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The Causal Relationship between Intelligence Beliefs and Performance in the Chemistry Course with the Mediating Role of Emotion Self-Regulation in Female Senior High School Students in Mahmudabad

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Abstract
Emotional self-regulation plays a very critical role in promoting intelligence beliefs and improving students' academic performance. Through emotional self-regulation, students can believe in the effectiveness of their intelligence and achieve higher performance in their educational and learning processes. The aim of the present study was to investigate the relationship between IQ beliefs and chemistry performance with emotional self-regulation mediation in students. This study was applied in terms of purpose, and considering data collection procedure, it was descriptive-correlational. The statistical population included all 275 female students of 11 public senior high schools in Mahmudabad, the 11th grade, in the academic year 2020-2021. Based on the census method, the whole population of the research community was used as a sample. The instruments used for data collection included the Intelligence Beliefs Questionnaire (Babaei, 1998) and the Emotion Self-Regulatory Questionnaire (Gross & John, 2003). Also, the final score of the chemistry course was used as the chemistry performance of the participants. To analyze the data, Kaiser-Meyer-Olkin test, Bartlett's test, correlation coefficient, regression, path analysis and structural equation modeling were used. The findings showed that there was a statistical significant relationship between intelligence beliefs, emotion self-regulation and students' chemistry performance. In addition, intelligence beliefs and emotion self-regulation have a direct effect on students' performance in chemistry. Also, intelligence beliefs have a significant effect on the performance of students' chemistry lessons through the mediation of emotion self-regulation. It should be mentioned that the research model had a very good fit. Given that intelligence beliefs and emotion self-regulation can predict the performance of students in the chemistry course, it is recommended to modify cognitive beliefs and teach emotion self-regulation techniques in order to improve students' academic performance.

Keywords: Chemistry course performance, Emotional self-regulation, Intelligence beliefs

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Introduction

Chemistry is an empirical science. Early humans thought about the ways to protect themselves from hot and cold weather, satisfy their hunger, and in general, they thought about protecting their existence before any sort of thinking and theorizing about the structure and the way their surrounding environment was created (Haetami et al., 2020). From the onset of civilization, human beings have taken effective steps to change the nature and to make the most out of it. Thus, the science of chemistry played a key role in the process of life and its learning became necessary for human beings. Moreover, due to the importance and necessity of chemistry, it has gained a considerable attention in the process of educating students (Nouri et al., 2019).

Many students in the chemistry classroom face different educational situations which can determine their academic success (Hardiyaniti et al., 2020). Meanwhile, the most important criterion in the educational process is to measure the performance of learners and how they can practically apply what they have learned in this course (Sobhi et al., 2016) which can be measured through the performance and progress of students in the chemistry course (Kim & Seo, 2015).The term "performance in the chemistry course" or in general, "academic performance" means the rate of school learning, which is measured by various tests (Forsberg, 2007; Wardani et al., 2019). Academic performance is a set of academic behaviors in the field of knowledge acquisition that emerges in two dimensions of academic achievement and academic regression (Nazemian, 2020).

Various factors, such as intelligence, talent, family status and even parents' attitudes toward education affect academic performance (Savari & Nouri, 2014). In recent years, research conducted in schools and universities has shown that intelligence beliefs also have a positive effect on academic performance, especially the performance in the chemistry course (Altundag, 2018). Intelligence beliefs are divided into two types of innate intelligence beliefs and incremental intelligence beliefs (Jeeping, Brunch, and Buryat, 2017). People who have innate intelligence beliefs suppose that their intelligence traits are constant, unchangeable and measurable (Mirzabeigi et al., 2019). According to these people, intelligence has a constant, inflexible and non-incremental quality. As a result, they make the least effort to achieve their goals and overcome their problems (Jamshidi & Haghighi, 2018). On the other hand, people who believe in incremental intelligence hold that intelligence is not a fixed and unchangeable essence; rather, it can be changed through effort and experience (De Almeida et al., 2019). In general, these people strive to acquire new knowledge and improve their competencies and seek to overcome past failures (Nemati-Moghaddam et al., 2013).

