeable life events and look for new justifications and solutions for new situations. This is very important for students and their academic performance. Thus, if students need to make cognitive changes and use different new solutions in determining their learning goals, academic planning, and studying, they need to have cognitive flexibility, and this is done by mindful training and being in the present moment. Through mindful training, the individual positively reconstructs his/her intellectual framework and accepts complex and new situations. To do this, they focus on the task or situation and consider their goal step by step. At each stage, they apply their reconstructed thinking. Each research project has a series of limitations, thus this research was limited, as it was done on girls' elementary schools in Masjed Soleyman, Khuzestan Province, Iran. Consequently, the results cannot be generalized to male students, other levels, and other cities in Khuzestan province and nationwide. Since the subjects of this study were sixth-grade female students in primary schools in Masjed Soleyman, Khuzestan Province, Iran, it is

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suggested that a similar study should be conducted on male students so that by comparing the results, further information can be achieved on the effectiveness of mindfulness training on cognitive flexibility in both sexes. Additionally, parental involvement and awareness of the skills taught in the mindfulness training course can increase the effectiveness and sustainability of such skills. Thus, it is suggested that parents also participate in the educational program in forthcoming research. According to researchers and theorists, this study could motivate teachers and school principals to teach mindfulness as students' extracurricular programs to achieve the positive effects of such training on improving academic performance.

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