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EFFECT OF DUVAL'S SEMIOTIC APPROACH ON HIGHER ORDER THINKING SKILLS IN RELATION TO GENDER

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ABSTRACT

The present Pre test - Post test experimental research was conducted to study the effect of Duval's Semiotic approach (DSA) on Higher Order Thinking Skills (HOTS) of Boys and Girls of X Class. Out of the sample of 268 math's students, 132 respondents were included in the investigational group and remaining 136 students were categorized as control Group. A pre-test for Higher Order Thinking Skills was given to both the groups, investigator had given a 40 days treatment based on Duval's semiotic Approach to the experimental group, which were then administered a post test of Higher Order Thinking Skills. The results show Duval's Semiotic Approach as an efficient treatment strategy to develop the Higher Order Thinking Skills in the mathematics students and results also show that interaction effect of instructional strategies (DSA/CGL) and Gender yielded significantly different means score on Higher Order Thinking Skills.

Keywords: Mathematics, Treatment, Conversion, Semiotic Register, Representations.

1. Introduction

Mathematics has its individual verbal communication and code to shorten the long statements. It helps in the expression of ideas or things by providing them the precise outline. Mathematics is the creation of the mind of the man. Lindsay a great mathematician remarked "Mathematics is the language of physical sciences and certainly no more marvellous language was ever created by the mind of man."

Mathematics is based on reason and originality; it is pursued both for realistic purposes and for its inherent significance. The real meaning of mathematics is in its magnificence and scholarly challenges. Main importance of mathematics is in its appliance. Mathematics plays a very important role in the growth of contemporary background, science and technology. Some fundamental perception of the temperament of the subject is required for its technical knowledge and relevance. The Kothari commission in its report in 1966 said that "It emphasized the

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importance of children's learning mathematics for the development of science and technology and for industrial growth. One of the outstanding characteristic of scientific culture is quantification. Mathematics therefore assumes a prominent position in modern education. Apart from its role in physical sciences, it is now playing an increasingly important part in the development of biological sciences".

1.1 Duval's Semiotic Approach

Duval's emphasis on "registers of representation" (words, symbolic expressions, graphs, diagrams) reminds of Post, Behr, Lesh, and Harel's ideas regarding modes of representation in their Rational Number Project investigations (Behr, Khoury, Harel, Post, & Lesh, 1997; Behr & Post, 1980; Behr, Harel, Post, & Lesh, 1993; Lesh, Behr, & Post, 1987). But it is different, too. The RNP's attention was on external figurations and meanings they possessed, whereas Duval's notion of representation (semiotic system) is more attuned to the activity of the representer. But his point is well taken that we must give explicit attention in instructional design to students' coordinating representational processes across registers.

Duval (1995, p.21) says a semiotic system of representation is called a **register of semiotic representation** when it satisfies the three cognitive activities which are inherent to all representations:

- Constitutes a set of perceptible **mark(s)** that allow one to identify it (them) as a representation of something on a given system.
- The representations can be **transformed** within the semiotic system (according to the rules in it) such that the obtained representation constitutes a gain in knowledge in comparison with the initial representation.
- The representations can be **converted**, from one system into another, such that (the resulting representation) allows one to make explicit other meanings related to that which is represented.

It is important to notice that not all semiotic systems are **registers** of semiotic representation. (cf. Duval, 1995, p.22)

1.2 Higher Order Thinking Skills

Higher Order Thinking Skills (HOTS) deal with one's competence with regard to putting in practice one's erudition, aptness and values in reasoning, reflection, problem-solving, decision-making, innovating and making and making of new things (Ministry of Education [MOE], 2013). In the 21st century pedagogy, it is desired of that educators have the ability to inculcate HOTS constituents for the purpose of encouraging in-depth reasoning activities amidst their pupils. This

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is in line with the aspiration of the Malaysian Education Blueprint 2013-2025. Reasoning abilities are indeed some inborn basic abilities that can be articulated in the classroom teaching and are a key to high accomplishments by all pupils, (Nessel& Graham, 2007). The perception of higher order thinking (HOT) began from the Bloom (1956) classification of cognitive terrain (Forehand, 2010), these cognitive domains deal with knowledge and the expansion of academic skills and in hierarchically ordered from solid understanding to theoretical topics(Pappas, Pierrakos & Negal, 2012). Now, HOTS comprise rational thinking, decisive thinking and calculating skills which are some of the vital skills for daily life, separately from the educational accomplishments (Marshall & Horton, 2011).