Generally, beliefs guide thought, feeling, and behavior, give meaning to experiences and form a behavioral and semantic system (Sookoo-Singh & Boisselle, 2018). Beliefs affect behaviors and along with emotional factors such as emotional self-regulation, determine the strength and stability of behaviors (Chen et al., 2019). Emotional self-regulation is the process of initiating, maintaining, modifying or changing the rate of emergence, intensity and continuity of inner feeling (Etesami-Nasr et al., 2018). This skill is related to psychosocial and physical processes and plays an important role in achieving goals (Weems & Pina, 2010). Emotional self-regulation skill, in addition to emotion regulation, includes behavior management, too. Thus, emotional self-regulation involves not only emotional processes, but also cognitive processes (King et al., 2017).

Emotion self-regulation involves creating thoughts and behaviors that inform people what kind of emotion they have and when it arises (Tatnell et al., 2017). Developmental neuropsychological findings also support this point stating that emotion regulation and executive functions are indirectly related to each other and work together to analyze information and perform activities (Dávila-Acedo & Borrachero, 2016). Thus, cognitive ability helps shape emotional life (Davis, 2017).

The studies conducted in this field are in line with the research literature. For example, the findings of Parviz (2019) study showed that the types of intelligence can create effective individual differences in the process of learning-teaching chemistry. Also, the research done by Barzegar Befrooi et al. (2012) showed that epistemological beliefs and the perception of a constructive learning environment have a significant direct effect on the performance in the chemistry course. Moreover, it was found that academic self-efficacy and high-level cognitive strategies play a mediating role in the relationship between epistemological beliefs, the perception of a constructive learning environment, and the performance in chemistry lesson.

In addition to the mentioned research, Haetami et al. (2020) research showed that there was a significant relationship between the concept acquisition model and logical intelligence with the learning outcomes of in chemistry lesson. Also, the research by Wardani et al. (2019) demonstrated that according to the learning-based research model, intra-individual intelligence beliefs affect the performance of students in chemistry lesson. Furthermore, Chen et al. (2019) found that emotional self-regulation training based on the

combined education model has an effect on the learning process and academic performance of students in the chemistry course. King et al. (2017) also concluded that there is a significant relationship between emotional self-regulation and learning rate with the performance of chemistry lessons.

Given the importance of intelligence beliefs and emotional self-regulation in the performance of chemistry lessons, the present study sought to test a hypothetical model related to intelligence beliefs and performance in the chemistry lesson with the mediating role of emotional self-regulation. This study, in addition to filling the gaps and developing the existing research literature, emphasizes the role of intelligence beliefs and emotional self-regulation in the performance in chemistry lesson. Accordingly, the main research question is:

Does emotional self-regulation have a mediating effect on the relationship between intelligence beliefs and students' performance in chemistry lessons?

Method

Design of the Study

The present study was applied in terms of purpose, and considering the data collection procedure, it was descriptive-correlational.

Participants

The statistical population of the study included all 275 female students of 11 public senior high schools, the 11th grade, in Mahmudabad in the academic year 2020-2021. Based on the census method, the whole population of the research community was used as a sample.

Instruments

In this study, the following instruments were used:

The Intelligence Beliefs Questionnaire: The Intelligence Beliefs Questionnaire was developed by Babaei (1998). This questionnaire contains 14 items that measure two components called the inherent intelligence and the incremental intelligence. The component of inherent intelligence consists of four questions (1, 4, 6 and 14) and the component of incremental intelligence consists of ten questions (2, 3, 5, 7, 8, 9, 10, 11, 12 and 13). The questionnaire, which measures intelligence beliefs, was developed on a 5-point Likert scale (completely disagree with the numerical value of 1 to strongly agree with the numerical value of 5) and the range of scores is between a minimum of 14 and a maximum of 70. An example of the questionnaire item is: "Students who are moderately average in intelligence can increase their intelligence with consistent effort." Items 1, 4, 6 and 14 have a reverse score; that is, a higher score indicates better intelligence beliefs. Also, the content and construct validity of this questionnaire was confirmed (Babaei, 1998). Also, its reliability coefficient using Cronbach's alpha method was .72, which is a desirable reliability coefficient. In the present study, using Cronbach's alpha, the component of inherent intelligence had a reliability coefficient of .67 while the component of incremental intelligence had a reliability coefficient of .74 and the total reliability was estimated to be .76.

