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Effect of learning style and intelligence on achievement in biology

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Abstract
This study is part of an ongoing research aiming to examine the effect of learning style and intelligence on achievement in Biology. The sample included 320 Class IX students from Amritsar city. Achievement test in Biology, Kolb Learning Style Inventory and General Group Test of Intelligence were used to collect the data. Experimental group was taught by web based instruction accommodating the students with different types of learning styles and levels of intelligence. Control group was taught by conventional mode of instruction. Interaction effect of learning style and intelligence was studied and the F value calculated by using two way ANOVA test came out to be 3.16 which is significant at 0.05 level of confidence. t-values for the difference in mean gain score on the variable of achievement in Biology with the different combination pairs (DI/CO/AC/AS-HI/LI) were also found. t-values for few combination pairs came out to be significant and for few came to be insignificant, thus partially accepting the hypothesis.

Keywords: Achievement in Biology, Learning style and intelligence.

1. Introduction
K-era exposes students to a competitive world and its core weapon is knowledge. Caring, sharing and using knowledge are key factors that can help them in facilitating learning, applying knowledge and allowing them to become more active participants in the teaching-learning process. For achieving the above objectives, students have to acquire, analyze, present and communicate information in a way different from the conventional way. But during their education period, most of them are taught in the style that is compatible to a teacher not to students. Every student has a unique style of processing and digesting information. Learners with a strong preference for a specific learning style might have difficulties in learning if their learning style is not supported by the teaching environment (Felder and Silverman, 1988; Felder and Soloman, 1997). Many experimental studies in differential psychology have shown that individual differences play an important role in learning. In search of practical means to respect these differences, research was directed towards the concept of "learning style" relating to the individual's learning preferences (Brusilovsky and Millán, 2007).

Individuals may have different preferences with regard to when, where and how to learn. Though all human beings have common bio-psychological and social characteristics in the learning process, yet individuals vary in ways they perceive and process the information which is known as their learning style. Some prefer to learn actively and interactively, others function more introspectively and individually (Felder, 1996). In this sense, learning style is, on one hand, sensory and on the other hand, mental (Kolb, 1984). There is no right or wrong/good or bad learning style. Learning styles refer to how individuals prefer to organize and represent information (Reed and Oughton 1997).

Many educational theorists and researchers consider learning style as an important factor in the learning process and agree that incorporating them in education will make learning easier for students, help to improve the teaching-learning process and ultimately lead to better learning outcomes. According to Zapalska and Dabb (2002), an understanding of the way students learn improves the selection of teaching strategies best suited to student learning. For the effectiveness of teaching environments, it is important to take account of group or individual learners' characteristics, competences and experiences (pre-learning) throughout the process of planning learning environments (Kemp, Morrison and Ross, 1998).

Understanding students' unique learning style preferences and instructional needs can assist teachers in developing a more favourable view of all students' abilities and thereby stimulate

the development and implementation of differentiated instructional practices and the provision of intentional and personalized intervention (Evans and Waring, 2006; Honigsfeld and Schiering, 2004; Rosenfeld and Rosenfeld, 2008). Often, the resulting increased success of all students serves as further incentive for continued attention to individual learners' needs (Rosenfeld and Rosenfeld, 2008). Thus, teachers must become proficient in differentiating instruction to accommodate those needs, make learning more meaningful, and enhance student success (Honigsfeld and Schiering, 2004).

Besides learning styles, intelligence also plays an important role in achievement. "Individuals differ from one another in their ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought (Neisser, Boodoo, Bouchard, Boykin, Brody, Ceci, Halpern, Loehlin, Perloff, Sternberg and Urbina, 1996)." ". . . certain set of cognitive capacities that enable an individual to adapt and thrive in any given environment they find themselves in, and those cognitive capacities include things like memory and retrieval, and problem solving and so forth. There's a cluster of cognitive abilities that lead to successful adaptation to a wide range of environments" (Simonton, 2003). "Intelligence is the ability to use optimally limited resources – including time– to achieve goals." Kurzweil (2000).

