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Effectiveness of Critical Thinking Education on Divergent Thinking and Academic Enthusiasm of High School Students

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A B S T R A C T

Purpose: Enhancing divergent thinking and academic enthusiasm in students can positively affect their academic and non-academic performances. Consequently, the present study aimed to determine the effectiveness of critical thinking education on divergent thinking and the academic enthusiasm of high school students.

Methodology: This quasi-experimental study followed a pre-test, post-test, and follow-up design with experimental and control groups. The research population comprised all female students in the 10th and 11th grades of the academic branch in Saveh city for the 2022-23 academic year, with a sample size calculated as 25 for each group based on G*Power software. Thus, 50 individuals were purposively selected and randomly assigned to experimental and control groups. The experimental group underwent 10 sessions of 75-minute critical thinking training, while the control group received no intervention during this period. The research instruments included the divergent thinking subscale in Kolb's (1984) Learning Style Inventory and Schaufeli et al.'s (2002) Academic Enthusiasm Questionnaire. Data were analyzed using repeated measures ANOVA and Bonferroni post-hoc tests in SPSS software.

Findings: The results showed significant differences between the experimental and control groups in post-test and follow-up stages in terms of divergent thinking and academic enthusiasm. In other words, critical thinking education led to an increase in divergent thinking and academic enthusiasm among high school students, and the results were sustained at the follow-up stage ($P<0.05$).

Conclusion: According to the results of this study, counselors and psychologists can use critical thinking education alongside other effective educational methods to improve academic and non-academic characteristics of students.

Keywords: *Critical thinking education, Divergent thinking, Academic enthusiasm, Students.*

1. Introduction

Students are the fundamental pillar of the education system for achieving educational objectives, and attention to their educational and pedagogical development plays a significant role in improving the society's status compared to other communities (Hämäläinen et al., 2023). In recent decades, the focus on factors affecting learners' academic performance towards achieving educational goals has been of interest to education system officials and education experts (Zhang & Liu, 2019). One of the problems in various educational systems is the low level of motivation and the increase in academic burnout or the decrease in students' academic enthusiasm within these systems (Anton et al., 2020). One of the very important factors in students' success and progress is their academic enthusiasm (Nicholas et al., 2022).

Academic enthusiasm is one of the most important indicators of academic progress in students, describing investment and engaged behavior in students' learning processes (Sabbaghi et al., 2020). Academic enthusiasm is a construct related to learning and academic progress that refers to the quality of effort that a learner spends on purposeful educational activities to achieve desirable academic outcomes (Lee, 2021). Academic enthusiasm means the amount of time and energy that learners deliberately and planned spend on educational activities and learning (Fang & Ding, 2020). This educational construct, as a motivational construct with dimensions of absorption (focus and immersion in education and learning), vigor (high levels of energy and mental resilience for education and learning), and dedication (intense psychological involvement of the individual in tasks and duties related to education and learning), reflects the learner's commitment to education and learning (Neumann et al., 2023). The construct of academic enthusiasm represents the physical and psychological involvement of the learner in education and learning, showing itself as attachment to the learning environment, participation and attention in class, effort and investment towards learning, and interaction between teaching and learning (Topu & Goktas, 2019). Academic enthusiasm has cognitive (application of cognitive and metacognitive learning strategies for learning), motivational (having positive educational emotions and desire for learning), and behavioral (active presence in the educational environment for learning) components (Yang et al., 2022). Additionally, cognitive enthusiasm refers to flexibility in problem-solving, preference for challenging academic activity, positive coping with academic failures, and use of self-regulated learning approaches. Motivational enthusiasm is related to effective attitudes towards feeling a sense of belonging to the place of study. Behavioral enthusiasm refers to learning activities, accuracy and attention, positive interactions, and presence at the place of study (Lyu & Wehby, 2023). Individuals with high academic enthusiasm compared to those with low academic enthusiasm spend more time on education and learning, have more attention and concentration on learning educational issues, are more committed to the rules of the educational system, use more self-regulation in studies, and overcome educational problems and challenges alone or with the help of others (Daddis & Meadows, 2021).

