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The impact of guided inquiry methods of teaching on the critical thinking of high school students

Kiumars Azizmalayeri[1] Ebrahim MirshahJafari[2] Mostafa Sharif[3] Mohammad Asgari[4] Maboud Omidi[5]
1. Department of education, University of Malayer, Iran
2. Department of education, University of Isfahan, Iran
3. Department of education, University of Isfahan, Iran
4. Department of education, University of Malayer, Iran
5. Department of studies in Education, University of Mysore, Manasagangothri, Mysore-57006, India
* E-Mail: K_ azizmalayeri@yahoo.com

Abstract
The objective pursued by the present study is to investigate the impact of guided inquiry and traditional methods of teaching on the critical thinking skills among second grade high school students. Given the purpose, a total of 190 second grade high school students were chosen through random, multi-step and cluster sampling methods in the form of 8 classes and placed into 8 experimental and control groups. A pre-test post-test design was administered to the control group. The demographic information was collected by a researcher –made questionnaire and the thinking skills information was determined by Watson - Glaser test. Two- factor covariance method was used for data analysis. Results showed that the guided inquiry method of teaching had significant impact (lower than 0.05) on the critical thinking skills of students in inference and conclusion subscales. The impact of gender factor on the students' critical thinking was significant, in terms of conclusion and interpretation subscales as well. The impact of interaction between gender and teaching method was also significant in inference and interpretation subscales.
Keywords: critical thinking, guided inquiry teaching method, traditional teaching method.

1. Introduction:

The main purpose of teaching is to stimulate further the learner's conceptual capacity as a researcher and a scholar (Lu & Ortlieb, 2009). In this regard, the critical thinking is considered as an essential condition and a defendable goal in education (Murphy, 2004). Concerning the critical thinking, a great number of definitions have been presented. As an illustration, the critical thinking can be defined as an implicit reasoning in critical research, an important tool for social responsibility, consideration of evidences in background information, theories, methods and criteria, and also as reflective thinking (Carter, et al., 2006). As for the classification of the critical thinking skills, there exist numerous divisions. According to Watson – Glaser, these divisions include inference, conclusion, assumptions, interpretation, and arguments apprise (Sendag, & odabs, 2009). Despite being of great importance, the critical thinking is often neglected, which might stem from its complex and time-consuming nature. The researches indicated that most of the schools and university graduates possess poor skills to indentify and resolve the complicated issues (Eyler & Giles, 1999; Wollett & lyneh, 1997; King & Kitchener, 1994; Suliman & Halabi, 2007). Content teaching is not scientifically sufficient by itself (National Research council, 2007). Studies showed that in most of schools and universities, the learners have no critical intellectual challenge with their courses and are not supported to improve and develop their conceptual reasoning skills (Goodlad & Keating, 1994; Paul, 1993). According to experts, the learners' poor thinking skill arises from the dominancy of traditional teaching methods and test centering (Goodlad, 1984; Mangena, 2005). In order to emphasize on research as an essential component of curriculum, an extensive modification in teaching must be noted (Jan, et al., 2001). Focus on active learning methods, especially the inquiry method, is the basic solution for the problems arisen from applying traditional methods (Lujan & Dicarlo, 2006).Teaching through the inquiry method results in increased understanding of sciences, improvement of academic achievement, more utilization of critical thinking (Prince & Felder, 2006), and progress in prediction skills (Nicholas, et al., 2005). Studies have shown that utilization of discussion, writing assignments, questioning, role playing and small group learning, as well as creating opportunity for theorization, have a significant impact on participants' critical thinking (Kuhen & Felton, 1997; Anderson, et al., 2001; Schwartz, et al., 2003; Simpson, 2002; Van Gelder, 2004). The research results indicated the significant effect of problem-solving strategy (Shabani, 1999; Badri, 2007; Angeli, 2002), group dynamics sessions (Khosrovani Zangeneh, 2002), critical reading programs (Islami, 2003), critical writing assignments (Asgari, 2007), collaborative teaching methods (Hussaini, 2009) on the learners' critical thinking skills. Moreover, the relationship between gender and thinking skills has been confirmed by some researchers (Ricketts & Rudd, 2002) and disproved by some others (Thompson, et al., 2002; Rudd & Hoover, 2000). Researchers have applied different strategies to teach critical thinking, however, the

weakness in critical thinking still continues. Regarding the overlap of science structure and scientific research with thinking structure (Paul & Elder, 2003).

