Influence of Formal logic course on gender– A Pre and Post study in Nizwa College of Technology, Sultanate of Oman

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Abstract

The aim of this paper is to examine impact of formal logic course on the reasoning skill of higher education students. A sample of 214 students is selected from all the three departments Engineering, Information Technology and Business department from Nizwa College of Technology, Sultanate of Oman. Watson Glacier critical thinking model was adopted and a structured questionnaire was used for data collection. The analysis revealed that there is no significant relationship between critical thinking variables and formal logic course. It is found that formal logic course offered for the students is ineffective. There is no significant relationship between gender and the critical skills. The mean value of critical skills before and after learning formal logic course showed that inference skills, deductions skills, interpretation and argument skills of male students have increased. The mean of inference skills, assumptions, interpretation and argument skills for female students have decreased after learning formal logic course. The coefficient of variation values showed that males are more consistent in their critical skills compared to the females.

Key words: Inference, Assumptions, Deductions, Interpretations, Arguments

Introduction

Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and evaluating information gathered from observation, experience, reflection, reasoning or communication as a guide to belief and action (Scriven & Paul, 1996). Critical thinking is the ability to think about one's thinking in such a way as to recognize strengths and weaknesses and to think in an improved form. Critical thinking involves asking questions, defining a problem, examining evidence, analyzing assumptions and biases, avoiding emotional reasoning, avoiding oversimplification, considering other interpretations, and tolerating ambiguity Wade (1995).

Scope of the study

The goal for critical thinking instruction is to teach students to be reasonable in examining beliefs and making decisions that affect their lives (Donald 1999). The process of rational evaluation contains three steps: clarification, evaluation, and articulation. If students are not taught the fundamentals of formal logic and its application to reasoning results in (1) lack a clear standard to evaluate arguments, (2) cannot present their own ideas in a clear fashion, and (3) have trouble organizing the arguments they encounter. Oliver and Utermohlen (1995) see students as too often being passive receptors of information. Due to technology, the amount of information is massive. Students need a guide to clear through the information and not just passively accept it. Students need to develop and effectively apply critical thinking skills to their academic studies, to the complex problems that they face, and to the critical choices they will be forced to make. It is important to teach students how to ask good questions, to think critically, in order to continue the advancement of the fields we are teaching (Center for Critical Thinking, 1996). Beyer (1995) proposed the teaching of critical thinking as important to the nation. He

argued that to live successfully in a democracy, people must be able to think critically in order to make sound decisions about personal and civic affairs. If students learn to think critically, then they can use good thinking as the guide by which they live their lives.

Literature review

Modern logic is applied in the field of critical thinking, and its importance is manifested in the existence of numerous critical reading textbooks and studies (e.g. Brookfield, 1987; Browne, 2001; Browne & Keeley, 2006; Kahane & Cavender, 2006; Paul, 1990; Ruggiero, 1991). Kahane (1980) claimed that cogent reasoning must meet three criteria: believable premises, the search and inclusion of all relevant information, and valid arguments. Kahane (1989) stated that many critical thinking courses overemphasize valid arguments, and as a result, students do not study critical reasoning, but instead simply receive formal logic training. Paul (1982) argued that when teachers emphasize valid arguments over the first two criteria, students lack important critical reasoning skills such as refraining from prejudice. Consequently, students do not improve their ability to deal effectively with life's everyday problems. Kahane (1989) therefore argued that engaging students with real-life problems is an effective vehicle to shift back the emphasis of critical thinking courses to all three criteria. While Kahane views critical thinking as its own topic of study, other researchers emphasize the need to infuse critical thinking into every aspect of students' learning. Swartz, Fischer, and Parks (1998), claimed that infusing critical and creative thinking into the high-school classroom improves student learning by eliminating hastiness, narrow-mindedness, obscurity, and lack of focus. Pascarella and Terenzini (1991) reported that while the effects of learning critical thinking on college freshmen are profound, such effects quickly depreciate over time. Studying critical thinking in high school allows students to incorporate these skills into their learning process at an earlier age, thereby providing continuity and a strong foundation from which to expand during college level instruction, ultimately resulting in greater skill retention. This approach can be coupled with the support approach of Thomas, Davis, and Kazlauskas (2007), which is implemented in a variety of college courses. Eshet-Alkalai and Geri (2007) found that students, particularly of a younger age, have insufficient critical thinking and propose to infuse student classes with digital literacy skills. Critical thinking allows students to assess information by sorting out subjective, biased, or even false information and has become a key factor in transforming students into efficient information consumers (Kerka, 1999; Salomon, 2000).