The Emotion Self-Regulation Questionnaire: The Emotion Self-Regulation Questionnaire was developed by Gross and John (2003). This questionnaire has 10 questions and 2 subscales called cognitive reappraisal and expressive suppression. In this questionnaire, 6 questions are related to the subscale of reappraisal (1, 3, 5, 7, 8, and 10) and 4 questions are related to the subscale of suppression (2, 4, 6, and 9). The questionnaire was developed on a 7-point Likert scale (in the range of completely disagree with the numerical value of 1 to completely agree with the numerical value of 7); the higher score in the questionnaire indicates bad mood and lower emotion self-regulation. The content and construct validity of the questionnaire was confirmed by the developers. Also, its reliability, through Cronbach's alpha for the reappraisal subscale, .78, and for the suppression subscale, .83 was reported. In Iran, the content and construct validity of this questionnaire was confirmed by Ghasempour et al. (2012), and its reliability using Cronbach's alpha for the reappraisal and suppression subscales is reported .60 and .81 respectively. In the present study, using Cronbach's alpha, the reliability coefficients of the reappraisal and suppression subscales were estimated to be .71and .73 respectively while the reliability coefficient of the total questionnaire was .79.

Chemistry Course Performance: Students' chemistry course performance was assessed through the final achievement score, available at academic documents.

Procedure

Considering that the sample size for performing factor analysis and structural equation modeling should be more than 200 people (Hooman, 2014), according to the census method, all members of the research community were used as a statistical sample. First, before conducting the research, the purpose of the study was explained to the participants and they were assured that their information would be kept confidential. Also, the informed consent was obtained from the participants. Then, the Intelligence Beliefs Questionnaire and the

Emotion Self-Regulatory Questionnaire were administered to the participants. The final achievement scores of the students' chemistry course were also used as their performance in the chemistry course. Then, SPSS and Amos software, version 24, were used to analyze the research data.

Findings

Prior to conducting factor analysis, Kaiser-Meyer-Olkin and Bartlett tests were used to ensure sampling adequacy and data sphericity significance. Table 1 presents the results of the Kaiser-Meyer-Olkin and the Bartlett tests.

Table 1.
Kaiser-Meyer-Olkin Values and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		**.628**
Bartlett's Test of Sphericity	Approx. Chi Square	2598.268
	df	21
	Sig.	.000

Given that the value of the Kaiser-Meyer-Olkin index is equal to .628, the data are adequate for factor analysis. Also, considering that, in Table 1, the significance level of Bartlett's test is equal to zero, therefore, the null hypothesis is rejected and it can be concluded that there is a significant relationship between the variables. Accordingly, the necessary condition for factor analysis is provided.

Table 2.
Correlation between Intelligence Beliefs, Emotion Self-Regulation, and Chemistry Performance

Variables	**Intelligence Beliefs**	**Emotional Self-Regulation**	**Chemistry Performance**	**df**	**sig**
Intelligence beliefs	١	-٠/٣٠٥	٠/٢٦٥	273	.000
Emotion self-regulation	-٠/٣٠٥	١	-٠/٢٥٦	273	.000
Chemistry performance	٠/٢٦٥	-٠/٢٥٦	١	273	.000

P<0.01

Table 2 presents the interrelationships between intelligence beliefs, emotion self-regulation, and chemistry performance. Considering that the absolute value of the calculated correlation coefficients (-.305, 0.265 and -0.256), is greater than the correlation coefficient of the table with the degrees of freedom (n-2 = 273) and the significance level of 99% (.181), so with 99% confidence, the null hypothesis is rejected and the opposite hypothesis is confirmed. Considering the rejection of the null hypothesis with 99% confidence it can be claimed that there is a significant relationship between the study variables.