It is the intelligence that increases the individual's capacity to learn quickly, solve problems, perform tasks accurately, comprehend and to carry ability for abstract thinking and thus, contribute to higher achievement. Studies of Aruna and Usha 2006; Deary, Strand, Smith and Fernandes, 2007; Gurubasappa, 2009 and Mandeep and Ravinder, 2013 have found that intelligence is a significant contributor to achievement. Significant interaction effect of instructional strategies and intelligence on achievement was found by Mandeep and Ravinder (2013).

Based on the above literature review, students' learning style and intelligence seem to be associated with achievement. Research is needed to understand the interaction effect of students' learning style and intelligence on achievement. For this, following null hypothesis was framed:

There will be no significant interactional effect of learning style and intelligence on achievement of class IX students in Biology.

2. Research Method

2.1 Research Design

In the present study, 4 X 2 factorial experimental design was employed.

2.2 Sample for the Study

Class IX student sample (N=330) was drawn randomly from the three schools of Amritsar city. The sample comprising of 330 students was administered two tests-test of achievement in Biology and test of intelligence. Out of 330 students, six students did not respond to all the items of achievement and four students did not respond to some items of intelligence test i.e. total of 10 students were dropped from the sample of 330 students. The scores of these students were not considered at the time of analysis. Hence sample comprising of 320 students were randomly divided into two groups- the experimental group and the control group. In order to make equivalent groups, matching was done at the pre-test stage for two variables- variable of achievement in Biology (pre-test) and intelligence. t-test was employed to compare mean scores on the variable of achievement in Biology and Intelligence. Insignificant t-ratio showed that both the groups were matched and equivalent. The experimental group was taught with web based instruction catering to different learning styles and the control group was taught with conventional mode of instruction.

2.2.1 Sample Distribution on the basis of Learning Style and Intelligence

As the present study involved four learning styles (diverging, converging, accommodating and assimilating) and two levels of intelligence (high and low), hence the students (N=320) were distributed at two stages-on the basis of learning styles and on the basis of intelligence.

Stage I Sample Distribution on the basis of Learning Style

To distribute the sample on the basis of learning style, Kolb Learning Style Inventory was employed. On the basis of scores the students obtained on the inventory (as per manual), they were identified with different learning styles. Out of these 83 students had diverging style, 76 students had converging style, 80 students had accommodating style and 81 students had assimilating style. As the number of students with different learning styles varied and ranged from 76 to 83, only 76 students were retained randomly for every learning style. This was necessary to ensure that experimental group and control group had equal number of students with different learning styles. At this stage the sample comprised of 304 students divided into four learning styles of 76 students each. Further these 76 students were randomly assigned to two groups of 38 each- experimental and the control. The distribution of sample on the basis of learning styles is shown in table 1.

Table 1: Distribution of the Sample on the basis of Learning Style (N=320)

Sr. No.	Treatment Groups	Learning Style				Total No. of Students
		Diverging	Converging	Assimilating	Accommodating	
1.	WBI	38	38	38	38	152
2.	CMI	38	38	38	38	152
Total		76	76	76	76	304

Stage II Sample Distribution on the basis of Intelligence

The students with four learning styles retained for the purpose of study (N= 304) were to be distributed into three levels of intelligence viz. high level of intelligence, average level of intelligence and low level of intelligence. For this purpose, General Group Test of Intelligence (GGTI) was employed. On the basis of the scores obtained, students coming in the top 27 percent were the students with high level of intelligence and students in the bottom 27 percent (Kelley, 1939) were those with low level of intelligence and students coming between the range of 28 to 72 percent had average level of intelligence. The middle group of students

with average level of intelligence was excluded from the study. At this stage, the sample consisted of 160 students with four different learning styles, each with 40 students and every learning style with 20 students with high level of intelligence and 20 students with low level of intelligence. Further, out of these 20 students with high level of intelligence, 10 were to be taught with web based instruction and the rest with conventional mode of instruction. The same strategy was applicable to the students with other learning styles.

The data distribution at this stage on the basis of intelligence is presented in table 2.