2. Objectives of the study

The present study aims to study:

1. The impact of guided inquiry teaching method on second grade high school students' critical thinking.
2. Comparison of critical thinking of boys and girls in high school students.

3. Hypotheses of the study

1) There is a significant difference between critical thinking skills in guided inquiry and traditional groups.
2) There is a significant difference between critical thinking of high school male and female students.

4. Method:

4.1 Participants

Participants in the present study were 190 second-grade high school students studying in Malayer city of Iran. 95 of the participants were male students, and 95 were female students.

4.2 Design of the study

To conduct the present study, the quasi-experimental research design was applied. From the variant quasi-experimental designs, non-equivalent pretest-posttest controls design seems very appropriate. The proposed design is a multi-factor design consisting of the dependant variables of teaching method and gender as its factors. Given the design, the selected classes are randomized into two experimental and control groups.

4.3Instruments

The Watson-Glaser test of critical thinking**:** is a paper-pencil multiple-choice test with 100 questions, suiting to the reading level of a first-grade high school student. The Watson-Glaser test of critical thinking essentially consists of 5 subscales to assess the critical thinking components, including deduction, inference, recognition of assumptions, interpretation and, evaluation of arguments. The participants selected the best choice for each of the above five skills. These tools were repeatedly used in measuring the students' critical thinking at the beginning and end of a curriculum, comparing the participants' critical thinking in different educational levels, and examining the correlation between the critical thinking and other variables (Behrens, 1996).

The convergence method was applied to determine the construct validity of the Watson-Glaser test of critical thinking test. The correlation between California critical thinking scores and Watson-Glaser test scores was estimated to be 64% (r=64%). The significant and positive correlation indicated both tests measure the same construct. As a result, the Watson-Glaser test of critical thinking test has convergent validity. The test reliability was determined by Kuder-Richardson (73%) and test-retest (68%) methods. In the present study, test reliability was also computed through Kuder-Richardson on the research sample (66%).

4.4 Sample and population

Participants of this study were drawn from the whole second-grade high school students of Malayer city (a total of 3341 students, 1548 females and 1793 males), in 2011-2012 academic year. Sampling method used in this study is a combination of simple random, multi-step and cluster samplings. The selected sample included a total number of 190. Of these, 95 participants were female and 95 participants were male. In addition, the participants were homogeneous in a number of controllable features, such as age, academic grade, field of study, intelligence, and, place of study.

4.5Procedure of data collection

In this study, the data was collected using two measuring tools. The data related to critical thinking skills was determined through Watson-Glaser test (form A) and the participants' demographic information was collected by a researcher-made questionnaire.

5. Analysis and Interpretations of results

In the present study, descriptive statistics were used to show mean and standard deviation of critical thinking in both groups. Two factors covariate analysis (ANCOVA) were used to investigate the impact of guided inquiry teaching method on second grade high school students' critical thinking.

5.1 Results

Total critical thinking scores: Two factors covariate analysis (ANCOVA) revealed a significant influence of guided inquiry teaching method on critical thinking, as the obtained F value was found to be statistically significant ($F=4.501$; $p<.05$) indicating that a significant difference is between the experimental group and the control group in critical thinking skills scores. However, it is found that the sex did not have significant influence over mean scores on critical thinking skills scores, as the obtained F value was found to be statistically non-

significant (F=2.799; p<.05). The interaction between guided inquiry teaching method and sex was found to be significant (F=3.929; p<.05).

