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The Mediating Role of Working Memory and Attentional Control in the Relationship between Problem Solving and Empathy in University Students

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Abstract

In order to better understand the relationship between problem solving and empathy, this study looked into the mediating roles of working memory and attentional control. The descriptive-correlation research design was used for this study. All of the university students in Zahedan who enrolled in university semesters made up the statistical population of the study, roughly 40,000 students. From among the population, 500 students were chosen as the participants in this study using the cluster sampling method. The problem-solving questionnaire by Hepner and Petersen(1982), the attentional control scale(2013), the empathy questionnaire by Jolliffe and Farrington(2006), and the working memory questionnaire(2012) were used to gather data. The data were analyzed using SPSS and Amos software using descriptive and inferential statistical methods like Pearson correlation and structural equation modeling. The findings showed that the direct approach to problem solving is detrimental and requires attention (-0.518). Additionally, the non-significant direct relationship was found between working memory and cognitive emotional empathy (-0.060). There is a negative and significant direct path of attention to cognitive emotional empathy (0.219) and the direct correlation between cognitive emotional empathy and problem solving is negative and significant (-0.463) while the indirect effect of problem solving on empathy with the mediation of attentional control is favorable and significant ($P < 0.01$). In general, the findings of the research indicate that paying attention to the role of mediating factors in the relationship between problem solving and empathy is of particular importance, and considering the indirect effects of problem solving on empathy, interventions can be designed to promote empathy.

Keywords: Attentional Control, Empathy, Problem Solving, Working Memory

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Introduction

Students, as the future human resources of the society, play an important role in the country. Therefore, it is necessary to pay special attention to students' communication skills. In many professions, including social science, psychology, education, management, and health care, empathy is seen as a crucial skill that helps enhance intergroup attitudes and interactions (Ewen et al., 2021). Given that empathy has a distinctive position in a number of disciplines, it is not surprising that multiple definitions of this multidisciplinary structure have been proposed in the literature. In fact, there are a

number of similarities between these definitions. According to several research, empathy is the capacity to put oneself in another person's shoes and see situations from their point of view in a manner that is emotionally and intellectually compatible with them. This skill is crucial for providing feedback to others about the current situation (Dean et al., 2021). In actuality, empathy is a multifaceted concept with both emotional and cognitive components. Emotional empathy, in essence, is the capacity to feel what other people are experiencing (Weises and Sikara, 2021). This aspect of empathy might involve sharing feelings, being concerned for others, and experiencing their sorrow (Bray et al., 2021). In other words, emotional empathy is a person's emotional reaction to how they perceive another person's circumstance (Wright et al., 2021). The ability to perceive another person's mental state is known as cognitive empathy (Schreiter et al., 2013). Impaired social functioning may result from poor empathetic abilities (Zhang et al., 2021).

One of the debated subjects in cognitive research is the connection between cognitive variables and empathy (Pericle et al., 2018). According to recent studies, people's degrees of empathy and their capability for problem-solving, a highly developed cognitive skill, are related (Ai et al., 2020). Without having a clear answer, problem solving involves attempting to change a current condition into a desired one (Weiss et al., 2020). These five fundamental elements make up the issue-solving process: problem orientation (sense of control over the process), problem description and goal identification, solution formulation, decision-making, and execution. This suggests that a disruption in any of these levels impairs a person's capacity for problem-solving (Lira & Newman, 2020). The logic-based heuristic method of problem solving is seen as a tool for both inductive and deductive reasoning (Sun & Lee, 2020). In other words, the ability to engage in cognitive processing to comprehend and resolve challenging future situations for which there is no clear solution and a variety of cognitive skills, including creativity, critical thinking, and a scientific mindset to solve, are referred to as problem-solving. The matter is significant (Chen et al., 2020). According to recent study, those who are better at addressing problems also have better communication abilities (Fadli, 2020). An intermediary function for communication abilities may be played in the connection between empathy and problem-solving (Huang & Park, 2020). Knowing these factors is crucial because it helps us better grasp the explanation for the association between problem solving and empathy. It seems that additional mediating variables, which have received less attention, play a role in the relationship between problem solving and empathy. This greatly helps in the creation of educational initiatives and successful interventions to foster empathy.

According to research, working memory can be crucial to the process of problem-solving (Gilholly & Webb, 2018). In fact, working memory is the capacity to remember information to guide behavior in the direction of a goal (Montez et al., 2017). According to some research, working memory can predict empathy, so having a better working memory is associated with having better empathy (Godfrey et al., 2020). These results suggest that the relationship between problem-solving and empathy may be mediated by working memory.

Controlling attention appears to be another cognitive process that aids in problem solving (Duma et al., 2019). When faced with conflicting demands, attentional control is the deliberate and adaptable allocation of focus to goal-related stimuli, which elicits automatic reactions (Thomas et al., 2020). The goal-oriented system, which regulates attention processing and is influenced by current goals, personal expectations, and knowledge, and the stimulus-oriented system, which is sensitive to salient stimuli and processes the environment to find the threatening stimulus, are the two components of the attention system, according to the theory of attention control (Dariberry & Reid, 2002). According to Juda et al. (2013), attention control can be divided into two activities: concentration, which is the capacity to pay attention while avoiding distractions, and attention shifting, which is the capacity to shift attention from one task to another. The high ability to control attention in people facilitates the process of empathy because empathy necessitates the capacity to adopt other people's point of view and feelings as well as to control other potential sources of information, such as one's own feelings and point of view at that particular time (Goodhue & Edwards, 2021). As a result, it appears that the relationship between problem-solving and empathy may also be mediated by attention control.