Table 2: Distribution of the Sample on the basis of Intelligence (N=160)

Sr. No.	Treatment Groups	Learning Style								Total No. of Students
		Diverging		Converging		Assimilating		Accommodating		
		High level of Intelligence	Low level of Intelligence	High level of Intelligence	Low level of Intelligence	High level of Intelligence	Low level of Intelligence	High level of Intelligence	Low level of Intelligence	
1.	WBI	10	10	10	10	10	10	10	10	80
2.	CMI	10	10	10	10	10	10	10	10	80
Total		20	20	20	20	20	20	20	20	160

3. Tools Used

In the present study the following tools were used:

1. An achievement test in Biology for class IX was constructed and standardized to measure the performance of students before and after the treatment.
2. The Kolb Learning Style Inventory by Kolb (2007).
3. General Group Test of Intelligence (GGTI) by Ahuja (2005).

4. Procedure

4.1 Conducting the Experiment

The present study was conducted in four phases:

Phase I: Construction of an Achievement Test in Biology

Phase II (a): Matching the Groups

Phase II (b): Administration of an Achievement Test (pre-test), Learning Style Inventory and Intelligence Test

Phase III: Teaching the experimental group with instructional method catering different learning styles and levels of intelligence and control group with conventional method.

Phase IV: Administration of the Achievement Test (post-test)

5. Results

F values were calculated to study the interaction effects of two factors viz. learning style and intelligence with regard to gain scores of class IX students on the variable of achievement in Biology. The F values calculated by using two way ANOVA test is presented in table 3.

Table 3: Showing summary of 4 X 2 Analysis of Variance on gain scores on variable of achievement in Biology in relation to learning style and intelligence (N=160)

Source of Variation	SS	d_f	MSS	F-ratio
(Learning Style x Intelligence)	562.56	3	187.52	3.16*

*Significant at 0.01 level of Confidence.

Table 3 reveals that the F-ratio for the difference in mean gain score on the variable of achievement in Biology of students due to interaction between four learning styles and two levels of intelligence came out to be 3.16 which is significant at 0.05 level of confidence leading to rejection of hypothesis to be stated. It means that interaction of learning styles yielded different mean gain score for students with high level of intelligence and low level of intelligence. Hence, the null Hypothesis stating "There will be no significant interactional effect of learning styles and intelligence on achievement of class IX students in Biology" is rejected. The finding is in line with the finding of Zarinabegum (2011) who concluded that urban student teachers have got higher learning style, intelligence, adjustment and self concept as compared to student teachers in rural location.

To investigate further F–ratio was followed by t–test. Students on the variable of achievement in Biology were compared in different combination pairs of four learning styles-diverging/converging/accommodating/assimilating (DI, CO, AC and AS) with intelligence (HI/LI). The results from the interactions of different combination pairs are presented in table 4.

Table 4: Comparison of students on the variable of achievement in Biology in different combination pairs of four learning styles-diverging/ converging/ accommodating/assimilating (DI, CO, AC and AS) with intelligence (HI/LI) (N=160)

Learning Styles →	Diverging Style (DI)		Converging Style (CO)		Accommodating Style (AC)		Assimilating Style (AS)	
Intelligence →	High Intelligence (HI)	Low Intelligence (LI)	High Intelligence (HI)	Low Intelligence (LI)	High Intelligence (HI)	Low Intelligence (LI)	High Intelligence (HI)	Low Intelligence (LI)
Combination Pair ↓	Mean = 28.25 SD = 7.77 N = 20	Mean = 19.30 SD = 9.99 N = 20	Mean = 25.45 SD = 6.87 N = 20	Mean = 18.40 SD =8.45 N = 20	Mean = 20.20 SD = 10.89 N = 20	Mean = 19.40 SD = 6.77 N = 20	Mean = 20.80 SD = 9.08 N = 20	Mean = 20.35 SD = 9.73 N = 20
DI with HI	-	3.16*		3.83*		3.83*	--	2.83*
DI with LI	-	-	2.26**		.272		.497	
CO with HI	-	-	-	2.892*		2.80*		1.91
CO with LI	-	.	-	-	.584		.865	
AC with HI	-	-	-	-	-	.279		.046
AC with LI	-		-	-	-	-	.553	
AS with HI	-	-	-	-	-	-	-	.151
AS with LI	-	.337	-	-	-	-	-	-

