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Effect of the Jigsaw-Based Cooperative Learning Method on Sense of Connectedness with School and Social Skills in Sixth Grade Elementary Students

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ABSTRACT: The current study aimed to investigate the effect of Jigsaw-based cooperative learning method on sense of connectedness with school and the social skills of Sixth grade elementary students in Abhar City, Iran. The research method was quasi-experimental (pre-test, post-test with control group). The statistical population included all sixth grade elementary school female students in Abhar city in the academic year of 2019-2020. The experimental group benefited from Jigsaw-based cooperative learning training for 12 sessions (2 hours per week including 40 minutes). Data were collected using Brew, Betty and Watt students' sense of connectedness with school scale (2004) and Matson's Evaluation of Social Skills with Youngsters (MESSY) questionnaire and analyzed using SPSS software and analysis of covariance as well. The results indicated there was a significant difference between the pre-test and post-test of the experimental group, the control group in the sense of connectedness with school (p = 0.0001) and the improvement of social skills (p = 0.001). Accordingly, the Jigsaw-based cooperative learning in experimental group was more effective on the sense of connectedness with school and the social skills compared to the control group.

Keywords: Jigsaw, sense of connectedness with school, social skills, elementary students.

Introduction

Education in any country plays an important role in the individual and social behavior of individuals. In fact, the educational activities of each country can be considered as an investment of one generation for another generation that aims at human development (Zarabian, Rastegarpour, Zandi, Sarmadi, & Farajollahi, 2010). The efficiency of educational systems depends on the richness of educational programs, strategies and, most importantly, psychological dimensions recognition of students and developing their talents. Students enjoy a healthy social connection while connecting with the school and accepting their existential value (Kadivar, 2011). One of the most important psychological issues of students that has always been emphasized by researchers is the sense of connectedness with school. They express the feeling of belonging to the school as the quality of communication, solidarity of students with their classmates and teachers, and the feeling of acceptance, respect and support of the school environment for the student (Abolghasemi Najafabadi, Mirali Rostami, & Sheikhi Fini, 2014). Anderman, Cupp, and Lane (2009) also considered the sense of connectedness with school as students' feeling of being respected and feeling comfortable in the school. Another important goal and program of educational systems for the comprehensive development of students is the development of social skills. Life skills are a set of abilities that provide the basis for adaptation and positive and useful

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behavior and enable the individual to take on the responsibilities of social roles (Khanifar & Pour Hosseini, 2011).

Considering the importance of connecting students with school, social development requirement and the acquisition of related skills, it was valuable to identify the areas and factors affecting them. Teaching patterns and methods as important and key topics in the educational system had a great impact on psychological issues of learners. The predominant style in most traditional teaching methods is competitive, and students were less likely to encounter challenging situations in learning activities, and they had fewer opportunities to think, interact, and discuss with each other; they were more likely to increase the risk of isolation among them (Abramczyk & Jurkowski, 2020). In the competitive method, students' success and failure was not related to others, and as a result, the student was solely responsible for own learning. Usually, such students had communication problems and would not be in line with the norms that govern society. With the increasing growth of human knowledge and the need for comprehensive development of learners, educational methods were expected to take an active, creative and dynamic approach (Sajadi & Sha'bani, 2014).

Studies on cooperative learning showed that the effectiveness of this approach was higher than traditional approaches. Cooperative learning had a positive effect on achievement, academic motivation, development of social skills, friendships and relationships of students' interest of school and their self-confidence (Abbasi, Sadipoor, & Asadzadeh, 2016; Afshani & Janatifar, 2016; Artut, 2009; Gull & Shehzad, 2015; Heydari & Taleb, 2019; Karami, Mohammadzade, & Afshari, 2012; Shekarey, 2012; Soltani & Hosseininasab, 2011). Cooperative learning was based on a dynamic and active learning environment in which collaboration in learning activities led to successful learning and the learner becomes an active, social and creative learner (Munafo, 2016). Participatory methods were divided into four categories: students' team learning, learning together, jigsaw, and group review (Slavin, 1990). In the meantime, Jigsaw teaching method was one of the useful and relatively new models that was first invented by Aronson (1978). In this method, the walls of the traditional teaching method were removed and the cooperation and collaboration of students was prioritized (Karacop, 2017). The jigsaw method is a technique of organizing classroom activity that makes students dependent on each other to succeed. It breaks classes and assignments into groups and pieces that the group assembles to complete the (jigsaw) puzzle (Halimah & Sukmayadi, 2019). Compared to other learning methods, this method provided a special opportunity to practice the skill of responsibility and enhance learning, and allowed students to develop common goals (Aronson, 1978). As the results of earlier studies, Jigsaw method was useful in gaining self-confidence and attending classes and was effective on the sense of belonging to peers, participation in school, relationships with peers, connection with school, participation in society and the development of social skills (Ebrahim, 2012; Gull & Shehzad, 2015; Kamaruddin & Yusoff, 2019; E. Sadeghi & Ganji, 2020; Van Ryzin & Roseth, 2021).