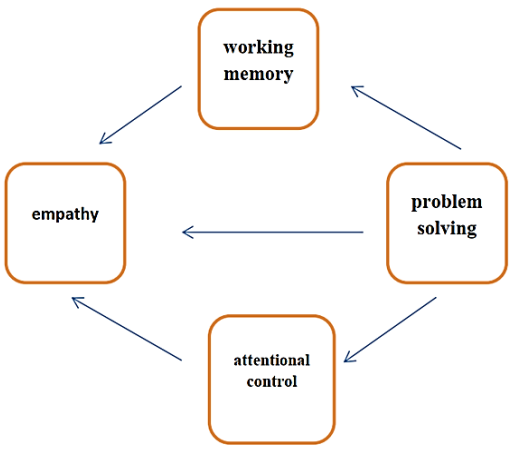
Ay et al. (2020) concluded that problem solving skills are of high importance in the quality of patient care and problem solving skills can affect cognitive empathy skills. In the research of Goodhew and Edwards (2021), the results indicated that two distinct aspects of attention control, i.e. focus and shifting, can have different effects on empathy. The results of their research show that people with greater ability to focus reported lower levels of emotional empathy, but another aspect of attention control, namely attention shifting, had a positive relationship with cognitive empathy. Also, in another study, Goodhew and Edwards (2022) found that for cognitive empathy, cognitive deficits related to distraction are specifically negatively related to the individual, while cognitive deficits related to

forgetfulness are positively related. Yan et al. (2020), in their research, concluded that executive functions are more related to cognitive empathy than emotional empathy, and cognitive empathy is closely related to the sub-components of executive functions. Executive, including inhibitory control, working memory and cognitive flexibility, while affective empathy was only significantly related to inhibitory control. According to Godfrey et al. (2020), working memory has a positive relationship with cognitive and emotional empathy and a negative relationship with committing physical violence and aggression in men. Also, DeCaro and Beilock (2010) found that the ability to control attention helps people to ignore unnecessary information, and this function usually facilitates the problem solving process, but sometimes having higher levels of attention control can reduce the power of problem solving.

Examining the theoretical foundations and background of the research shows that cognitive processes can have different effects on the dimensions of empathy. Problem solving, as a high-level cognitive function, can be a function of other cognitive functions, including attention control and working memory. The conducted research shows that attention control and working memory, despite the fact that they always seem to facilitate problem solving, can sometimes be considered as an obstacle to problem solving. On the other hand, research shows that attention control can have both benefits for empathy and can harm empathy. However, the number of studies that show the correlation between working memory and empathy is limited. In addition, there is a lack of research that examines the indirect effects of problem solving on empathy through the control of attention and working memory, this research investigated the indirect effects of problem solving on empathy.

Figure 1

The Conceptual Model of the Research



Method

In terms of data collection, this study is categorized as a descriptive (non-experimental) study, and in terms of methodology, it is categorized as a correlational study using structural equations.

Participants

All of the students in Zahedan who enrolled in classes during the academic year of 1400–1400 made up the statistical population of the study. With roughly 40,000 students, Zahedan is home to six university centers, including the University of Medical Sciences, Islamic Azad University, State University of Sistan and Baluchistan, Payam Noor University, and Farhangian University. A sample of 500 students were chosen by the cluster sampling method from among all of the students, taking into account the fact that there are 10 input predictor variables (input variable), and that at least 20 people should be taken into account for each predictor variable (Bartlett et al., 2001). In addition, 100 main participants were taken into consideration, and 200 additional people were added to account for potential attrition and incomplete questionnaires.

Instruments

Working Memory Questionnaire (WMQ): The 28 questions on this survey are distributed among a possible six answers. The six possibilities are never, barely, sometimes, a lot, very much, and not relevant. The challenges that arise as a result of flaws and deficiencies in active memory have been highlighted in this questionnaire. Storage, attention, and executive control are the three sections of this quiz. The storage area's questions are 3, 5, 7, 11, 15, 17, 21, 25, 27, and 30. The attention area questions are from the following categories: 10, 13, 19, 19, 22, 26, 28, and executive area questions were 2, 9, 12, 16, 18, 20, 29, and 23. In a research Valat-Azo, Pradat-Wail, and Azo (2012) examined the psychometric qualities of the working memory questionnaire and came to the conclusion that the questionnaire had high internal consistency in both healthy participants and patients with brain injury (Cronbach's alpha: .80). The cognitive failure questionnaire and attention behavior rating scale's concurrent validity were examined, and the Spearman coefficient was reported .90 (Valat-Azovi et al.
, 2012). In the present study, Cronbach's alpha was calculated for the subscales of this questionnaire and its value was as follows: Storage: .79, Attention: 0.77,

Executive: .72. Cronbach's alpha obtained for the Working memory total was .92.