***Significant at 0.01 level of Confidence** ****Significant at 0.05 level of Confidence.**

6. Discussion of Results

Table 4 reveals that t-values for the difference in mean gain score on the variable of achievement in Biology with the following combination pairs are found to be significant:

Students with diverging style- Comparison of HI with LI

The probable reason for this result may be that the high level of intelligence leads to divergent thinking that may result in high mean gain score. Zacharis (2010) found that the divergers performed the best.

Students with converging style- Comparison of HI with LI

The probable reason for this result may be that the high level of intelligence contributed to high mean gain score. Terrell (2002) found that in a web-based learning environment, students whose learning styles belonged to convergers and assimilators were likely to succeed more than students whose learning styles belonged to divergers and accommodators.

Comparison between students-HI and DI with LI and CO

It may be due to the fact that students with diverging style go by their own feelings and also giving shape to their thoughts.

Comparison between students-HI and DI with LI and AC

It may be due to the fact that students with diverging style have ability in looking from different points to concrete situations and organize the relations.

Comparison between students-HI and DI with LI and AS

It may be due to the fact that students with diverging style are best at viewing concrete situations from several different viewpoints.

Comparison between students-LI and DI with HI and CO

The probable reason for this result is that intelligence has contributed to high achievement in students with converging style. Students with converging style like to enjoy carrying out plans and involving themselves in new and challenging experiences which is available in web based instructional package in the form of e-links.

Comparison between students-HI and CO with LI and AC

It suggests that students with converging style having high level of intelligence achieved higher as compared to the students with accommodating style having low level of intelligence. It may be due to the fact that students with converging style have problem solving and decision making abilities that led to their higher achievement.

t-value for the following combination pairs are found to be insignificant (table 4).

Students with accommodating style- Comparison of HI with LI

Students with assimilating style- Comparison of HI with LI

Comparison between students-LI and DI with HI and AC

Comparison between students-LI and DI with HI and AS

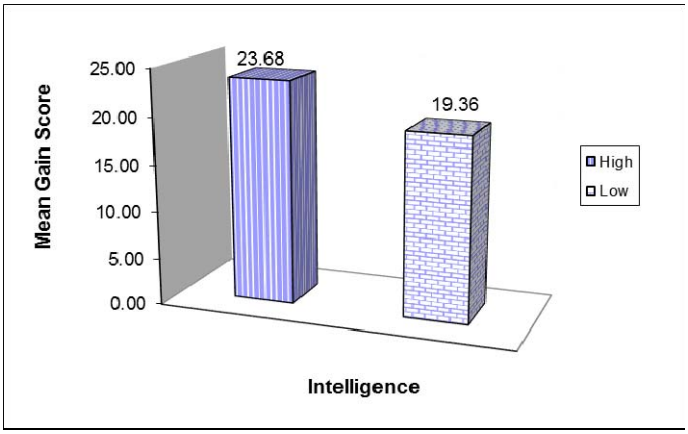
Comparison between students-HI and CO with LI and AS

Comparison between students-LI and CO with HI and AC

Comparison between students-LI and CO with HI and AS

Comparison between students-HI and AC with LI and AS

Comparison between students-LI and AC with HI and AS



The t-values for the difference in mean gain score on the variable of achievement in Biology of the group of students with above combination pairs are insignificant. It leads to the conclusion that the above group of students with these combination pairs achieved equal mean gain score.

7. Conclusion

Interaction effect of learning style and intelligence was found to enhance the achievement of students in Biology. Students with diverging style and high level of intelligence (Mean = 28.25) achieved higher as compared students with converging, accommodating and assimilating learning style with high level of intelligence as well as showed higher achievement as compared their counterparts.

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