Objectives of the study

1. To analyse the gender effectiveness of formal logic course on critical thinking skills.
2. To determine whether critical thinking variables are associated with gender.
3. To identify the favourable critical thinking variable improved after learning formal logic course.

Research design

The sampling frame of the study was formal logic students of Nizwa College of technology. To study the effectiveness of formal logic course a pretest and posttest was conducted on the students who studied formal logic course. A sample of 214 students was selected from all the three departments Engineering, Information Technology and Business students. The study period was Semester 2, from January 2015 to May 2015. The pretest was done in the first week of January 2015 and the posttest was administered in the last week of May 2015. Stratified random sampling was adopted to collect the samples. Watson Glacier critical thinking model was adopted and a structured questionnaire was used for data collection. The same instrument was administered before the test and after the test to the same students. Students were instructed to complete the questionnaire within 30 minutes in a relaxed atmosphere. The

study measures the critical thinking variables like inference, assumption, deduction, interpretation and arguments. Paired t-test and coefficient of variation tools are used for analysis.

Analysis and Discussion

1. Inference

An inference is a conclusion that a person can draw from certain observed or supposed facts. After each statement of fact students find several possible inferences i.e., conclusions are drawn from the stated facts. The test examines each inference separately, and makes a decision as to its degree of truth or falsity.

Table 1.1 Paired Samples Statistics (Inference of males)

	Mean	N	Std. Deviation	Std. Error Mean
Before	1.0236	127	.84011	.07455
After	1.0394	127	.90327	.08015

The mean inference skill of the male students before learning formal logic course was 1.02 with a standard deviation of 0.84. The inference skill of the males after studying formal logic course is 1.03 with a standard deviation of 0.90. The mean value shows that the inference skills of males have increased after learning formal logic course. Hence the following hypothesis is tested.

Ho: There is no change in inference skills of males after studying Formal Logic course.

H1: There is a difference in inference skills of males after studying Formal Logic course

From table 1.2, it is observed that the t-statistic, t = -0.1358 and p = 0.89.This shows there is no significant impact of formal logic on inference skills of male students. The null hypothesis is accepted, since p > 0.05. There is no strong evidence (t = -0.135, p = 0.893) that learning formal logic course has improved the inference skills of the male students. In this data set, the inference skill is increased, on average by 0.015 points.

Table 1.2. Paired Samples Test (Inference of males)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Before – After	-.01575	1.31526	.11671	-.24671	.21522	-.135	126	.893

The paired samples correlation adds the information that before and after inference skills are negatively correlated (r = -0.13, p = 0.12). At 95% confidence level the true value of difference lies between -0.24 to 0.21. This confirms that the difference in inference skills is statistically insignificant. Thus it is concluded that the increase in inference skills of male students is not due to the impact of formal logic course.

Table 1.3 Paired Samples Statistics (Inference of females)

	Mean	N	Std. Deviation	Std. Error Mean
Before	1.0460	87	.81993	.08791
After	.9080	87	.80163	.08594

The mean inference skill of the female students before learning formal logic course was 1.04 with a standard deviation of 0.81. The inference skill of the females after studying formal logic course is 0.908 with a standard deviation of 0.80. The mean value shows that the inference skills of females have decreased after learning formal logic course. Hence the following hypothesis is tested.

Ho: There is no change in inference skills of females after studying Formal Logic course.
H1: There is a difference in inference skills of females after studying Formal Logic course

From table 1.4, it is observed that the t-statistic, t = 1.191 and p = 0.237.This shows there is no significant relationship between inference skills and female students. The null hypothesis is accepted, since p > 0.05. There is no strong evidence (t = 1.191, p = 0.23) that learning formal logic course has improved the inference skills of the female students. In this data set, the inference skill is decreased, on average by 0.13 points.

Table 1.4 Paired Samples Test (Inference of females)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Before - After	.13793	1.08019	.11581	-.09229	.36815	1.191	86	.237

The paired samples correlation adds the information that before and after inference skills are negatively correlated (r = -0.113, p = 0.29). At 95% confidence level the true value of difference lies between -0.09 to 0.36. This confirms that the difference in inference skills is statistically insignificant. Thus it is concluded that the decrease in inference skills of female students is not due to the impact of formal logic course.