The application of HOTS in pedagogy and assessment for example, through inquiry-based learning and high-level questioning in pedagogy and assessment, can promote HOTS among students and directly improve students' achievements (Boaler& Staples, 2008; Franco, Sztajn, &Ramalho, 2007). Accordingly, education development can definitely become beneficial for learners in case these learners are straightway roped in the thinking practice (Vygotsky, 1962; 1934). These approaches encourage the use of higher-order thinking skills and cognitive development.

2. Objectives

This research was conducted by observance in vision the subsequent objectives:

1. To study the effect of two instructional strategies (DSA vs. CGL) on higher order thinking skills.
2. To study the effect of Gender on higher order thinking skills.
3. To study the interactive effect of Gender and two instructional strategies (DSA vs. CGL) on higher order thinking skills.

3. Hypothesis

H01: There exists no significant difference in Higher Order Thinking Skills of students studying through instructional strategies (DSA vs. CGL).

H02: There exists no significant difference in Higher Order Thinking Skills of Male & Female students.

H03: There exists no significant interaction effect of Gender (male & female) and two instructional strategies (DSA vs. CGL) on Higher Order Thinking Skills.

H03.1: Through DSA, Male and Female students do not differ in their post- test scores of HOTS.

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H03.2: Through CGL, Male and Female students do not differ in their post- test scores of HOTS.

H03.3: Male students achieve equal HOTS mean scores in DSA and CGL.

H03.4: Female students achieve equal HOTS mean scores in DSA and CGL.

4. Tool Used

1. Duval's Semiotic Approach (prepared by the researcher himself)
2. Higher Order Thinking Skills (prepared by the researcher himself)

5. Sample

The data for the present investigation was collected from 268 higher and secondary school students comprising of 157 boys and 111 girls from 4 schools belonging to private type of management .The study is undertaken in the schools of Amritsar district of Punjab.

6. Results and Discussion

In this segment by using various statistical techniques (Analysis of Variance & t-test on post test scores) the hypotheses of the research investigation was verified as given below:

Table 1. Summary of ANCOVA to test the effect of Instructional Strategies (DSA vs. CGL) on Higher Order Thinking Skills.

Sources of variation	Sum of Squares (SS)	df	Mean Sum of Squares (MSS)	F-ratio	Level of Significance
Main Effect: (A) **Instructional strategies** DSA and CGL	1334.217	1	1334.217	164.456**	.01 level

** Significance at the 0.01 level of confidence

Main Effect: (A)
Instructional Strategies (DSA and CGL)

Table 1 depicts that F-ratio, testing main effect for two instructional strategies viz. DSA and CGL on Higher Order Thinking skills was significant at the 0.01 level of confidence, indicating that two groups differ significantly on their means as measured by the HOTS. Hence, the hypothesis H01 stating that *there exists no significant difference in Higher Order Thinking Skills of students studying through instructional strategies (DSA vs. CGL)* was rejected at specified level. It may be concluded that the HOTS mean of total scores were significantly different for students learning through two instructional strategies. These differences have been further study

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by applying t-test. The Means, SD and t-ratios for the differences between HOTS adjusted mean of different combination group- DSA and CGL were computed and have been reported in Table 2.

Table 2: Adjusted Mean and t-ratio for difference on Post Test HOTS Score for DSA and CGL

Group	N	Adjusted Mean	SD	t-value	Level of significance
DSA	132	23.14	12.98	3.32**	0.01 level
CGL	136	18.59	9.15		

** Significance at the 0.01 level of confidence

Table 2 depicts that the t-ratio for the difference in Post Test HOTS scores of DSA and CGL (t= 3.32) was significant at the 0.01 level of confidence, suggesting that the post test HOTS mean scores of students learning through two instructional strategies differed beyond the contribution of chance factor. As seen from the table DSA yielded higher HOTS mean (M=23.14) than CGL (M=18.59).

Mean gain scores of main effect corresponding to instructional strategies (DSA and CGL) on Higher Order Thinking Skills are depicted through bar diagram figure 1.