Jolliff and Farrington Empathy Questionnaire (2006): There are 20 items total in this test, and there are two subscales: emotional empathy and cognitive empathy. Scoring is done using a 5-point Likert scale, with 1 being fully opposed and 5 being completely in agreement (5). The cognitive subscale is built with 9 questions (questions: 3, 6, 9, 10, 12, 14, 16, 19, 20) and the emotional subscale with 11 questions (1, 2, 4, 5, 7, 8, 11, 13, 15, 17, 18). The correlation between the subscales and the overall score was utilized to examine the validity of this questionnaire, and coefficients of 0.91 and 0.90 were obtained for the emotional and cognitive subscales, respectively. Additionally, the reliability assessed using the Cronbach's alpha was 0.87 (Joliff & Farrington, 2006). In the present study, Cronbach's alpha was calculated for the subscales of this questionnaire and its value was as follows: Cognitive empathy: .82, Emotional empathy: .76. Cronbach's alpha obtained for the Total empathy: .83.

Hepner and Petersen's Problem Solving Questionnaire (1982): This self-report questionnaire was created by Hepner and Petersen to assess the problem-solving skills of individuals. This questionnaire has 35 items and three subscales, which are as follows: A) Confidence in problem-solving (PSC) with eleven statements: 5-10-11-12-19-23-24-27-33-34-35. B) Style of tendency-avoidance (AA) containing 16 phrases: 1-2-4-6-7-8-13-15-16-17-18-20-21-28-30-31. C) Personal control (PC) with five phrases: 3-14-25-26-32. D) Additional phrases: 9-22-29. On a 6-point Likert scale, responses are scored as follows: completely agree, agree, agree, slightly agree, slightly disagree, disagree, and completely disagree. The reported reliability of this test is .90. The test's validity demonstrated that the instrument measures personality-related constructs, particularly locus of control. In the present study, Cronbach's alpha was calculated for the subscales of this questionnaire and its value was as follows: Confidence problem solving: .81, Tendency-avoidance problem solving: .75, Personal control problem solving: .75. Cronbach's alpha obtained for the total problem solving: .84.

Attentional Control Scale (ACS): Driberry and Reed created this questionnaire in 2002, and subsequently Juda, Grant, Mills, and Lechner analyzed and normalized it in 2013. In this study, the 12-item form developed by Joda et al. (2013) were used, which comprises two concentration and transfer components. Questions 1, 2, 3, 4, 5, 6, 8, and 7 through 12 pertain to the concentration subscale, whereas questions 7, 9, 10, 11, and 12 pertain to the transfer subscale. The final test score is determined from a total of 12 questions. On a 4-point Likert scale, 1 corresponds to almost never, 2 to occasionally, 3 to frequently, and 4 to always. The scoring for questions 1, 2, 3, 4, 5, 6, and 8 is inverted. In a research done by Juda et al. (2013), the results of this test for concentration components and transfer were 0.82 and 0.71, respectively (Judah et al., 2013). In the present study, Cronbach's alpha was calculated for the subscales of this questionnaire and its value was as follows: Concentration: .83, Transfer: .70. Cronbach's alpha obtained for the total score is: .80.

Procedure

First, Semnan University of Medical Sciences research code ID: IR.SEMUMS.REC.1401.024 was followed up on in terms of administrative procedures, and the Ethics Council approved the ethics ID. Then, Sistan and Baluchistan University was chosen from among the universities in Zahedan. The participants' satisfaction and desire to participate in the study, as well as their age to be between 18 and 50, were requirements for entering the study while incomplete answering the questions was the criterion for exiting from the study. The questionnaire was answered by the students in the faculties of literature and humanities, arts, management and economics, educational sciences and psychology, engineering, and basic science. However, due to the conditions in Corona and the impossibility of gaining access to students in person, the questionnaire link was created online on the Google Form platform. Through the virtual networks of WhatsApp, Telegram, and Instagram, the survey was distributed. Also, the university's virtual pages, student groups' channels, and the websites of scientific associations were used to inform the students. No participant ID or confidential identifier was requested in order to maintain the confidentiality of the information, and when the link was published, it was made clear what the purpose of the study was and that the information would only be used for the study.

Findings

The age range of the participants was between 18 to 50 years (25.29 ± 5.57). 358 participants were female (72%) and 139 were male (28%). considering their education level, 35 (7%) were associates, 263 (52.9%) were bachelors, 154 (31%) were masters, and 45 (9.1%) held PhD. 366 people (73.6%) were single, 124 (24.9%) were married, and 7 people were divorced (1.4%). 134 students studied the humanities (27%), 134 psychology (27%), 106 engineering (21.3%), 56 basic sciences (11.3%), 14 art (2.8%) and 52 were studying economics (10.5%).

To check the normality of the distribution of scores, Kolmogorov-Smirnov test was used; the results are shown in Table 1.

Table 1
Kolmogorov-Smirnov test

Variable	Statistics	Degree of freedom	Sig.
Emotional empathy	0.064	497	0.000
Cognitive empathy	0.068	497	0.000
Cognitive emotional empathy	0.071	497	0.000
Store	0.091	497	0.000
Attention	0.109	497	0.000
Executive control	0.123	497	0.000
working memory	0.089	497	0.000
Concentration	0.80	497	0.000
Transfer	0.101	497	0.000
Attention control	0.065	497	0.000
Confidence in problem solving	0.057	497	0.001
Approach-avoidance style	0.046	497	0.014
Personal control	0.105	497	0.000
Problem Solving	0.040	497	0.058

According to Table 1, the results of the Kolmogorov-Smirnov test indicate that the scores of the research variables do not follow a normal distribution. The results of Table 2 indicate, however, that the skewness and elongation indices of the research variables are within the normal range, allowing parametric analysis and structural equation models.