Table 3.
Summary of Correlation Coefficient, Coefficient of Determination and Square of the Variable between Intelligence Beliefs, Emotion Self-Regulation and Chemistry Performance

Predictor Variables	**(R)**	**($R^{2)}$**	**Adjusted R^2**	**SEM**	**Durbin-Watson Statistic**
Intelligence Beliefs and Emotion Self-regulation	.322	.104	.097	1.169	**1.828**

Table 3 shows that 0.10 variance related to intelligence beliefs and emotion self-regulation is explained by students' performance in chemistry. Also, the value of the Durbin-Watson statistic is between 1.5 and 2.5, which indicates that the observations are independent. Accordingly, the results of Table 3 show that the autocorrelation assumption of observations exists.

Table 4.
Summary of the Step-By-Step Regression Model of Intelligence Beliefs, Emotion Self-regulation, and Chemistry Performance

Predictor Variable	Model	Sum of Squares	df	Mean Squares	F	Sig.
Academic Performance	Regression	6647.675	۲	3323.837	47.954	.000
	Residual	16011/334	۲۲۲	69.313		

The results of regression analysis in Table 4 show that F observed equals 15.750. Given that the F observed (15.750) with the degrees of freedom of 2 and 272 and the significance level of = 0.01 is greater than the critical F in the Table (4.71), therefore, with 99% confidence it can be concluded that the regression model is significant. In other words, intelligence beliefs and emotion self-regulation can predict students' performance in the chemistry lesson in one step.

Table 5 summarizes the stepwise regression statistical characteristics of intelligence beliefs, and emotion self-regulation with chemistry performance.

Table 5.
Summary of the Stepwise Regression Statistical Characteristics of Intelligence Beliefs, Emotion Self-Regulation with Chemistry Performance

	Unstandardized Coefficients		Standardized Coefficients	t	P
	B	**Std error**	**Beta**		
Constant	17.106	1.574		10.869	.000
Intelligence Beliefs	0.068	0.020	0.206	3.418	.000
Emotion Self-regulation	-0.086	0.027	-0.193	-3.200	.000

The results of the regression coefficients of the predictor variable indicate that intelligence beliefs (β = 0.206; t = 3.418) and emotion self-regulation (β = -0.193; t = -3.200) can explain the variance of the students' chemistry lesson performance.

Y = ax1 + bx2 + cx3 = 17.106+0.068+-0.086

Also, the path analysis direction and the validity of the final research model were examined. The results of the path analysis test are presented in Tables 6 and 7 and its conceptual model is presented in Figure 1.

Table 6.
Direct Model Estimation with Maximum Likelihood (ML) Method

Variable	b	β	R^2	t- statistic	P
Intelligence Beliefs to Chemistry Performance	0.297	0.201	0.059	2.573	.001
Emotion Self-regulation to Chemistry Performance	-0.251	-0.193	0.048	2.496	.001