Despite research on the Jigsaw partnership model in other countries and examining the positive effects of this approach in different disciplines and courses, the effectiveness of this type of teaching method was not examined on psychological variables such as social skills and sense of connectedness with

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school. Accordingly, the present study seeked to answer the question of whether the Jigsaw cooperative model was effective on the social skills and sense of connectedness with school in sixth grade elementary students?

Material and Methods

The methodology of the present study was quasi-experimental with pretest-posttest design and control group. The statistical population included all sixth grade female students in Abhar, Iran, in 2020 academic year. Using cluster random sampling method, one school was randomly selected from Abhar girls' schools, and two classes were randomly selected from the sixth grade classes of the selected school. Among the selected classes, one class was considered as the control group and the other class was considered as the experimental group (Jigsaw model), randomly. 15 people in each group and a total of 30 people participated in the study. The sixth grade social studies textbook for the sixth grade of elementary school was considered as the material of the present study. In the experimental group, 12 group sessions (two 40-minute sessions per week) were taught by Jigsaw participatory learning method and in the control group, social studies were taught by traditional teaching method. Before training, pre-test was performed in both groups, and after training, post-test was performed in both groups. Subjects were given informed consent to participate in the study and were explained that they could leave the study at any time. To collect the data, the students' sense of connectedness with school scale and Matson Evaluation of Social Skills with Youngsters (MESSY) questionnaire were used.

In Brew, Beatty, and Watt (2004) research, students' sense of connectedness with school scale was used to measure sense of connectedness with school. This questionnaire had 27 items and 6 subscales of Belonging / acceptance with peers, Teacher Support, Participation in community, Relatedness of self with School, Academic engagement and Fairness & Safety, using Likert-type scaling procedures (four-point scale - strongly agree, agree, disagree and strongly disagree). The factor structure of this scale had been approved by its designers (Brew et al., 2004). The reliability coefficient of the questionnaire through Cronbach's alpha for the whole questionnaire was .75, and for Belonging / acceptance with peers .73, Teacher Support .89, Fairness & Safety .75, Participation in community .84, Relatedness of self with School .69 and Academic engagement was reported to be .78 (Brew et al., 2004).

To measure social skills, the Matson Evaluation of Social Skills with Youngsters (MESSY) questionnaire was developed by Matson, Ratori, and Helsel (1983) for individuals aged 4 to 18 years (Teodoro, Käppler, de Lima Rodrigues, de Freitas, & Haase, 2005). This scale had 56 questions with a 5-point Likert scale. Its sub-scales included appropriate social skills, antisocial behaviors, aggression and impulsive behavior, superiority and high self-esteem, and relationships with peers. The reliability coefficient of the social skills scale for the whole scale was equal to 0.86. (Matson, 1983). Research had shown that the Matson Social Skills Scale had acceptable psychometric stability, high retest reliability, and acceptable differential validity (Teodoro et al., 2005). The obtained data were analyzed by SPSS 20 software in two parts: descriptive (mean and standard deviation) and inferential (one-way analysis of covariance).

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Results

Shapiro-Wilk (SW) and Kolmogorov–Smirnov (KS) tests were used to determine the normality of data related to social skills and students' sense of connectedness with school variables. Results are presented in Table 1.

Table 1. Kolmogorov–Smirnov and Shapiro-Wilk normality test of data in the pre- and post-test

Variables	Phase	KS			SW		
		Value	N	*p*	Value	N	*p*
sense of connectedness	Post test	.188	15	.063	.833	15	.78
	Pretest	.171	15	.073	.898	15	.89
social skills	Post test	.196	15	.065	.823	15	.120
	Pretest	.178	15	.080	.863	15	.099

According to table 1, the results of Kolmogorov-Smirnov and Shapiro-Wilk tests were not significant for any of the variables (P> 0.05). This finding suggested that the data were normal in all variables in both pre- and post-test cases.