Fig 1: Adjusted mean Score of Instructional Strategies on HOTS

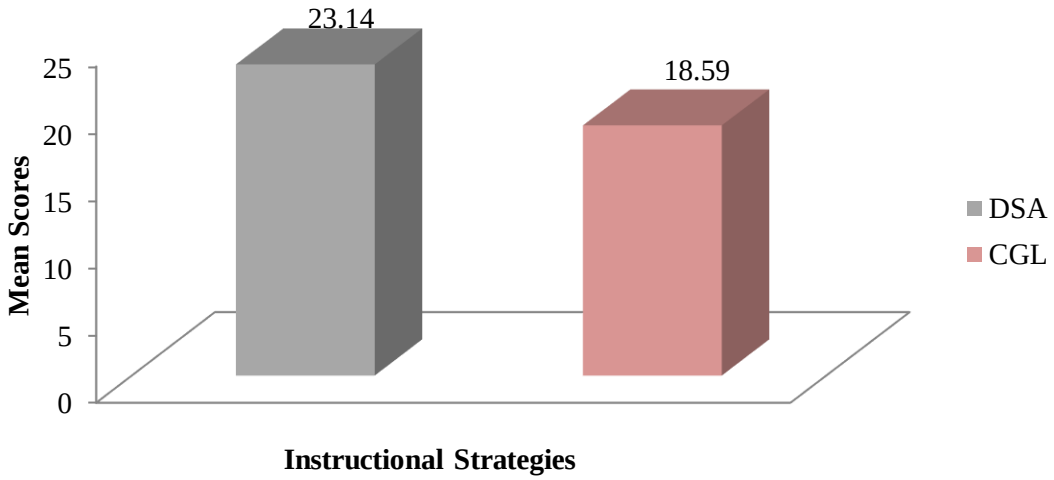

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Figure 1 shows that mean scores of group taught through Duval's Semiotic Approach is higher than that of the group taught through conventional learning on Higher Order Thinking Skills Gender wise.

Table 3. Summary of ANCOVA to test the effect of Gender on Higher Order Thinking Skills

Sources of variation	Sum of Squares (SS)	df	Mean Sum of Squares (MSS)	F-ratio	Level of Significance
Main Effect: (B) Gender (Male / Female)	1.432	1	1.432	.176	N.S.

NS- Non significant

Main Effect: B
Gender

Table 3 depicts that F-ratio; testing main effect of Gender (Male & Female) on Higher Order Thinking skills was not significant even at the 0.05 level of confidence, leading to supporting the hypothesis *H02: There exists no significant difference in Higher Order Thinking Skills of Male & Female students.* It may be concluded that HOTS mean scores were not significantly different for male and female students.

Table 4. Summary of ANCOVA to test the effect of interaction effect of gender and instructional strategies (DSA vs. CGL) on Higher Order Thinking Skills.

Sources of variation	Sum of Squares (SS)	df	Mean Sum of Squares (MSS)	F-ratio	Level of Significance
Interaction (A X B) Instructional Strategies × Gender	114.125	1	114.125	14.067**	.01 Level

**Significant at the 0.01level of confidence

Interaction Effect: (A× B)

Table 4 depicts that F-ratio, testing Interaction effect (Instructional Strategies × Gender) on Higher Order Thinking skills was found to be significant at the 0.01 level of confidence. Hence, the hypothesis H012 stating that *there exists no significant interaction effect of Gender and two instructional strategies (DSA vs. CGL) on Higher Order Thinking Skills* was rejected at specified level. It leads to conclude that groups were different beyond chance. The differences were

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examined further with the help of t-test. The t-ratios for the difference in means score of various combination groups were computed and have been placed in the table 5.