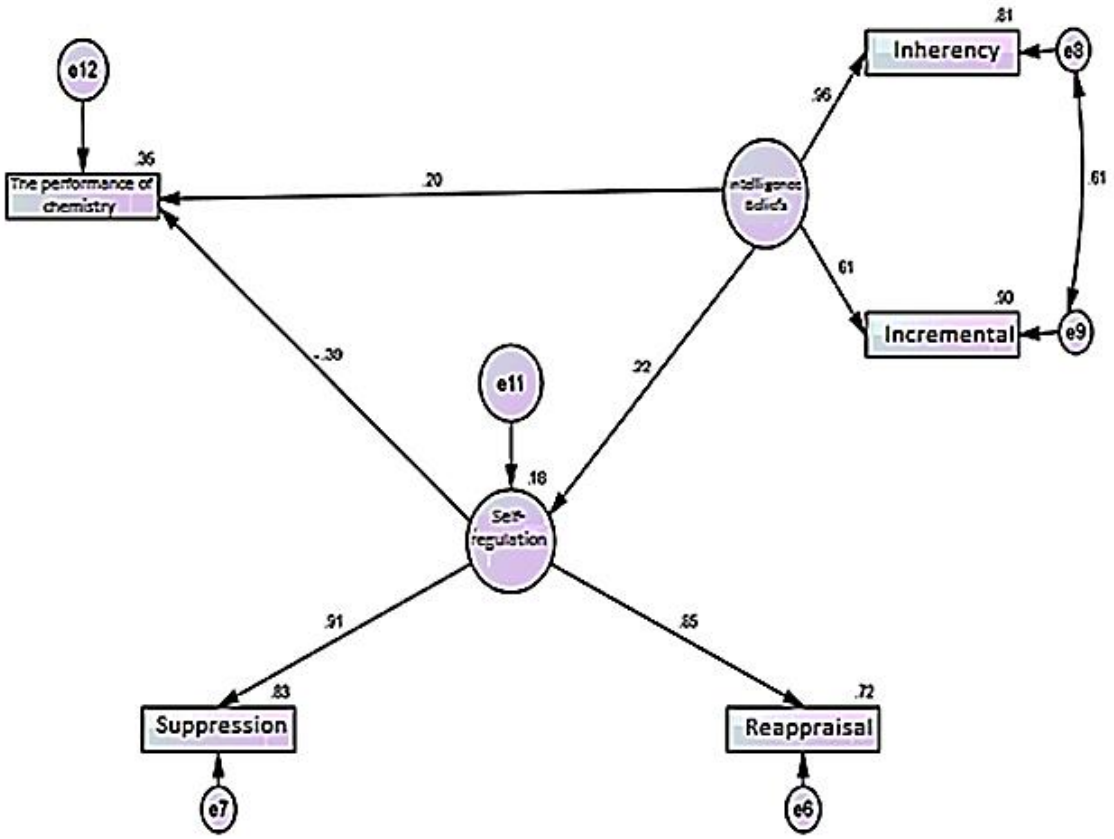
According to the results of Table 6, it is concluded that exogenous variables (intelligence beliefs and emotion self-regulation) have a significant effect on the endogenous variable (chemistry performance).

Table 7.
Indirect Estimation of the Model Using the Bootstrap Method

			Limit		
Variable	**B**	**R^2**	**Lower**	**Upper**	**P-value**
Intelligence Beliefs to Chemistry Performance with the mediation of Emotion Self-regulation	-0.391	0.358	-0.428	-0.215	.000

According to the results of Table 7, through the bootstrap estimation method, intelligence beliefs affect chemistry performance through the mediating role of emotion self-regulation.

Figure 2.
The Final Model with Standardized Predicted Values



According to the estimation of the second order factor analysis fit indices, the value of the second root index of the average of the residual squares is equal to .029. Because this value is less than 0.08; thus, it is acceptable. Moreover, the ratio of chi-square to degree of freedom is equal to 2.196, and because this ratio is less than 4, it has an acceptable fit. In addition, the Good Fit Index, the Comparative Fit Index, and the Normed fit index are greater than 0.90, indicating that the final model has a very good fit. Table 8 summarizes the results of the second-order confirmatory factor analysis fit indices.