Another very important factor in students' success and progress is their divergent thinking (Zhang et al., 2020). Thinking and thought is one of the superior characteristics of humans that distinguishes them from other creatures and includes two types of thinking: convergent and divergent (Fink et al., 2018). Divergent thinking is one of the aspects of creativity and an important characteristic of creativity that is very important for offering a variety of solutions for generating creative ideas (Wronska et al., 2019). Divergent thinking examines various solutions that involve inventing new solutions and is characterized by features such as high motivation for progress, abundant curiosity, a great interest in order and organization, strong assertiveness, self-sufficiency, norm-breaking personality, much effort and perseverance, independence, and having critical and intuitive thinking (Chang et al., 2017). Unlike divergent thinking, convergent thinking is a type of conservative thinking based on specific rules and laws that can mix new thoughts into old ones but cannot generate new ideas by itself. Divergent thinking enables individuals to look beyond their closed circle of experiences and generate new ideas (Zabelina & Ganis, 2018). Convergent thinking emphasizes old and familiar responses based on reasoning, while divergent thinking attempts to combine existing information in the brain to present new and creative responses (Adnan et al., 2019). Therefore, divergent thinking thinks about challenges and the connections between challenges, helping people to see the world and its challenges better and more creatively (Forthmann et al., 2017). Individuals with divergent thinking try not to easily accept things and phenomena as they see them and look at them with a different perspective, away from mental molds (Hutten et al., 2019).

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One of the potentially effective methods in improving divergent thinking and academic enthusiasm is critical thinking education. Critical thinking means logical, insightful, and thoughtful thinking about decision-making for doing or not doing and believing or not believing in a phenomenon or event (Seki et al., 2023). Critical thinking is considered a basic cognitive process for transformation and benefiting from knowledge and plays an effective role in decision-making and problem-solving (Tiruneh et al., 2014). Critical thinking skill is a style of thinking about any subject or content in which the thinker enhances the quality of thinking by analyzing, evaluating, and reconstructing it. This skill is a cognitive, self-regulated, and purposeful process that results from interpretation, analysis, evaluation, and inference, helping the individual to state reasons for the correctness and incorrectness of various issues (Niu et al., 2013). Critical thinking education is criterion-based and self-correcting education leading to judgments and decisions that individuals can apply in environments outside the learned environment (Puig et al., 2019). This educational method has six components: identifying and validating sources and observations, inference and deductive judgment, defining and recognizing assumptions, testing the plan and predicting possible outcomes, reasoning and judging on inductive results, and semantics, which as a complex and challenging process, teaching and promoting it requires practice and application of skills in new situations (Simonovic et al., 2023). Critical thinking education includes deliberately creating a state of disequilibrium so that individuals can exchange, correct, and reconstruct their thought processes (Ugwuozor et al., 2021).

Few studies have been conducted on the effectiveness of critical thinking education, and no research was found in this area on divergent thinking and academic enthusiasm of high school students, but studies have been conducted in this area, which are briefly described below. For example, the results of the study by Zhang et al. (2023) showed that the effect of critical thinking inclinations caused an increase in creative cognitive processing and its components (Zhang et al., 2023). Golmohammad Nazhad Bahrami and Asgharzadeh (2020), in a study, concluded that critical thinking education led to an increase in academic self-efficacy and improvement in Kolb's learning styles, namely increasing reflective observation, abstract conceptualization, and active experimentation, and decreasing concrete experience (Golmohammad Nazhad Bahrami & Asghar Zadeh, 2020). In another study, Marashi and Akbar-Hosseini (2019) reported that teaching critical thinking techniques led to an increase in convergent and divergent thinking in English language learners (Marashi & Akbar-Hosseini, 2019). Hashemi et al. (2014), in a study, concluded that teaching the critical thinking model led to improvement in critical and creative thinking and life skills (problem-solving, analytical, truth-seeking and curiosity, decision-making, and effective communication) of male high school students (Hāshemi et al., 2014). Also, the results of the study by Ulubey and Alpaslan (2022) showed that critical thinking had a positive and significant correlation with enthusiasm for school and academic progress (Ulubey & Alpaslan, 2022). In another study, Sahebi, Hosseini Nasab, and Aqdasi (2022) reported that strategic thinking education led to an increase in academic vitality of elementary students (Sahebi et al., 2022). Mirchooli and Naemi (2020), in a study, concluded that there was a positive and significant relationship between critical thinking and academic enthusiasm in students (Mirchooli, 2020).

Regarding the importance and necessity of the present study, it can be said that the role of academic enthusiasm during the study period and its impact on academic outcomes is an important issue and of interest to many experts in educational systems and counselors and psychologists of the education system. Also, two reasons for the necessity of critical thinking education are that thinking is an innate part of human development and humans enjoy appropriate rational stimulation and challenge. Critical thinking indicates the ability for purposeful and self-regulated judgment, which is a necessary and essential skill for living in a changing and evolving world. Another important point is that the results of this study can help experts and policymakers of the education system to gain a deeper understanding of the efficiency and effectiveness of critical thinking education in terms of its effectiveness on divergent thinking and academic enthusiasm and, if such an effect exists, to design programs for critical thinking education. Therefore, improving divergent thinking and academic enthusiasm in students can positively affect their academic and non-academic performances. Consequently, the present study was conducted with the aim of determining the effectiveness of critical thinking education on divergent thinking and the academic enthusiasm of high school students.