Table 2
Descriptive Statistics of Research Variables

Variable	Number	Mean	Standard Deviation	Skewness		kurtosis	Standard Deviation
Emotional empathy	497	39.1147	5.82757	-0.393	0.110	1.234	0.219
Cognitive empathy	497	34.03944	4.82323	-0.254	0.110	0.486	0.219
Cognitive emotional empathy	497	75.5091	8.95443	-0.344	0.110	0.993	0.219
Store	497	18.7203	6.05721	0.905	0.110	1.147	0.219
Attention	497	22.1207	6.51994	0.745	0.110	0.860	0.219
Executive control	497	16.3179	5.43543	1.003	0.110	1.218	0.219
Work memory	497	57.1590	16.86429	0.868	0.110	1.211	0.219
Concentration	497	17.5835	3.56811	-0.513	0.110	0.329	0.219
Transfer	497	12.2032	2.83216	0.261	0.110	0.104	0.219
Attention control	497	29.8767	5.19487	0.044	0.110	0.089	0.219
Confidence in problem solving	497	48.5231	6.77816	-0.204	0.110	0.106	0.219
Approach-avoidance style	497	42.7243	8.84331	0.267	0.110	0.682	0.219
Personal control	497	14.7284	3.56572	-.0106	0.110	0.765	0.219
Problem Solving	497	105.9759	17.02144	-0.053	0.110	0.458	0.219

Table 3
Correlation Matrix between Research Variables

Variable	emotional empathy	Cognitive empathy	Sympathy cognitive emotional	Store	Attention	Executive control	work memory	Concentration	Transfer	Attention control
Emotional empathy	1	***0.408	**0.871	**0.135	**0.155	**0.137	**0.153	**-0.188	0.007	**-0.125
Cognitive empathy		1	**0.804	**-0.164	**-0.138	**-0.181	**-0.171	**0.157	**0.216	**0.225
Cognitive emotional			1	-0.001	0.027	-0.009	0.007	-0.038	**0.121	0.040
Store				1	**0.827	**0.795	**0.935	**-0.628	**-0.272	**-0.580
Attention					1	**0.818	**0.947	**0.653	**-0.288	**-0.605
Executive control						1	**0.924	**-0.641	**-0.325	**-0.618
Work memory							1	**-0.685	**3	**-0.641
Concentration								1	**0.308	**0.855
Transfer									1	**0.757
Attention control										1
Confidence in problem										
Approach-avoidance style										
Personal control										
Problem Solving										

Variable	Emotional empathy	Cognitive empathy	Cognitive emotional	Store	Attention	Executive control	Work memory	Concentration	Transfer	Attention control	Confidence in problem	Approach-avoidance style	Personal control	Problem Solving
Confidence in problem solving	0.034	**-0.312	**-0.146	**0.411	**0.424	**0.423	**0.448	**-0.452	**-0.364	**-0.509	1			
Approach-avoidance style	0.071	**-0.321	**-0.126	**0.391	**0.359	**0.350	**0.392	**-0.433	**0.375	**-0.502	**0.667	1		
Personal control	**0.117	**-0.309	0.090**	**0.378	**0.365	**0.364	**0.395	**-0.441	**-0.379	**-0.510	**0.589	**0.705	1	
Problem Solving	0.075	**-0.355	**-0.143	**0.446	**0.432	**0.426	**0.465	**-0.497	**-0.419	**-0.570	**0.868	**0.933	**0.810	1

According to Table 3, there is a significant connection ($p < 0.01$) between the four primary variables of the study. The findings revealed a negative correlation between problem solving and the two variables of empathy and attention control, but a positive correlation between problem solving and working memory. Examining the correlation coefficients reveals that the correlation intensity between issue solving and empathy is -0.143, the correlation intensity between problem solving and attention control is -0.570, and the correlation intensity between problem solving and working memory is 0.465 ($p < 0.01$).

Figure 2

Structural Relationships of Problem Solving and Emotional Empathy: The Mediating Role of Attention and Working Memory