Table 1.5 Coefficient of variation of inference skills

Departments	Before mean	SD	CV	After mean	SD	CV
Males	1.02	0.84	82.35%	1.03	0.90	87.37%
Females	1.04	0.81	77.88%	0.90	0.80	88.88%

Coefficient of variation helps to measure the variation of before and after means of the test. The inference skills were consistent for female students before learning formal logic course. After learning the course, the consistency of males is more than the females. Moreover, the mean value shows that inference skills have increased only for males. The variable with less CV is less dispersed. Thus it is inferred that inference skills are more consistent for males.

2. Assumptions

An assumption is something presupposed or taken for granted. Each statement is followed by several proposed assumptions. Students should decide for each assumption whether it can be taken for granted, justifiably or not.

Table 2.1 Paired Samples Statistics (Assumptions of males)

	Mean	N	Std. Deviation	Std. Error Mean
Before	2.8031	127	.82654	.07334
After	2.6929	127	.92163	.08178

The mean assumption skill of the male students before learning formal logic course was 2.80 with a standard deviation of 0.82. The assumption skill of the male students after studying formal logic course is 2.69 with a standard deviation of 0.92. The mean value shows that the assumption skills reduced after learning formal logic course. Hence the following hypothesis is test1ed.

Ho: There is no difference in assumption skills of male students after studying Formal Logic course.

H1: There is a difference in assumption skills of male students after studying Formal Logic course

From table 2.2, it is observed that the t-statistic, t = 1.12 and p = 0.26. This shows there is no difference in assumption skills of male students. The null hypothesis is accepted, since p > 0.05. There is no strong evidence (t = 1.12, p = 0.26) that learning formal logic course has improved the assumption skills of the male students. In this data set, the assumption skill is decreased, on average by 0.110 points.

Table 2.2 Paired Samples Test (Assumptions of males)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Before - After	.11024	1.09999	.09761	-.08293	.30340	1.129	126	.261

The paired samples correlation adds the information that before and after assumption skills are positively correlated (r = 0.212, p = 0.17). At 95% confidence level the true value of difference lies between -0.08 to 0.303. This confirms that the difference in assumption skills is statistically insignificant. Thus it is concluded that the decrease in assumption skills of male students is not due to the impact of formal logic course.

Table 2.3 Paired Samples Statistics (Assumptions of females)

	Mean	N	Std. Deviation	Std. Error Mean
Before	2.9080	87	.74134	.07948
After	2.7011	87	1.00134	.10735

The mean assumption skill of the female students before learning formal logic course was 2.90 with a standard deviation of 0.74. The assumption skill of the female students after studying formal logic course is 2.70 with a standard deviation of 1.00. The mean value shows that the assumption skills have reduced after learning formal logic course. Hence the following hypothesis is tested.

Ho: There is no difference in assumption skills of female students after studying Formal Logic course.

H1: There is a difference in assumption skills of female students after studying Formal Logic course

From table 2.4, it is observed that the t-statistic, t = 1.51 and p = 0.13. This shows there is a no significant relation between assumption skills and female students. The null hypothesis is accepted, since p > 0.05. There is no strong evidence (t = 1.51, p = 0.13) that learning formal logic course has improved the assumption skills of the female students. In this data set, the assumption skill is decreased, on average by 0.206 points.

Table 2.4 Paired Samples Test (Assumptions of females)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Before - After	.20690	1.27715	.13692	-.06530	.47909	1.511	86	.134

The paired samples correlation adds the information that before and after assumption skills are negatively correlated (r = -0.53, p = 0.625). At 95% confidence level the true value of difference lies between -0.06 to 0.47. This confirms that the difference in assumption skills is statistically insignificant.

Thus it is concluded that the decrease in assumption skills of female students is not due to the impact of formal logic course.

Table 2.5 Coefficient of variation of assumption skills

Departments	Before mean	SD	CV	After mean	SD	CV
Males	2.80	0.82	29.28%	2.69	0.92	34.20%
Females	2.90	0.74	25.51%	2.70	1.00	37%

The mean value of assumptions skills shows that there is no positive change in gender. The coefficient of variation score of assumption skills before learning was less dispersed for females. But after learning the course the coefficient value is more consistent and less variable for males. The variable with less CV is less dispersed. Thus it is inferred that assumption skills are more consistent for males.

3. Deductions

An exercise consisting of several statements followed by several suggested conclusions is given. The statements in each exercise are considered as true without exception. The students should judge whether each conclusion necessarily follows the statement.