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2. Methods and Materials

2.1. Study Design and Participants

This semi-experimental study was conducted with a pre-test, post-test, and follow-up design, alongside experimental and control groups. The research population included all female students in the 10th and 11th grades of the theoretical branch in Saveh city for the 2022-23 academic year, with a sample size calculated as 25 for each group using G*Power software. Inclusion criteria for this study were being in the age range of 16 to 18 years, consent to participate in the research, scoring low on divergent thinking and academic enthusiasm questionnaires, no history of receiving critical thinking training, and not concurrently participating in other educational courses. Exclusion criteria included missing more than two sessions and withdrawing from the study.

The research procedure began with necessary coordination with the education department officials of Saveh city, and the divergent thinking and academic enthusiasm questionnaires were administered among students of several schools. From these, 50 students who scored lower on the questionnaires and met the inclusion criteria were selected as the sample. The importance and necessity of the research and ethical considerations were explained to the samples, and they were asked to sign the informed consent form and obtain their parents' signature. The samples were randomly assigned to two equal groups by drawing lots, with one group designated as the experimental group and the other as the control group.

2.2. Measures

The research instruments included the divergent thinking subscale in the Learning Styles Questionnaire designed by Kolb (1984) and the Academic Enthusiasm Questionnaire. The Learning Styles Questionnaire has 12 items, each with four options corresponding to concrete experience, reflective observation, abstract conceptualization, and active experimentation, from which the score for each of the four learning styles is derived. In this instrument, the divergent thinking style is derived from the sum of concrete experience and reflective observation scores, the convergent thinking style from the sum of abstract conceptualization and active experimentation, the accommodating thinking style from the sum of concrete experience and active experimentation, and the assimilating thinking style from the sum of reflective observation and abstract conceptualization. In this study, only the divergent thinking style was used. The score for the Academic Enthusiasm Questionnaire is calculated by summing the item scores, with the lowest score being 17 and the highest being 85, with higher scores indicating greater academic enthusiasm. Kolb (1984) examined the construct validity of the instrument using exploratory factor analysis, with results indicating the presence of four factors, and reported the reliability of the instrument for these factors using Cronbach's alpha as 0.51, 0.53, 0.49, and 0.47, respectively (Kolb, 2014). In Iran, Hashemi, Vahedi, and Tabatabaei (2017) calculated the reliability of these factors using Cronbach's alpha as 0.68, 0.68, 0.77, and 0.76, respectively (Hashemi et al., 2017).

The Academic Enthusiasm Questionnaire was designed by Schaufeli et al. (2002). It consists of 17 items, each rated on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). Schaufeli et al. (2002) examined the construct validity of the instrument using exploratory factor analysis, with results indicating the presence of three factors: vigor, dedication, and absorption, and reported the instrument's reliability using Cronbach's alpha as 0.73 (Schaufeli et al., 2002). In Iran, Ghasemzadeh Alishahi, Panahi, and Samadi (2021) calculated the overall reliability of the Academic Enthusiasm Questionnaire in the pre-test and post-test stages using Cronbach's alpha as 0.77 and 0.78, respectively (Ghasemzadeh Alishahi et al., 2021).

2.3. Intervention

The experimental group underwent 10 sessions of 75-minute critical thinking training, and the control group received no intervention during this time. Critical thinking training used the package by Kamali Zarch et al. (2013) based on the perspectives of Paul (1984), Myers (1986), and Fisher (2005) (Kamali Zarch et al., 2013), the objectives and content of which were briefly reported in Table 1.