Table 2. Descriptive statistics of control group and experimental groups in the social skills and its components

Variables	Group	Phase	N	Mean	SD
Appropriate social skills	Experimental	Pretest	15	71.87	10.44
		Posttest	15	87.13	2.42
	Control	Pretest	15	77.13	11.10
		Posttest	15	76.73	9.53
Antisocial behaviors	Experimental	Pretest	15	38.80	9.82
		Posttest	15	33.47	6.99
	Control	Pretest	15	28.60	8.07
		Posttest	15	28.33	7.61
Impulsive and aggressive behaviors	Experimental	Pretest	15	44.13	9.93
		Posttest	15	36.47	9.22
	Control	Pretest	15	29.93	8.47
		Posttest	15	30.20	8.26
Supremacy	Experimental	Pretest	15	28.20	1.82
		Posttest	15	20.20	4.75
	Control	Pretest	15	18.27	4.40
		Posttest	15	18.47	4.39
Relationships with peers	Experimental	Pretest	15	25.47	9.72
		Posttest	15	32.40	7.47
	Control	Pretest	15	24.53	10.64
		Posttest	15	24.47	9.91
Self-confidence	Experimental	Pretest	15	25.13	9.75
		Posttest	15	32.67	7.65
	Control	Pretest	15	23.20	9.88
		Posttest	15	23.87	9.72
Total social skills	Experimental	Pretest	15	187.47	23.05
		Posttest	15	230.67	18.86
	Control	Pretest	15	44.13	9.93
		Posttest	15	36.47	9.22

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Table (2) showed that the scores related to the positive dimensions of the development of social skills, i.e. appropriate skills and relationships with peers in the post-test stage of the experimental group had increased. In addition, the score related to the negative dimensions of social skills, i.e. antisocial behavior, aggression and impulsive behavior, superiority and high self-confidence in the experimental group decreased. This indicated the improvement of these dimensions in the experimental group; in the control group, the components of appropriate social skills and peer relationships did not improve in the post-test phase, but quite the opposite happened. Also, in the components of antisocial behavior, aggression and impulsive behavior, aspiration for superiority and self-confidence, the average scores had increased, which indicated that these dimensions had not improved.

Table 3. Descriptive statistics of control group and experimental groups in the sense of connectedness and its components

Variables	Group	Phase	N	Mean	SD
Teacher Support	Experimental	Pretest	15	19.67	2.50
		Posttest	15	31.93	2.40
	Control	Pretest	15	24.00	3.02
		Posttest	15	25.27	3.90
Participation in community	Experimental	Pretest	15	11.80	3.43
		Posttest	15	14.73	2.09
	Control	Pretest	15	10.93	2.52
		Posttest	15	11.07	2.12
Fairness & Safety	Experimental	Pretest	15	11.47	3.14
		Posttest	15	13.60	2.20
	Control	Pretest	15	10.47	2.50
		Posttest	15	10.53	2.42
Belonging / acceptance with peers	Experimental	Pretest	15	9.60	2.10
		Posttest	15	10.93	1.16
Relatedness of self with School	Control	Pretest	15	9.40	2.20
		Posttest	15	10.67	1.35
	Experimental	Pretest	15	10.60	1.96
		Posttest	15	9.87	2.13
Academic engagement	Control	Pretest	15	9.93	2.25
		Posttest	15	10.67	1.35
	Experimental	Pretest	15	10.40	2.06
		Posttest	15	10.07	1.98
Total sense of connectedness	Control	Pretest	15	71.87	10.44
		Posttest	15	92.53	4.75
	Experimental	Pretest	15	77.13	11.10
		Posttest	15	76.73	9.53

Table 3 showed that the average scores of the components of the sense of connectedness in the experimental group had increased in the post-test. In addition, the components of individual relatedness of self with school and academic engagement in the control group did not improved the situation.

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Table 4. Analysis of covariance on the scores of social skills

Variable	Source	SS	DF	MS	F	*p*	Effect size	Power
Social skills	Corrected model	1323.897	2	661.948	10.298	.001	.433	.977
	Group	487.283	1	487.283	7.581	.010	.219	.756
	Error	1735.57	27	64.280				
	Total	431706.00	30					

Table 4 showed that the analysis of covariance was significant for examining the differences between groups in pretest and posttest for the social skills at the level below 0.01. Therefore, it could be said that there was a significant difference between the experimental and control groups in terms of social skills. On the other hand, by carefully looking at the descriptive data and comparing the means of the two groups in table 1, it was observed that the mean of the experimental group in post-test of social skills was higher than the control group. Therefore, it was inferred that the application of the Jigsaw teaching method had been effective in increasing students' social skills.