Table 3.1 Paired Samples Statistics (Deductions of males)

	Mean	N	Std. Deviation	Std. Error Mean
Before	1.7165	127	.90762	.08054
After	1.7953	127	.79020	.07012

It is clear from table 3.1 that the mean deduction skill of the male students before learning formal logic course was 1.71 with a standard deviation of 0.90. The deduction skill of the male students after studying formal logic course is 1.79 with a standard deviation of 0.79. The mean value shows that the deduction skills have increased after learning formal logic course. Hence, the following hypothesis is tested.

Ho: There is no difference in deduction skills of male students after studying Formal Logic course.

H1: There is a difference in deduction skills of male students after studying Formal Logic course.

From table 3.2, it is observed that the t-statistic, t = -0.740 and p = 0.461. This shows there is a large probability of this result occurring by chance, under the null hypothesis of no difference. The null hypothesis is accepted, since p > 0.05. There is no strong evidence (t = -0.74, p = 0.46) that learning formal logic course has improved the deduction skills of the male students. In this data set, the deduction skill is increased, on average by 0.078 points.

Table 3.2 Paired Samples Test (Deductions of males)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Before - After	-.07874	1.19925	.10642	-.28933	.13185	-.740	126	.461

The paired samples correlation adds the information that before and after deduction skills are not correlated (r = 0.007, p = 0.938). At 95% confidence level the true value of difference lies between -0.289 to 0.131. This confirms that the difference in deduction skills is statistically insignificant. Thus it is

concluded that the increase in deduction skills of male students is not due to the impact of formal logic course.

Table 3.3 Paired Samples Statistics (Deductions of females)				
	Mean	N	Std. Deviation	Std. Error Mean
Before	1.6782	87	.65582	.07031
After	1.7471	87	.79560	.08530

It is clear from table 3.3 that the mean deduction skill of the female students before learning formal logic course was 1.67 with a standard deviation of 0.65. The deduction skill of the female students after studying formal logic course is 1.74 with a standard deviation of 0.79. The mean value shows that the deduction skills increased after learning formal logic course. Hence, the following hypothesis is tested.

Ho: There is no difference in deduction skills of female students after studying Formal Logic course.

H1: There is a difference in deduction skills of female students after studying Formal Logic course.

From table 3.4, it is observed that the t-statistic, t = -0.630 and p = 0.53. This shows there is no significant relationship between formal logic and deduction skills of female students. The null hypothesis is accepted, since p > 0.05. There is no strong evidence (t = 0.63, p = 0.53) that learning formal logic course has improved the deduction skills of the female students. In this data set, the deduction skill is increased, on average by 0.068 points.

Table 3.4 Paired Samples Test (Deductions of females)								
	Paired Differences							
				95% Confidence Interval of the Difference				
	Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Before - After	-.06897	1.02064	.10942	-.28649	.14856	-.630	86	.530

The paired samples correlation adds the information that before and after deduction skills are slightly correlated (r = 0.02, p = 0.851). At 95% confidence level the true value of difference lies between -0.286 to 0.148. This confirms that the difference in deduction skills is statistically insignificant. Thus it is concluded that the increase in deduction skills of female students is not due to the impact of formal logic course.

Table 3.5 Coefficient of variation of deduction skills

Departments	Before mean	SD	CV	After mean	SD	CV
Males	1.71	0.90	52.63%	1.79	0.79	44.13%
Females	1.67	0.65	38.92%	1.74	0.79	45.40%

The mean value of deductions skills shows that there is a positive change in gender. The mean score of deductions have increased for both males and females after the course. The coefficient of variation score of deduction skills before learning was less dispersed for females. But after learning the course the coefficient value is more consistent and less variable for males. The variable with less CV is less dispersed. Thus it is inferred that deduction skills are more consistent for males.

4. Interpretations

This skills measure whether students can logically conclude from a given set of information. The problem is to judge whether or not each of the proposed conclusions logically follows beyond a reasonable doubt from the information given.

Table 4.1 Paired Samples Statistics (Interpretations of males)

	Mean	N	Std. Deviation	Std. Error Mean
Before	1.3228	127	.92481	.08206
After	1.5197	127	1.06048	.09410

Table 4.1 shows that the mean interpretation skill of the male students before learning formal logic course was 1.32 with a standard deviation of 0.924. The interpretation skill of the male student after studying formal logic course is 1.51 with a standard deviation of 1.06. The mean value shows that the interpretation skills have increased after learning formal logic course. Hence the following hypothesis is tested.