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Table 1

Objective and Content of Critical Thinking Education

Session	Objective	Content
1	Introduction and Overview	Introduction to the educational program of critical thinking and its explanation
2 & 3	Analytical Skill	Analysis of discussions and experiences, breaking down tasks and questions into smaller pieces, distinguishing facts from hypotheses, analyzing the relationships between statements in a text, breaking down a concept or general phenomenon into parts, observing similarities and differences, and teaching note-taking and summarizing
4	Interpretation Skill	Explanation of the concept of interpretation, interpreting experiences, and reconstructing perspectives
5	Evaluation Skill	Explaining the role of evaluation in growth and thinking, concept of evaluation and its stages, identifying criteria and standards in evaluation and judgment, recognizing strengths and weaknesses of logical judgment principles
6 & 7	Inference and Understanding Skill	Converting symbolic signs into verbal signs, creating a logical relationship between new concepts and previous experiences, abstractly and technically expressing the understood content, and making inferences from spoken and heard content
8	Explanation Skill	Conceptualizing an idea as a whole, outlining an appropriate introduction for the topic, and principles of oratory
9	Self-Regulation Skill	Understanding and recognizing one's mental abilities, the role of attitude in self-confidence, collecting information through note-taking and summarizing, asking questions and self-evaluation
10	Conclusion	Review of the previous sessions' content and expressing gratitude to the participants

2.4. Data Analysis

In this study, data were analyzed using repeated measures ANOVA and Bonferroni post-hoc tests in SPSS software.

3. Findings and Results

The analyses of the current study were conducted for both groups with an equal sample size (each group having 25 participants) due to no dropouts in either the experimental or control groups. The results of the means and standard deviations of divergent thinking and academic enthusiasm of high school students are reported in Table 2.

Table 2

Results of Mean and Standard Deviation for Divergent Thinking and Academic Enthusiasm of High School Students at Evaluation Stages

Variable	Group	Pre-test		Post-test		Follow-up	
		Mean	SD	Mean	SD	Mean	SD
Divergent Thinking	Experiment	18.60	1.59	23.40	3.31	22.80	3.16
	Control	15.60	1.79	18.00	1.73	17.80	1.89
Academic Enthusiasm	Experiment	36.90	4.25	41.06	4.84	41.10	4.83
	Control	37.30	5.13	37.60	4.82	37.40	4.71

According to the results of Table 2, the means of divergent thinking and academic enthusiasm of the high school students in the experimental group increased more than those in the control group in the post-test and follow-up stages.

Examination of the assumptions for repeated measures ANOVA showed that the assumption of normality for the variables of divergent thinking and academic enthusiasm based on the Shapiro-Wilk test in the pre-test, post-test, and follow-up stages, the assumption of homogeneity of error variances based on Levene's test, and the assumption of homogeneity of covariance matrices based on Box's M test were not violated ($P>0.05$), but the sphericity assumption for the variables of divergent thinking and academic enthusiasm was violated ($P<0.05$). Therefore, the Greenhouse-Geisser correction had to be used in the repeated measures ANOVA. The results of the repeated measures ANOVA to determine the effectiveness of critical thinking education on divergent thinking and academic enthusiasm of high school students are reported in Table 3.

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Table 3

Results of Repeated Measures ANOVA for Determining the Effectiveness of Critical Thinking Education on Divergent Thinking and Academic Enthusiasm of High School Students

Variable	Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F Statistic	Significance	Effect Size
Divergent Thinking	Time	889.90	1.26	706.26	89.62	0.001	0.68
	Time*Group	884.46	1.26	701.95	89.08	0.001	0.68
	Group	347.90	1	347.90	21.40	0.001	0.50
Academic Enthusiasm	Time	477.30	1.06	448.80	288.70	0.001	0.87
	Time*Group	136.44	1.06	128.72	83.05	0.001	0.79
	Group	186.70	1	186.70	3.01	0.040	0.12

According to the results of Table 3, there were significant differences between the experimental and control groups in terms of divergent thinking and academic enthusiasm regarding group, time, and the interaction of time and group ($P<0.05$). The results of the Bonferroni post-hoc test for comparing the effectiveness of critical thinking education on divergent thinking and academic enthusiasm of high school students in the pre-test, post-test, and follow-up stages are reported in Table 4.

Table 4

Results of Bonferroni Post-Hoc Test for Comparing the Effectiveness of Critical Thinking Education on Divergent Thinking and Academic Enthusiasm of High School Students at Evaluation Stages

Variable	Evaluation Stages	Mean Difference	Standard Error	Significance
Divergent Thinking	Pre-test vs Post-test	-5.53	0.54	0.001
	Pre-test vs Follow-up	-5.35	0.56	0.001
	Post-test vs Follow-up	-0.17	0.23	1.000
Academic Enthusiasm	Pre-test vs Post-test	-9.62	0.01	0.001
	Pre-test vs Follow-up	-8.77	0.01	0.001
	Post-test vs Follow-up	-0.84	0.01	1.000

According to the results of the Table 4, there was a significant difference between the pre-test scores of divergent thinking and academic enthusiasm and their post-test and follow-up scores ($P<0.05$), but there was no significant difference between the post-test and follow-up scores of these variables ($P>0.05$). In other words, the results indicate the effectiveness and sustainability of the effectiveness of critical thinking education on divergent thinking and academic enthusiasm of high school students.