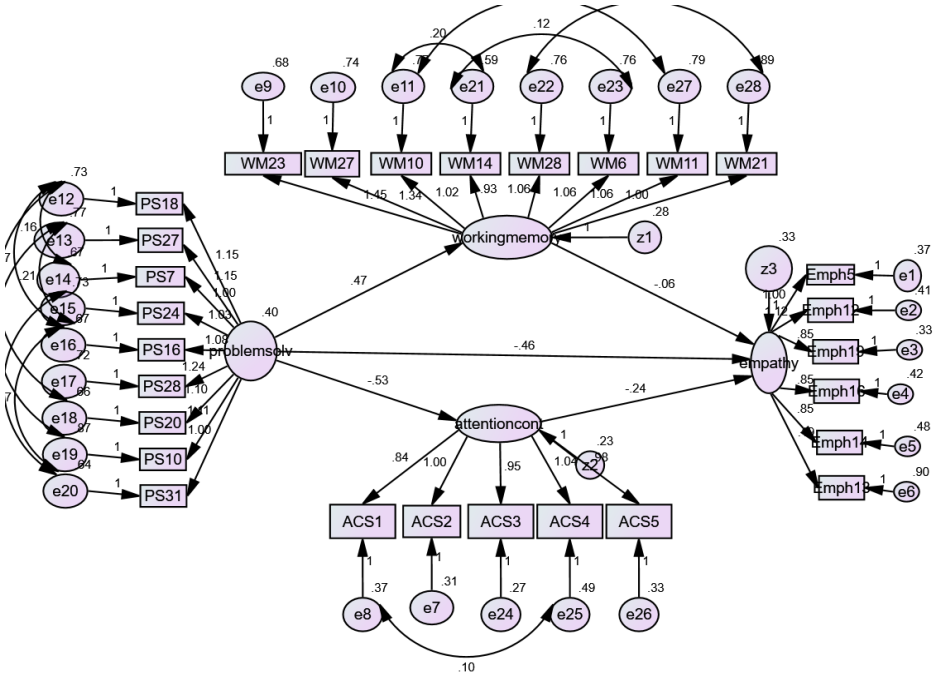


Figure 2 examines the conceptual model of the research. To refer to the path coefficients, first the model fit is checked in Table 4 and then the path coefficients are provided.

Table 4
Fit Indices of the Structural Equation Model of the Mediator Model

Index type	index name	desired amount	Values of the research model
Absolute indices (fitness of the model)	degrees of freedom (fd)	-	333
	Chi Square (NIMC)	-	854.880
	significance level (P)	Less than 0.05	0.001
	Chi-square ratio to degrees of freedom (CMIN/df)	Between 1 and 5	2.567
Relative indicators	root mean square error of estimate (RMSEA)	10 to down	0.056
	goodness of fit index (CFI)	90 to up	0.90
	Modified Fit Index (NFI)	Near one	0.85
	Tucker-Lewis Index (TLI)	90 to up	0.89
	Incremental Fit Index (IFI)	90 to up	0.90
	Relative Fit Index (RFI)	60 to up	0.83
	parsimonious comparative fit index (PCFI)	60 to up	0.79
	Parsimonious Normalized Fit Index (PNFI)	60 to up	0.75

Chi-square index is one of the absolute indices; the lower the number, the greater the model's satisfaction.. According to Table 4, this number is 2.567, which is an acceptable value for the required model. The modified fit index is one of the comparative indices, and a value larger than 0.80 and near to one suggests that the model is well-fitting.

This value for the research sample is 0.85. The square root of the estimate error is determined by the index of the residual matrix. Acceptable patterns have an index value of 0.10 or less. The fit of models with values over 0.10 is deemed inadequate. The index value for this model is 0.056, indicating the model's acceptance. Therefore, the model shown in Figure 2 has an excellent fit.

Table 5
Path Coefficients of the Structural Equation Model: Mediation Model

Path	Unstandardized coefficient	Standard coefficient	standard error	T	P
Problem solving → working memory	0.466	0.489	0.065	7.183	0.001
Problem solving → Attention	-0.518	-0.568	0.058	-8.897	0.001
Working memory → cognitive emotional empathy	-0.062	-0.060	0.066	-0.950	0.342
attention → cognitive emotional empathy	-0.238	-0.219	0.077	-3.105	0.002
Problem solving → cognitive emotional empathy	-0.458	-0.463	0.085	-5.408	0.001

The direct relationship between problem solving and working memory (0.489) is substantial and beneficial, according to Figure 2 and Table 5. The direct approach to issue solutions is detrimental and requires care (-0.518). Additionally, the non-significant direct relationship between working memory and cognitive emotional empathy (-0.060). There is a negative and large direct route of attention to cognitive emotional empathy (0.219). The direct correlation between cognitive emotional empathy and problem solving is negative and substantial (-0.463). The squared multiple correlation for the mediation model's variables measuring attention (0.323), working memory (0.239), and cognitive emotional empathy (0.170).

Total Effects Model

In the total effects model, the impact of mediating variables was removed and only the effect of problem solving on emotional-cognitive empathy was examined.

Figure 3

Structural Relationships of Problem Solving and Cognitive Affective Empathy: Total Effects Model