Ho: There is no difference in interpretation skills of male students after studying Formal Logic course.

H1: There is a difference in interpretation skills of male students after studying Formal Logic course

From table 4.2, it is observed that the t-statistic, t = -1.642 and p = 0.103. This shows there is no difference in interpretations skills of male students. The null hypothesis is accepted, since p > 0.05. There is no strong evidence (t = -1.642, p = 0.10) that learning formal logic course has improved the interpretation skills of the male students. In this data set, the interpretation skill is increased, on average by 0.196 points.

Table 4.2 Paired Samples Test (Interpretations of males)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Before - After	-.19685	1.35130	.11991	-.43415	.04045	-1.642	126	.103

The paired samples correlation adds the information that before and after interpretation skills are positively correlated (r = 0.078, p = 0.38). At 95% confidence level the true value of difference lies between -0.434 to 0.040. This confirms that the difference in interpretation skills is statistically insignificant. Thus, it could not be concluded that the increase in interpretation skills of male students is due to the impact of formal logic course.

Table 4.3 Paired Samples Statistics (Interpretations of females)

	Mean	N	Std. Deviation	Std. Error Mean
Before	1.3563	87	.88891	.09530
After	1.2644	87	.89520	.09598

Table 4.3 shows that the mean interpretation skill of the female students before learning formal logic course was 1.35 with a standard deviation of 0.88. The interpretation skill of the female students after studying formal logic course is 1.26 with a standard deviation of 0.895. The mean value shows that the interpretation skills of the females decreased after learning formal logic course. Hence the following hypothesis is tested.

Ho: There is no difference in interpretation skills of female students after studying Formal Logic course.

H1: There is a difference in interpretation skills of female students after studying Formal Logic course

From table 4.4, it is observed that the t-statistic, t = 0.679 and p = 0.499. This shows there is no significant relationship between formal logic course and the interpretation skills of female students. The null hypothesis is accepted, since p > 0.05. There is no strong evidence (t = 0.670, p = 0.49) that learning formal logic course has improved the interpretation skills of the female students. In this data set, the interpretation skill is decreased, on average by 0.091 points.

Table 4.4 Paired Samples Test (Interpretations of females)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Before - After	.09195	1.26337	.13545	-.17731	.36121	.679	86	.499

The paired samples correlation adds the information that before and after interpretation skills are negatively correlated (r = -0.003, p = 0.979). At 95% confidence level the true value of difference lies between -0.177 to 0.361. This confirms that the difference in interpretation skills is statistically insignificant. Thus, it could not be concluded that the decrease in interpretation skills of female students is due to the impact of formal logic course.

Table 4.5 Coefficient of variation of interpretations skills

Departments	Before mean	SD	CV	After mean	SD	CV
Males	1.32	0.92	69.69%	1.51	1.06	70.19%
Females	1.35	0.88	65.18%	1.26	0.89	70.63%

The mean value of interpretations skills have increased for the males after learning formal logic and the mean value has decreased for the females. The coefficient of variation shows that interpretation skills were consistent and favourable for females before the course. But the coefficient of variation is less for males after the course and it is more consistent for males. The variable with less CV is less dispersed. Thus it is inferred that interpretation skills are more consistent for males.

5. Arguments

In making decisions about important questions, it is desirable to be able to distinguish between arguments that are strong and arguments that are weak. For an argument to be strong, it must be both important and directly related to the question. An argument is weak if it is not directly related to the question.

Table 5.1 Paired Samples Statistics (Arguments skills of males)

	Mean	N	Std. Deviation	Std. Error Mean
Before	1.6535	127	.81043	.07191
After	1.6772	127	.80556	.07148

Table 5.1 shows that the mean argument skill of male students before learning formal logic course was 1.65 with a standard deviation of 0.810. The argument skill of the student after studying formal logic course is 1.67 with a standard deviation of 0.805. The mean value shows that the argument skills of the males have increased after learning formal logic course. Hence, the following hypothesis is tested.

Ho: There is no difference in argument skills of male students after studying Formal Logic course.

H1: There is a difference in argument skills of male students after studying Formal Logic course

From table 5.2, it is observed that the t-statistic, t = -0.231 and p = 0.817. This shows there is no difference in the argument skills of male students. The null hypothesis is accepted, since p > 0.05. There is no strong evidence (t = 0.231, p = 0.817) that learning formal logic course has improved the argument skills of the students. In this data set, the argument skill is increased, on average by 0.023 points.