Conclusion subscale scores: Two factors covariate analysis (ANCOVA) revealed a significant influence of guided inquiry teaching method on Conclusion sub scale, as the obtained F value was found to be statistically significant (F=3.950; p<.05) indicating that a significant difference is between the experimental group and the control group in post test of Conclusion sub scale. Also it is found that the sex have significant influence over mean scores on post test of Conclusion sub scale, as the obtained F value was found to be statistically significant (F=2.945; p<.05) . However, the interaction between group and sex was found to be non-significant (F=1.640; p<.05).

Inference subscale scores: Two factors covariate analysis (ANCOVA) revealed a significant influence of guided inquiry teaching method on inference sub scale, as the obtained F value was found to be statistically significant (F=4.273; p<.05) indicating that a significant difference is between the experimental group and the control group in post test of inference sub scale. However, it is found that the sex did not have significant influence over mean scores on post test of inference sub scale, as the obtained F value was found to be statistically non-significant (F=5.507; p<.05) . The interaction between group and sex was also found to be significant (F=5.859; p<.05).

Assumption subscale scores: Two factors covariate analysis (ANCOVA) revealed a non-significant influence of guided inquiry teaching method on assumption sub scale, as the obtained F value was found to be statistically non-significant (F=.241; p<.05). Also, it is found that the sex did not have significant influence over mean scores on post test of assumption sub scale, as the obtained F value was found to be statistically non-significant (F=.158; p<.05) . The interaction between group and sex was also found to be non-significant (F=.404; p<.05).

Interpretation subscale scores: Two factors covariate analysis (ANCOVA) revealed a non-significant influence of guided inquiry teaching method on interpretation sub scale, as the obtained F value was found to be statistically non-significant (F=.499; p<.05). However, it is found that the sex have significant influence over mean scores on post test of interpretation sub scale, as the obtained F value was found to be statistically significant (F=7.967; p<.05) . Also, the interaction between group and sex was found to be significant (F=7.279; p<.05).

Argument apprise subscale scores: Two factors covariate analysis (ANCOVA) revealed a non-significant influence of guided inquiry teaching method on argument apprise sub scale, as the obtained F value was found to be statistically non-significant (F=.394; p<.05). Also, it is found that the sex did not have significant influence over mean scores on post test of argument apprise sub scale, as the obtained F value was found to be statistically non-significant (F=3.675; p<.05) . The interaction between group and sex was also found to be non-significant (F=1.113; p<.05).

6. Main finding:

The main findings of the present study are:

1. A significant influence of guided inquiry teaching method was found on total critical thinking scores and conclusion and inference sub scales.
2. Boys and girls students did not differ in their scoring on total critical thinking. Also boys and girls did not differ in their scoring on inference, assumption, and arguments appraise sub scales. However, boys and girls have significant difference on conclusion and interpretation sub scales.

7. Discussion

This study examined the impact of guided inquiry teaching method on critical thinking scores among second grade high school students in Malayer city. In order to confirm or reject the hypotheses formulated, we have tried to compare our results with further studies done in the same area.

These findings were in line with the other researchers' findings about thinking skills teaching (Simpson, 2002; Schwartz, et al., 2003; Hussaini, 2009; Badri, 2007; Islami, 2003).

Critical thinking is a complex time-consuming process, requiring preparation for high-level intellectual functions. According to some researchers (Van Gelder, 2004; Badri, 2007), being a long-term process, critical thinking must be improved from elementary school. Thus, 12 treatment sessions was less likely to create sufficient impact on critical thinking components.

The second research hypothesis based on mean difference between male and female students was confirmed only in conclusion and interpretation sub scales. These results were consistent with some researchers' findings (Ricketts & Rudd, 2002) and inconsistent with some other researchers' findings (Thompson, et al., 2002; Rudd, et al., 2000). A number of theorists believe that critical thinking is a culture-related feature

(Atkinson, 1997; Durkin, 2008). Accordingly, gender can not certainly be an effective factor in learning critical thinking.