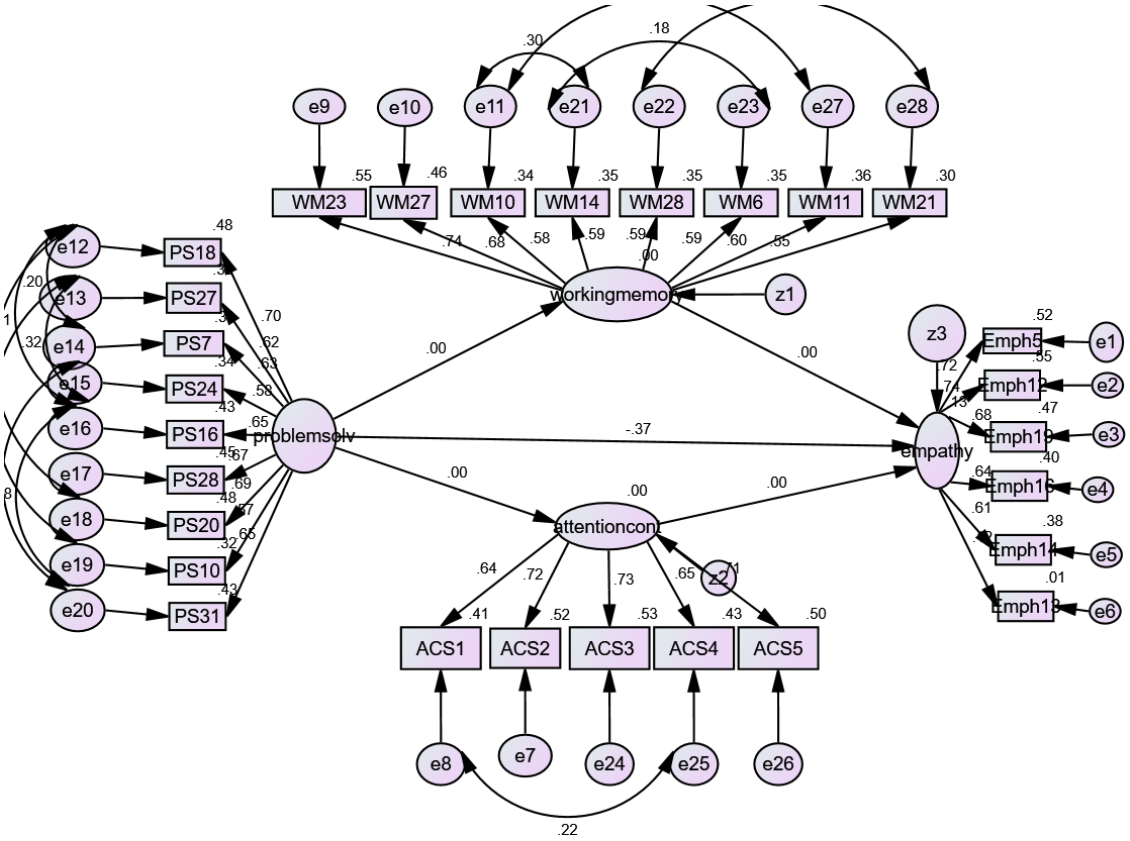


Figure 3 surveys the conceptual model of the research. To refer to the coefficients of the paths, first the fit of the model is checked in Table 6 and then the coefficients of the path are given.

Table 6

Fit Indices of the Structural Equation Model of the Total Effects Model

Index type	index name	desired amount	Values of the research model
Absolute indices (fitness of the model)	degrees of freedom (fd)	-	338
	Chi Square (NIMC)	-	1035.173
	significance level (P)	Less than 0.05	0.001
	Chi-square ratio to degrees of freedom (CMIN/df)	Between 1 and 5	3.07
Relative indicators	root mean square error of estimate (RMSEA)	10 to down	0.065
	goodness of fit index (CFI)	90 to up	0.87
	Modified Fit Index (NFI)	near one	0.81
	Tucker-Lewis Index (TLI)	90 to up	0.85
	Incremental Fit Index (IFI)	90 to up	0.87
	Relative Fit Index (RFI)	60 to up	0.80
	parsimonious comparative fit index (PCFI)	60 to up	0.77
	Parsimonious Normalized Fit Index (PNFI)	60 to up	0.73

The normalized chi-square index, one of the general indicators, is calculated by dividing the chi-square value by the degree of freedom. Values between 1 and 5 are appropriate for this indicator. This result for the intended model is 3.07, which is acceptable according to Table 6. One of the comparing indicators is the modified fit index, whose value is larger than 0.8 and near to one, indicating a strong fit

of the model. This value for the research sample is 0.81. Based on the index of the residual matrix, the root mean square of the estimate error is calculated. Patterns that are accepted have a value of 0.10 or less for this index. Models with values greater than 0.10 are regarded as having poor fit. This model's index value, which is 0.065, suggests that it is acceptable. As a result, the model in Figure 3 fits the data fairly well.

Table 7

Path Coefficients of the Structural Equation Model: Total Effects

Path	Unstandardized coefficient	Standard coefficient	standard error	T	P
Problem solving → cognitive emotional empathy	-0.349	-0.367	0.055	-6.299	0.001

Regarding Figure 3 and Table 7, the direct path of problem solving to cognitive emotional empathy (-0.367) is negative and significant. The squared multiple correlation for cognitive emotional empathy variable is 0.135.

Indirect Effects

In the indirect effects model, the direct path of problem solving to the cognitive affective empathy is removed and only indirect paths are kept.

Figure 4

Structural Relationships of Problem Solving and Cognitive Affective Empathy: Indirect Effects