Table 5.2 Paired Samples Test (Arguments skills of males)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Before - After	-.02362	1.15101	.10214	-.22575	.17850	-.231	126	.817

The paired samples correlation adds the information that before and after arguments skills are negatively correlated (r = -0.015, p = 0.87). At 95% confidence level the true value of difference lies between -0.225 to 0.178. This confirms that the difference in arguments skills is statistically insignificant. Thus it is concluded that the increase in arguments skills is not due to the impact of formal logic course.

Table 5.3 Paired Samples Statistics (Arguments skills of females)

	Mean	N	Std. Deviation	Std. Error Mean
Before	1.6897	87	.88015	.09436
After	1.6207	87	.85238	.09138

Table 5.3 shows that the mean argument skill of female students before learning formal logic course was 1.68 with a standard deviation of 0.88. The argument skill of the female student after studying formal logic course is 1.62 with a standard deviation of 0.85. The mean value shows that the argument skills of the females have decreased after learning formal logic course. Hence, the following hypothesis is tested.

Ho: There is no difference in argument skills of female students after studying Formal Logic course.

H1: There is a difference in argument skills of female students after studying Formal Logic course

From table 5.4, it is observed that the t-statistic, t = -0.560 and p = 0.577. This shows there is no significant relationship between argument skills and female students. The null hypothesis is accepted, since p > 0.05. There is no strong evidence (t = 0.560, p = 0.577) that learning formal logic course has decreased the argument skills of the students. In this data set, the argument skill is decreased, on average by 0.068 points.

Table 5.4 Paired Samples Test (Arguments skills of females)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Before - After	.06897	1.14925	.12321	-.17597	.31390	.560	86	.577

The paired samples correlation adds the information that before and after arguments skills are significantly positively correlated (r = 0.120, p = 0.267). At 95% confidence level the true value of difference lies between -0.175 to 0.313. This confirms that the difference in arguments skills is statistically insignificant. Thus it is concluded that the decrease in arguments skills of the female students is not due to the impact of formal logic course.

Table 5.5 Coefficient of variation of argument skills

Departments	Before mean	SD	CV	After mean	SD	CV
Males	1.65	0.81	49.09%	1.67	0.80	47.90%
Females	1.68	0.88	52.38%	1.62	0.85	52.46%

The mean value of argument skills have increased for the males after learning formal logic and the mean value has decreased for the females. The coefficient of variation shows that argument skills were consistent and favourable for males before and after learning the course. The variable with less CV is less dispersed. Thus it is inferred that argument skills are more consistent for males.

Findings of the study

1. It is found that formal logic course offered for the students is ineffective. It could not be proved that formal logic course has significantly contributed or improved the critical thinking skills of the students. There is no significant relationship between gender and the critical skills i.e. inference, assumptions, deductions, interpretations and arguments.

2. The mean value of critical skills before and after learning formal logic course showed that inference skills, deductions skills, interpretation and argument skills of male students have increased. The mean of assumptions skills have decreased for male students. The mean value of deductions skills have increased for female students. The mean of inference skills, assumptions, interpretation and argument skills for female students have decreased after learning formal logic course.

3. The Coefficient of Variation values showed that males are more consistent and the dispersion is less compared to the females. All the critical skills i.e., inference skills, assumption skills, deduction skills, interpretation skills and argument skills are more consistent for males than the female students.

Conclusion

In this study, the effect of gender on students' reasoning abilities was investigated. The study aimed to analyse the influence of formal logic course on gender in improving the critical skills of students. Results showed that boys have higher scores than girls on reasoning variables. The mean values showed that critical skills have increased for boys than girls. But it could not be statistically proved that gender has a relationship with formal logic course. The study concluded that formal logic course offered to the students was ineffective in improving their critical thinking skills. The analysis revealed that the decrease or increase in their critical skills was not due to formal logic course. The study findings matches with the results of Valanides (1996) that showed there were no significant differences between boys and girls with respect to five reasoning modes. However, if the course is modified to suit the requirements of students belonging to different departments, it may prove to more effective. The course would be more effective if the contents are modified matching with the graduate attributes. This will help to improve the skills set required by students from different departments. This study can be used a base for further longitudinal studies that would contribute towards developing curriculum design and teaching approaches in higher education that enables learning through critical thinking.

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