Table 5. Analysis of covariance on the scores of sense of connectedness

Variable	Source	SS	DF	MS	F	*p*	Effect size	Power
Sense of connectedness	Corrected model	258.901	2	129.451	21.500	.001	.614	1.000
	Group	195.166	1	195.166	32.414	.001	.546	1.000
	Error	162.56	27	6.021				
	Total	24166.00	30					

Table 5 showed that the analysis of covariance test to examine the differences between groups was significant for the sense of connectedness at the level 0.001. Therefore, it could be said that there was a significant difference between the experimental groups in terms of the sense of connectedness with school. On the other hand, by comparing the means of the two groups in table 2, it was observed that the mean of the experimental group in the sense of connectedness was higher than control group. Therefore, it was inferred that the application of the Jigsaw teaching method had been effective in increasing the students' sense of connectedness with school.

Discussion

The findings of the present study showed a significant effect of Jigsaw cooperative model on the development of social skills and the sense of connectedness with school in the elementary students. The students in the experimental group who received training with the Jigsaw cooperative model had a higher average in the components of social skills and sense of connectedness with school compared to the control group who were trained in the traditional method. These findings were in line with previous

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studies (Abbasi et al., 2016; Afshani & Janatifar, 2016; Artut, 2009; Gull & Shehzad, 2015; Heydari & Taleb, 2019; Karami et al., 2012; A. Sadeghi & Davoudy, 2019; Shekarey, 2012; Soltani & Hosseininasab, 2011) which showed that using Jigsaw cooperative teaching method was effective on cognitive and motivational constructs. With the effectiveness of Jigsaw cooperative method on the sense of connectedness with school and the development of social skills, it could be said in the Jigsaw cooperative model, students acquired complete skills in the part of the lesson pattern. They were required to learn and then pass on what they had learned to other members of their group. The advantage of the Jigsaw educational model was that although the results of each student's effort were different from the other, it gave all students different abilities and responsibilities; so that each member of the group studying a section or chapter of the book was responsible for teaching that section to other members of the group, so this method created a sense of intimacy and cooperation, and it caused students to transfer their skills by emphasizing a sense of cooperation. According to Aronson (2000), using Jigsaw class even for one hour a week had reduced inappropriate behaviors and increased students' interest in school. Also, according to Bandura (1986) cognitive-social theory, individuals could gain skills and information by observing their peers 'performance, and when their friends' success was enhanced, they became more eager to do the work. They appropriated role models for social and moral behavior and establish good relationships with their peers such as friendship, ability to regulate emotions and social awareness (ability to recognize public interest and group activity), and social skills (communication skills, orientation). In other words, learning ways to interact and exchange ideas with peers and friendships development among group members was part of the positive consequences of the Jigsaw participatory approach, in which students could express their ideas, defend them, and tolerate differences. At the same time, they learned to respect each other, appreciated each other, and participated instead of competing for success in the workplace and social relationships, which ultimately leads to a positive attitude toward school and a sense of connectedness with school (Kilic, 2008). According to the results of the present study on the usefulness of Jigsaw cooperative method, the development of social skills and sense of connectedness with school, it was recommended that curriculum planners and education system officials should provide the appropriate facilities in schools to use this method effectively.

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References

Abbasi, R., Sadipoor, E., & Asadzadeh, H. (2016). Comparison of the Efficacy of Three Methods of Cooperative Learning on Social Skills in Second Grade Female Students. *New Educational Approaches 11*(1), 105-124. doi:10.22108/nea.2016.21060

Abolghasemi Najafabadi, M., Mirali Rostami, U. K., & Sheikhi Fini, A. A. (2014). The effect of Jixaw participatory learning teaching method on the sense of belonging to school among high school students in Najafabad. *Curriculum Research, 4*(1), 23-35. doi:10.22099 / jcr.2014.3080

Abramczyk, A., & Jurkowski, S. (2020). Cooperative learning as an evidence-based teaching strategy: What teachers know, believe, and how they use it. *Journal of Education for Teaching, 46*(3), 296-308.

Afshani, S., & Janatifar, A. (2016). The Comparative Study of Social Participation between State and Non-profit High School Students in Yazd and Its Relevant Factors. *Journal of Applied Sociology, 27*(3), 73-96. doi:10.22108/jas.2016.20502

Anderman, E. M., Cupp, P. K., & Lane, D. (2009). Impulsivity and academic cheating. *The Journal of Experimental Education, 78*(1), 135-150.

Aronson, E. (1978). *The jigsaw classroom*: Sage.

Aronson, E. (2000). Nobody left to hate. *The Humanist, 60*(3), 17.

Artut, P. D. (2009). Experimental evaluation of the effects of cooperative learning on kindergarten children's mathematics ability. *International Journal of Educational Research, 48*(6), 370-380.

Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of social and clinical psychology, 4*(3), 359-373.