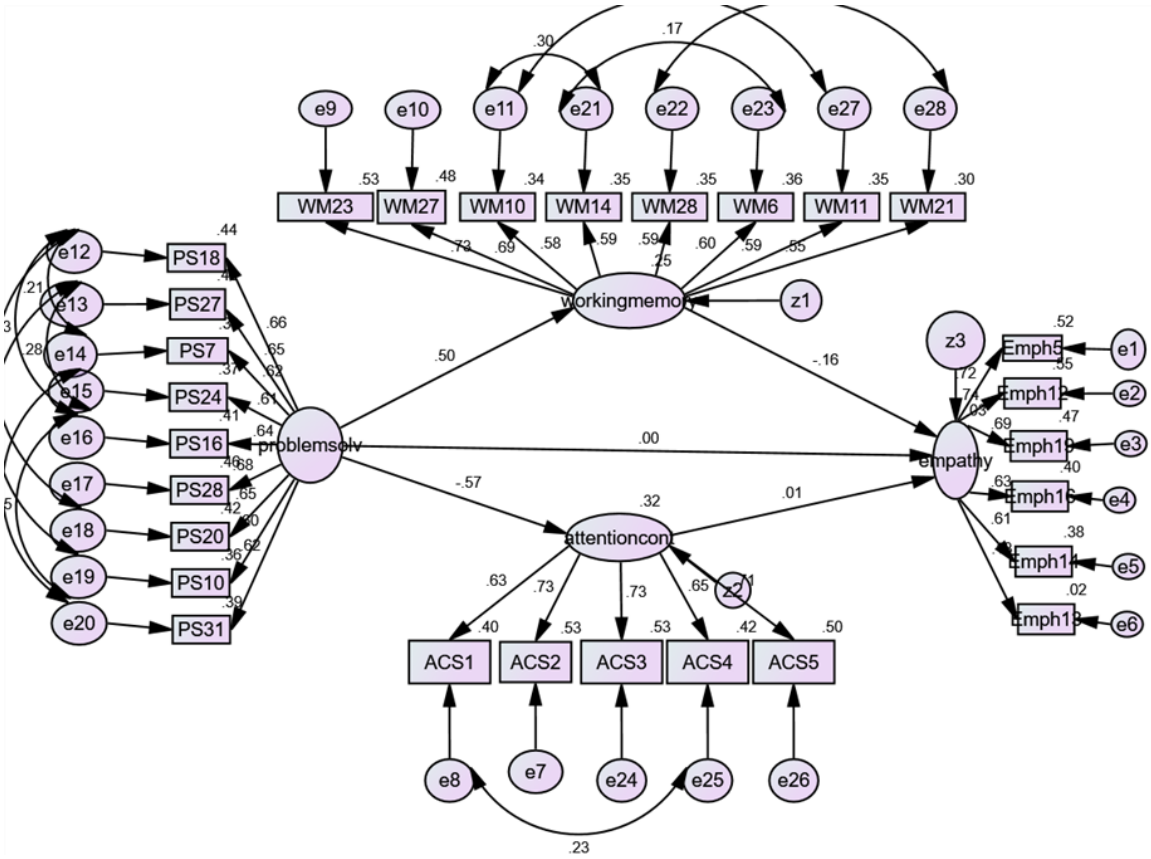


Figure 4 surveys the conceptual model of the research. To refer to the coefficients of the paths, first the fit of the model is checked in Table 8 and then the coefficients of the path are given.

Table 8
Fit Indices of the Structural Equation Model of the Indirect Effects Model

Index type	index name	desired amount	Values of the research model
Absolute indices (fitness of the model)	degrees of freedom (fd)	-	334
	Chi Square (NIMC)	-	897.263
	significance level (P)	Less than 0.05	0.001
	Chi-square ratio to degrees of freedom (CMIN/df)	Between 1 and 5	2.686
Relative indicators	root mean square error of estimate (RMSEA)	10 to down	0.058
	goodness of fit index (CFI)	90 to up	0.892
	Modified Fit Index (NFI)	Near one	0.840
	Tucker-Lewis Index (TLI)	90 to up	0.88
	Incremental Fit Index (IFI)	90 to up	0.89
	Relative Fit Index (RFI)	60 to up	0.82
	parsimonious comparative fit index (PCFI)	60 to up	0.79
	Parsimonious Normalized Fit Index (PNFI)	60 to up	0.74

One of the absolute indicators is the chi-square index; this value for the desired model is 1.587, which is an acceptable value according to Table 8. Also, the modified fit index, whose value is larger than 0.8 and near to one, indicating a strong fit of the model. This value for the research sample is 0.63. Based on the index of the residual matrix, the root mean square of the estimate error is calculated. Patterns that are accepted have a value of 0.10 or less for this index. Models with values greater than 0.10 are regarded as having poor fit. This model's index value, which is 0.044, indicates that it is acceptable. As a result, the model in Figure 4 fits the data very well.

Table 9
Path Coefficients of the Structural Equation Model: Indirect Effects Model

Path	Unstandardized coefficient	Standard coefficient	standard error	T	P
Problem solving → work memory	0.476	0.497	0.066	7.234	0.001
Problem solving → Attention	-0.524	-0.569	0.059	-8.881	0.001
Working memory → cognitive emotional empathy	-0.170	-0.164	0.062	2.770	0.006
attention → cognitive emotional empathy	0.016	-0.015	0.062	0.256	0.798

The direct relationship between problem solving and working memory (0.497) is significant and positive, according to Figure 4 and Table 9. The direct approach to problem solving is detrimental and requires attention. Additionally, there is a negative and significant direct path from working memory to cognitive emotional empathy (-0.164). The direct relationship between cognitive emotional empathy and attention is insignificant (0.016). Also, the squared multiple correlation for the variables working memory (0.247), cognitive emotional empathy (0.323), and attention (0.323) in the indirect effects model are insignificant.

Discussion

The results demonstrated that problem solving and attention regulation are connected. This conclusion is supported by Montagu (2007), DeCaro and Block (2010), and Wiley et al. (2012). The definition of cognitive methods to problem solving as a complex interplay of cognitive, metacognitive, and affective processes may be used to explain this hunch. It is reasonable to suppose that problem-focused discussions include intellectual acts aimed at modifying and improving the environment. To put it another way, problem-focused coping refers to an individual's attempts to alter the circumstance and directly address the issue, which increases people's capacity for attention (Pinar et al., 2018). Attentional control is related to participants' problem solving performance (DeCaro, 2014). However, sometimes having better attention control might hinder problem-solving by encouraging

individuals to choose more involved solutions (Dicaro et al., 2016).