4. Discussion and Conclusion

Enhancing and promoting divergent thinking and academic enthusiasm among students plays a significant role in various academic and non-academic variables. Accordingly, the present research aimed to determine the effectiveness of critical thinking education on divergent thinking and the academic enthusiasm of high school students.

The findings of the current study indicated that critical thinking education led to an increase in divergent thinking among high school students, and these results were sustained at the follow-up stage. These findings are consistent with the previous research (Ghasemzadeh Alishahi et al., 2021; Hāshemi et al., 2014; Marashi & Akbar-Hosseini, 2019; Zhang et al., 2023). In interpreting and explaining the effectiveness of critical thinking education in improving divergent thinking at post-test and follow-up stages, it can be inferred that divergent thinking style is created from the combination of concrete experience and reflective observation, and individuals with this type of thinking perceive objective situations from different perspectives. Their approach to situations is to observe rather than to act, and they prefer situations that require the expression of diverse thoughts and show interest in diverse cultural attractions and information gathering. As these individuals are capable of generating various thoughts and viewing matters from different angles, they generally possess imaginative power and emotion and show interest in people.

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Another important point is that critical thinking should be taught within the context of specific subjects and topics, and in this case, critical thinking can be transferred to other areas. In critical thinking education, using real-life issues is important for two reasons: real-life problems stimulate learners and involve ambiguous, messy, and complex issues that require critical thinking for resolution. One of the factors that make critical thinking education effective is choosing challenging and engaging content. Moreover, critical thinking education develops best in an environment rich with discussion and intellectual exchange, and for students to achieve critical thinking, they must actively practice this approach. Consequently, critical thinking education can lead to improvements in students' thinking, including divergent thinking, among high school students.

Another finding of this study showed that critical thinking education led to an increase in academic enthusiasm among high school students, and these results remained at the follow-up stage. These findings align with the previous studies (Mirchooli, 2020; Sahebi et al., 2022; Ulubey & Alpaslan, 2022). In interpreting and explaining the effectiveness of critical thinking education on improving academic enthusiasm at post-test and follow-up stages, it can be inferred that critical thinking education requires exploration, which in turn involves social interactions and shared experiences. Satisfying social interactions and shared experiences stimulate the nervous system and reduce stress, leading to increased happiness and vitality. Since critical thinking education increases critical thinking, and the distinct feature of high-level thinking classrooms is having warm and intimate relationships and freedom in expressing feelings and emotions, in such classrooms (those utilizing critical thinking education), all students feel accepted by others, successful in facing various issues and challenges, and fearless in confronting them. Therefore, a critical thinking education program for students can act as an efficient and effective approach to improving educational characteristics. Consequently, it seems logical that critical thinking education can improve academic variables among students, including academic enthusiasm among high school students.

Although the results of the present study indicate the effectiveness of critical thinking education on divergent thinking and academic enthusiasm, like other studies, this research has limitations. The study population consisted of female students in the 10th and 11th grades of the theoretical branch in Saveh city. Therefore, the findings cannot be generalized to female students in other grades or male students. This study used self-report tools, namely questionnaires for data collection, which can reduce result accuracy, especially if participants lack sufficient introspection and if respondents do not answer the tools truthfully. Considering the results of this study, further research involving male students, female students of other grades, and college students is recommended. Another research suggestion is the use of interviews instead of questionnaires for data collection. The last research suggestion is comparing the effectiveness of critical thinking education with other educational methods such as successful intelligence training, self-regulation education, cognitive and metacognitive strategies training, etc. The findings of this study have practical implications for managers, officials, and planners of the education system, allowing them to take effective steps to improve psychological and educational variables through critical thinking education. Given the educational effectiveness of critical thinking on enhancing divergent thinking and academic enthusiasm among high school students, counselors and psychologists can use critical thinking education alongside other effective educational methods to improve academic and non-academic characteristics of students.

Authors' Contributions

In this article, the corresponding author was responsible for the intervention implementation, data analysis, and manuscript writing, while the other authors supervised the data analysis and manuscript writing.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

No conflict of interest was reported.

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Ethical Considerations

All ethical standards were observed. This study was approved by the ethics committee of Islamic Azad University, Arak Branch, with the ethics code IR.IAU.ARAK.REC.1402.069.

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