Brew, C., Beatty, B., & Watt, A. (2004). *Measuring students' sense of connectedness with school.* Paper presented at the Australian Association for Research in Education Annual Conference, Melbourne.

Ebrahim, A. (2012). The effect of cooperative learning strategies on elementary students'science achievement and social skills in kuwait. *International Journal of Science and Mathematics Education, 10*(2), 293-314.

Gull, F., & Shehzad, S. (2015). Effects of cooperative learning on students' academic achievement. *Journal of Education and Learning, 9*(3), 246-255.

Halimah, L., & Sukmayadi, V. (2019). The Role of" Jigsaw" Method in Enhancing Indonesian Prospective Teachers' Pedagogical Knowledge and Communication Skill. *International Journal of Instruction, 12*(2), 289-304.

[Downloaded from ieepj.hormozgan.ac.ir on 2026-10-17]

[DOR: 20.1001.1.25884395.2021.3.4.1.0]

[DOI: 10.52547/ieepj.3.4.564]

Heydari, N., & Taleb, Z. (2019). Effect of jigsaw's teaching method on student's relation, school bonding and test anxiety. *Rooyesh-e- Ravanshenasi Journal, 8*(3), 19-28.

Kadivar, P. (2011). *Educational Psychology* (13 ed.). Tehran: Samt Publications.

Kamaruddin, S., & Yusoff, N. M. R. N. (2019). The Effectiveness of Cooperative Learning Model Jigsaw and Team Games Tournament (TGT) towards Social Skills. *Creative Education, 10*(12), 2529-2539.

Karacop, A. (2017). The Effects of Using Jigsaw Method Based on Cooperative Learning Model in the Undergraduate Science Laboratory Practices. *Universal Journal of Educational Research, 5*(3), 420-434.

Karami, M., Mohammadzade, A., & Afshari, M. (2012). The Effect of Cooperative Learning on Group tendency and Academic Achievement of High School Students in Mashhad. *Research in Curriculum Planning, 9*(33), 93-105.

Khanifar, H., & Pour Hosseini, M. (2011). *Life Skills*. Tehran: Hajar Publication.

Kilic, D. (2008). The effect of the Jigsaw technique on learning the concepts of the principles and methods of teaching. *World applied sciences journal, 4*(1), 109-114.

Munafo, C. (2016). Cooperative Learning as Formative Approach in Physical Education for All. *International Journal of Sport Culture and Science, 4*(2), 195-205.

Sadeghi, A., & Davoudy, S. M. (2019). The Relationship between Cooperative Learning and Skilled Learning with the Satisfaction of Students Studying Foreign Languages (Russian, English, and Arabic). *Iranian Evolutionary and Educational Psychology Journal, 1*(4), 286-294.

Sadeghi, E., & Ganji, M. (2020). The effects of cooperative learning on Iranian university students' class-engagement, self-esteem, and self-confidence. *Journal of Modern Research in English Language Studies, 7*(4), 89-109.

Sajadi, F., & Sha'bani, E. A. (2014). New Patterns and Methods of History Teaching. *Monthly journal of geography and history, 193*(18), 2-8.

Shekarey, A. (2012). Effects of cooperative learning on the development of students' social skills. *Education Strategies in Medical Sciences, 5*(1), 31-37.

Slavin, R. E. (1990). Research on cooperative learning: Consensus and controversy. *Educational leadership, 47*(4), 52-54.

Soltani, A., & Hosseininasab, S. D. (2011). The effects of cooperative learning on development of social skills among students. *The Journal of New Thoughts on Education, 7*(3), 9-29. doi:10.22051/jontoe.2011.132

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[DOR: 20.1001.1.25884395.2021.3.4.1.0]

[DOI: 10.52547/ieepj.3.4.564]

Teodoro, M. L. M., Käppler, K. C., de Lima Rodrigues, J., de Freitas, P. M., & Haase, V. G. (2005). The Matson Evaluation of Social Skills with Youngsters (MESSY) and its adaptation for Brazilian children and adolescents. *Revista Interamericana de Psicología/Interamerican Journal of Psychology, 39*(2), 239-246.

Van Ryzin, M. J., & Roseth, C. J. (2021). The Cascading effects of reducing student stress: Cooperative learning as a means to reduce emotional problems and promote academic engagement. *The Journal of Early Adolescence, 41*(5), 700-724.

Zarabian, F., Rastegarpour, H., Zandi, B., Sarmadi, M. R., & Farajollahi, M. (2010). Review The Impact of E-learning Program on Dictation Skills of Primary School Students Based on Design Principles. *Technology of Education Journal (TEJ), 4*(2), 137-149. doi:10.22061/tej.2010.1350

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