Table 5: t-ratios for different combination groups of instructional strategies and male & female students (Gender) on HOTS

Combination of Groups	DSA		CGL	
	Male M= 15.73 SD= 10.25 N= 75	Female M= 30.26 SD= 11.56 N= 57	Male M= 17.96 SD= 9.00 N= 82	Female M= 22.38 SD= 8.79 N= 54
Male.DSA	-	7.633**	1.451	3.854*
Female.DSA	-	-	7.044**	4.026*
Male.CGL	-	-	-	2.828*
Female.CGL	-	-	-	-

**Significant at the 0.01level of confidence

* Significant at the 0.05level of confidence

For Instructional Strategy

For DSA with Male and Female

Out of the t-ratios for the difference in means of male and female student learning through DSA, t-ratio for difference in male and female groups was seen to be significant at the 0.01 level of confidence. It suggested a significant difference in their means and not only a chance factor. Hence, H03.1 was rejected the female students scored higher means (M=30.26) as compared to that of male students (M=15.73).

For CGL with Male and Female

It may be observed from the table 5 that while going through conventional group learning (CGL), t-ratio for the difference in means of male and female students was significant even at the 0.05 level of confidence, suggesting that difference was not only by chance. Thus, the hypothesis H03.2 was rejected at the specified level. It led to conclusion that female students scored higher means (M=22.38) as compared to that of male students (M=17.96).

For Gender (Male & Female)

For Male through DSA and CGL

The t-ratio for the difference in means of male students, learning through DSA and CGL was not significant even at the 0.05 level of confidence. Thus, hypothesis H03.3 stands accepted at the specified level. It led to conclude that there was no significant difference in the means of male students learning through DSA and CGL on HOTS.

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For Female through DSA and CGL

The t-ratio for the difference in means score of female students learning through DSA and CGL was significant at the 0.05 level of confidence. Thus hypotheses H03.4 stands rejected at the specified level. An overview of their means leads to conclude that females achieved higher means score through DSA (M=30.26) rather than that of CGL (M=22.38). It led to conclude that the female students achieved higher means score when studying through DSA instructional mode as compared to CGL, for HOTS.

7. Discussion

Although no direct study was found to be sufficient for the support of rejected hypothesis

H01: *There exists no significance difference in Higher Order Thinking Skills of students studying through instructional strategies (DSA vs. CGL).*yet there were number of studies, which indirectly put emphasis on HOTS through teaching of mathematics and another strategies. Study conducted by **Hopson, Simms and Knezek (2001)** investigated the consequence of a technology-based classroom on learner`s progress of higher-order thinking skills and learners attitudes toward computers. Study revealed that establishing a technology-based classroom atmosphere had a encouraging effect on student attainment of higher-order thinking skills and teachers reported that the technology-enriched classroom differed from the traditional classroom in several significant ways.

Wing, Piaw and Chang (2014) investigated the effects of two teaching strategies, aural-imitative and aural-motivic analyses on higher-order thinking skills (HOTS) and original melodious product in composition improvement. Results of the SPANOVA test show that the aural-motivic analysis teaching strategy significantly improved HOTS and CMP of the participants.

Hadjichristou and Ogbonnaya (2015) examined the effect of using the Lakatosian heuristic method on students' achievement according to Bloom's taxonomy. Data analysis using shows that the investigational group scored more than the control group and also revealed more positive higher-order thinking skills than control group.

The findings of present investigation also provided sufficient evidence to accept the hypothesis ***H02:*** *There exists no significant difference in Higher Order Thinking Skills of students with Male & Female students.* The findings of the present study show similarity with the results reported by **Saido, Siraj, Bin Nordin and Al Amedy (2015) who study the** 7th grade students' higher order thinking skills level of 7^{th} class student. The overall findings revealed that the rejected hypothesis ***H03****: There exists no significant interaction effect of a gender students and two instructional strategies (DSA vs. CGL) on Higher Order Thinking Skills* was retained as

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instructional strategies and male & female students on HOTS are dependent of each other. No direct studies were found to be sufficient for the support of the hypothesis but the H03 indirectly supported by **Alsowat (2016)** investigated the effect of Flipped Classroom Teaching Model students' English higher order thinking skills (HOTS), engagement and satisfaction. Also, it examined the relationship between higher-order thinking skills, engagement and satisfaction. Findings of the research revealed there was significant relationship between HOTS and student engagement, HOTS and satisfaction and between student engagement and satisfaction. And **Shukla and Dungsungnoen (2016)** in their study explored the level of HOTS among students and its differences in males and females. The finding of the research revealed that teachers' professional components such as rank, teaching experience and qualification are significantly correlated with strategies used for inculcating higher order thinking skills.

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