Also, the results demonstrated that problem solving and working memory are connected. This result is in agreement with the studies by Wiley and Jarosz (2012), and Xing et al. (2019). To explain this discovery, it might be claimed that identifying the cognitive processes required to change the current condition into the desired scenario inside the issue space constitutes solving the problem (Robertson, 2017). In combinatorial forms, experts often use subpar problem-solving techniques and working memory is important in this situation (Diaz et al., 2015). A central executive in working memory oversees and supervises the activity of two subsystems (phonological cycle and visuospatial storage). The system's central executive controls everything and distributes resources to the various subsystems. It also has a connection to cognitive processes like reasoning and problem-solving. The inner eye or visual spatial design both store and process information in visual or spatial form. Thus, problem-solving and working memory are connected (Ozbuk & McLeod, 2010). One of the main contributions of working memory capacity in analytical problem solving is by helping problem solvers to control their attention, resist distraction, and limit their search in the problem space. In contrast, some evidence suggests that excessive concentration can impair performance on creative problem-solving tasks (Wiley& Jarosz, 2012).

However, the current research did not provide evidence to support the theory that problem solving indirectly influences empathy via working memory. This conclusion may be explained by pointing out that high working memory can affect problem solving in a variety of ways, as prior research has demonstrated. Working memory is often seen as a barrier to gaining insight since it does not always foresee the adaptive aspects of problem resolution (Dicaro & Blok, 2010). Working memory is thought to be a component of the memory system that employs cognition to keep facts briefly active in order to conduct various actions on them (Finn, 2020). People who have access to fewer remedies for their interpersonal issues learn more about their own conduct and that of others (Vanlisa et al., 2017). Cognitive empathy, specifically perspective-taking, correlated with overall memory performance (regardless of encoding condition) whereas affective empathy, specifically empathic personal distress, predicted social memory encoding differently from nonsocial memory encoding (Wagner et al., 2015). Working memory cannot connect problem solving with empathy because the intricacy of cognitive processes may sometimes cause people to ignore their emotions, which reduces their capacity for empathy.

The results revealed a negative link between attention control and empathy which is in consistent with the results of Goodhew and Edwards (2021, 2022). According to the results, the concentration and shift components of attention management have distinct consequences on empathy. It has been discovered that those with stronger capacity to concentrate have lower levels of emotional empathy, but attention shifting has a positive correlation with cognitive empathy. Therefore, it may not come as a surprise that attentional control harms the emotional processes involved in empathy and diminishes empathy (Goodhew & Edwards, 2022). The intricacy of neurological processes and neural infrastructures that are successful in both empathy and attention processes may also be a factor (Morley &Lieberman, 2013). The anterior ventral insula has unique functions for emotional empathy and temporal link for cognitive empathy, according to a study. These results demonstrate that intra- and inter-individual variations in altruism are influenced by separate social cognition pathways. (Toshe et al., 2016).

Lastly, the results demonstrated that problem solving has an indirect and positive association with empathy through attention management. This result was in accordance with that of Bang and Sim (2018), Ay et al. (2020), Goodhew and Edwards (2021), Dicaro et al. (2016), Dicaro (2014), and Duma et al. (2019) and Yan et al. (2020).

Conclusion

Concerning the results, it can be stated that understanding social functions may contribute to enhance problem-solving. Consequently, all forms of empathy training may play a significant role in enhancing people's social problem solving (Ay et al., 2020). Considering the negative relationship between attention control and problem solving and the negative relationship between attention control and empathy, it is possible that the promotion of problem solving may cause disturbances in attention control. Also, reducing the negative side effects that attention control can have on empathy may result in an improvement in empathy. According to the findings of the current study, increased problem-solving ability might reduce empathy. Overall, further research is required to determine if problem solving mediated by attentional control may enhance empathy. Some suggestions for further research are as follows: It is suggested that in future research, researchers investigate the relationship between intelligence and empathy. Also, the present study can be repeated using experimental studies to obtain more valid results. Considering that emotional, cognitive, behavioral, communicative, spiritual and coping factors

are involved, models can be developed that consider the sum of these factors.

Some of the practical suggestions of this research are as follows: in line with the results of this research, we can provide brochures, banners, etc. and by holding practical workshops in universities and scientific programs in the media, the society can be informed about the importance and process of problem solving, empathy, attention control and working memory. Moreover, developing educational and interventional programs with the aim of improving human relationships can bring effective skills and strategies to adolescents and young people in improving their relationships with parents and friends, modifying problem solving style, increasing health in family environment, university and society in general, and ultimately increasing participation.

As one of the limitations of this study, we might highlight the exhaustion of some participants while completing the questionnaires. In addition, a questionnaire was utilized to gather data for this study, and since it relies on self-reporting, it is not devoid of flaws and prejudice in replying. Future study should focus on both the function of additional cognitive characteristics and the mediation role of emotions in the link between cognitive parameters and empathy. In order to acquire more reliable findings, it is also suggested that the present study be replicated utilizing experimental methods.

Ethical Considerations

Following the principles of ethics in research

This article is drawn from the original author's master's thesis. The participants' information was kept anonymous and their participation in the study was voluntary. The current research was carried out in accordance with ethical standards. This study was in compliance with the Research Ethics Council of Semnan University of Medical Sciences with the ethics ID: IR.SEMUMS.REC.1401.024.

Contribution of Authors

This paper is derived from the master's thesis of the first author, who was responsible for the implementation of the project, collecting samples and preparing the first version of the article and editting the article.

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Conflicts of interest

The authors declared no conflicts of interest.

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