8. Conclusion

This study investigated the effects of guided inquiry teaching method on total critical thinking scores among second grade high school students. Analysis of result showed that there is a significant influence of guided inquiry teaching method on total critical thinking scores and conclusion and inference sub scales. Also there is not a significant difference between boys and girls on total critical thinking scores.

Collaborative group discussion was considered as one of the highlighted conditions in conducting guided inquiry method. The females' more preparation to collaborate in group activities was an observable factor in experimental group. In the present study, critical thinking instruction was administered in relation to the curriculum. Many of experts assume that content knowledge in each course is correlated with the thinking skills and research methods. As a result, these two can not be separately instructed (Paul & Elder, 2003; Linn, 1983). The main components in the structure of a scientific discipline have been formed through employing scientific research methods and thinking about that discipline, and the only way of understanding and applying these components can be through the utilization of thinking skills in that scientific discipline. The guided inquiry teaching method in this study was proposed and administered using structure-oriented perspective, especially the social one. In this model, students' collaboration in knowledge building, individual and group knowledge discovery, utilization of problem-solving and group discussion, process evaluation, self and peer-group evaluations were emphasized. The basic idea supporting this method was inspired from a number of experts' opinions based on the consistency of thinking structure with science structure and scientific research method.

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List of tables:

Table 1: posttest mean scores and standard deviation for critical thinking in experimental and control group

Group	M	SD
Experimental	52/97	6/78
Control	50/76	5/61

Table 2: Mean and standard deviation of critical thinking posttest based on the gender and group

Group	Gender	M	S.D
Experimental	female	55/67	6/23
	male	49/97	6/11
Control	female	51/35	5/09
	male	50/23	5/43

Table3: The results for analysis of co-variance test comparing posttest mean scores of critical thinking groups of experimental and control based on the gender.

Source	Ss	df	Ms	F
Covariant(pretest)	124/01	1	124/01	3/267*
Covariant(mean)	140/26	1	140/26	4/154
Covariant(intelligence)	29/52	1	29/52	/874
Group	151/99	1	151/99	4/501*
Gender	94/51	1	94/51	2/799
interaction	132/66	1	132/66	3/929*

Table4: The results for analysis of co-variance test comparing posttest mean scores of critical thinking subscales in groups of experimental and control based on the gender.

subscale	source	SS	DF	MS	F
conclusion	Covariant(pretest)	94.350	1	94.350	*13.157
	Covariant(mean)	4.994	1	4.994	0.696
	Covariant(intelligence)	22.129	1	22.129	3.086
	group	28.325	1	28.325	*3.950
	gender	21.121	1	21.121	*2.945
	interaction	11.763	1	11.763	1.640
inference	Covariant(pretest)	20.307	1	20.307	*3.960
	Covariant(mean)	19.164	1	19.164	3.761
	Covariant(intelligence)	0.071	1	0.071	0.014
	group	21.775	1	21.775	*4.273
	gender	2.586	1	2.586	5.507
	interaction	30.027	1	30.027	*5.859
assumption	Covariant(pretest)	52.261	1	52.261	*13.302
	Covariant(mean)	0.724	1	0.724	0.184
	Covariant(intelligence)	1.924	1	1.924	0.490
	group	0.947	1	0.947	0.241
	gender	0.620	1	0.620	0.158
	interaction	1.587	1	1.587	0.404
interpretation	Covariant(pretest)	21.584	1	21.584	*3.454
	Covariant(mean)	0.034	1	0.034	0.005
	Covariant(intelligence)	5.097	1	5.097	0.817
	group	3.116	1	3.116	0.499
	gender	49.717	1	49.717	*7.967
	interaction	45.421	1	45.421	*7.279
Argument apprise	Covariant(pretest)	22.004	1	22.004	*4.800
	Covariant(mean)	30.245	1	30.245	*6.580
	Covariant(intelligence)	0.138	1	0.138	0.030
	group	1.811	1	1.811	0.394
	gender	16.894	1	16.894	3.675
	interaction	5.115	1	5.115	1.113

P<.05