Table 8.
Confirmatory Indices of the Second Order Confirmatory Factor Analysis

Fit Indices	Indicator	Estimate	Level of Acceptance	Result
Chi-Square/df	CMIN/DF	2.196	Less than 4	Good fit
Root Mean Square Error of Approximation	RMSEA	0.029	Less than 0.08	Good fit
Goodness of Fit Index	GFI	0.999	More than 0.90	Good fit
Comparative Fit Index	CFI	0.994	More than 0.90	Good Fit
Normed Fit Index	NFI	0.992	More than 0.90	Good Fit

Discussion

The aim of this study was to investigate the causal relationship between intelligence beliefs and chemistry performance with emotional self-regulation mediation in female senior high school students in Mahmudabad. This results of the study showed that intelligence beliefs

have an indirect effect on the performance of students' chemistry lesson with the mediating role of emotion self-regulation. Also, there is a significant relationship between intelligence beliefs, emotion self-regulation and students' performance in chemistry lesson. In addition, intelligence beliefs and emotion self-regulation can predict the performance of students' in chemistry lesson. Results of the present study are in line with the findings of Parviz (2019), Barzegar Befrooi et al. (2012), Wardani et al. (2019), Chen et al. (2019), and King et al. (2017).

In explaining the results of the research, it can be stated that intelligence beliefs cause cognitive adjustment, which in turn, enhances self-regulatory adaptation. As a result, the skills of planning, monitoring, self-correction, cognitive-emotional strategies and self-awareness improve (Altundag, 2018). Intelligence beliefs influence students' goal setting, self-regulation, and planning through improved emotion self-regulation. This increases behavioral-cognitive motivations and improves performance in situations such as emotional processing, performance in the chemistry course and learning the issues of this course (Wardani et al., 2019).

In general, intelligence beliefs are a function of interaction, companionship and attention in learning. Intelligence beliefs, in the first place, prevent cognitive confusion and imperfect perception (Haetami et al., 2020) and second, they improve emotion self-regulation. This point increases the level of engagement with learning and improves motivation and a positive attitude towards learning (Dávila-Acedo & Borrachero, 2016). People who have enough emotion self-regulation feel that they have others to help them when problems arise. In this way, emotion self-regulation improves emotional processing and as a result, it has a positive effect on the individual and promotes academic performance in certain subjects, such as chemistry (King et al., 2017). The constructs of intelligence beliefs and emotion self-regulation have cognitive characteristics. From the perspective of cognitive sciences, intelligence beliefs and emotion self-regulation are based on information processing and play a leading role in symbolic and non-symbolic processes and visualizations (Chen et al., 2019).

Conclusion

Intelligence beliefs and emotion self-regulation are a kind of cognitive-emotional style. Weakness in these constructs manifests itself in the form of impaired expression and positive processing and the verbal description of emotions is damaged (Hassani Rad & Hamzehnejad, 2019). In fact, decreased emotion expression is a kind of lack or maladaptation of emotions (Chen et al., 2019). As a result, insufficiency in emotional processing capacities is a potential risk for learning and academic performance problems (Abedi, et al., 2015).

According to value-control theory, the pattern of cognitive-emotional processing, due to appropriate beliefs (competencies), leads to increased effective cognitive performance and improved academic performance (Rezaei, 2016). Thus, positive cognitive-emotional processing, both directly and indirectly, affects the academic performance of chemistry. Because, positive cognitive-emotional processing affects metacognitive (self-regulatory), behavioral, motivational and psychological (self-concept) processes, the quality of teacher-learner interactions and the effectiveness of teaching.

The present study, like all other studies, had some limitations. The most important limitations of this study were the limitations in the selection of the population and the statistical sample as well as the limitations caused by the pandemic COVID 19. Accordingly, it is suggested that in order to increase the generalizability of the findings, other age and gender groups be studied under normal circumstances.

Considering the effect of intelligence beliefs and emotion self-regulation on the performance of chemistry course, it is suggested that the techniques of emotion self-regulation and anger management be taught to the students. Also, it is suggested that intelligence-enhancing techniques be practiced through games in interactive learning environments. Moreover, through using film and pictorial education, experimental chemistry workshops should be held to increase both learning and retention of what has been taught.

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Conflicts of Interest

No conflicts of interest declared.

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