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Association of Cognitive Learning Style with Attitude towards Science

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Abstract

Scientific literacy has become an indispensable modern skill set. For a long time, cognitive psychologists and educators have been focused on the understanding of individual differences and its influence on teaching and motivation to learn science. This research was executed to find the association of Field Dependent- Field Independent cognitive learning styles and attitude towards science. Quantitative approach was used in this research and survey research method was used in it. A sample of 478 undergraduate science students was selected through stratified random sampling from three strata: BS Physics, Mathematics and Biosciences programs. The sample consisted of 158 male and 320 female undergraduate science students. The hypotheses were tested using chi-square , *t*-test and coefficient of correlation at 95% significance level. The data was collected through standardized test named as "SHAPES" to identify the cognitive learning style of students. The attitude towards science was measured through self-developed tool. The findings revealed that female undergraduate science students were significantly Field Independent and possess greater attitude towards science than Field Dependent undergraduate male science students. Significant relationship was found between attitude towards science and Field Dependent-Field Independent cognitive learning style. It is recommended that educators and curriculum developers focus on student's individual difference so they can learn according to their respective learning styles. In this way, Field Dependent undergraduate science students may also possess better science related attitude in support of improved academic achievement.

Keywords: Attitude towards Science, Cognitive Learning Styles, Field Dependent, Field Independent

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Introduction

Science and technology are playing a vital role in the modern world. Every day new innovations are being developed for the betterment of society. The socioeconomic status of countries is largely dependent on their advancements in scientific and technological fields. Science education has become essential for individual and collective success. Science education and science curricula are focused to increase scientifically literate individuals (AAAS, 1993; Kaya, 2012). Science-literate individuals are critical thinkers, good problem solvers, and effective decision-makers. Such individuals turn into lifelong learners and endure their curiosity about the surrounding world. Therefore, it is important to consider that curriculum developers highlight the complex problems of the 21stcentury (Morrison & Lederman, 2003) and prepare people to make informed decisions (Corrigan et al., 2007). The research revealed that "relatively few students are interested in pursuing careers in scientific disciplines, although there are large

variations between countries" (Sjøberg & Schreiner, 2005). It is remarkable to know that the countries where pupils obtained greater achievement in science have a smaller number of students articulating the importance of pursuing science-related careers. Moreover, in numerous countries around the world, an enormous dropout rate has been observed at the upper secondary level (OECD, 2008; Shukla, 2005). It is thus critical for nations to make serious efforts to increase scientific literacy and career interests if they are to ensure the provision of future scientifically literate persons. Although, opportunities for the provision of quality instruction are essential, however, there is also need to increase student's interest and motivation towards scientific careers.

Cognitive psychologists and educators have been concerned for a long time to understand individual differences due to cognition and their influence on learning and instruction. Prayekti (2018) found that students' cognitive learning styles strongly influenced their learning outcomes. Several studies have revealed that the information processing and problem-solving skills of learners are different due to their cognitive styles (Alamolhodaei, 2001; Ansburg, 2000; DeYoung et al., 2008; Mienaltowski, 2011). There are numerous dimensions of research work related to cognitive styles (Zaman, 2006). One kind of cognitive learning style might be better for effective learning in a discipline while in another discipline, it might not be favorable for learning. In education, Field Dependent - Field Independent cognitive learning styles are the most frequently explored dimensions.

Field Dependent -Field Independent cognitive learning style categorizes "an individual's mode of perceiving, thinking, problem-solving and remembering". Witkinet et al. (1971) provided field dependency theory to identify individual differences on the basis of the visual perception field. Field Dependency–Field Independency is defined as an "individual's dependency in a perceptual field while analyzing a structure or a form of that field" (Altun & Cakan, 2006). The Field Independent individuals are capable of abstracting a component from the nearby field and solving problems that require a vigorous section of the content. Contrary to this, Field Dependent individuals rely on the overall arrangement of a field; these individuals uphold a "global perception" problem-solving, while Field Independent individuals uphold an "analytical perception" (Goodenough, 1976; Saracho, 1998; Witkin, 1976).

In this era, much attention has been paid to model the behavior of learners (Abyaa et al., 2019). Learning styles and associated cognitive traits are the researched themes in the educational psychology texts (Wininger et al., 2019). Numerous researchers (Fyle, 2009; Kang et al., 2010, Jones & Leagon, 2014; Schmeck, 1988, Wyss, 2002) indicated that students must be aware of their own cognitive learning styles as this awareness empowers them to adopt the most suitable strategies for learning. Sadler-Smith & Smith (2004) have suggested that a "structured route through learning" must be provided to Field Dependent learners for problem-solving whereas "a global perspective of the content "must be provided to Field Independent learners. Lee et al. (1995) proposed that attitude and cognitive learning styles jointly contribute to the behavior of a learner. Koballa (1989) emphasized that although educators comprehend the significance of learners' feelings regarding science subjects; they give less weight to the "affective objectives". The cause for commonly disregarding the affective domain is that the teachers express difficulty in developing strategies that might be supportive to improve attitude towards

science. Generally, attitude is defined as the inclination to respond positively or disparagingly towards ideas, events, things, people, or places. In Western countries, the shocking deterioration of enrollment rate in science disciplines, students' disregard for science, and aptitude for inventive methods of research (associated with physiological expression) have triggered the efforts for the improvement of students' interest in science (Osborne et al., 2003).

Attitude towards science has an impact on the choices of learners for selecting various subjects, foci, and academic achievement in science. Generally, attitude towards science is defined as the "degree of positive or negative effect" where the encouraging or positive attitude towards science is useful for science learning whereas, a negative space leads to less science learning and less achievement. Therefore, Khine and Saleh, (2011) emphasized that the most interesting domain for research in science education is to identify "how students' science-related attitude affects their learning in science subjects". Hence, Shah and Mahmood (2011) highlighted that "the endorsement of a positive science-related attitude towards science has remained an important aim of the curriculum at the school level". Development in science education represents numerous attempts for assessing attitudes towards science and exploring the relationship between behavior, cultural dispositions, gender equity, career ambitions, and career achievements. The attitude towards science has a relationship with the teaching process (Bellová et al.,2021) and it can only be possible if teachers use such teaching methods that match with the learning style of students.

Rationale of the Study

Cognitive science is helping educators to understand the process and factor of cognition so that students can be motivated to pursue science education and adopt science-related careers. Although, many researchers found that "science-related attitude can be learned, and teachers can encourage students to like science subjects through persuasion". On the other hand, certain researchers consider that "science-related attitude is situated in context and has much to do with upbringing and environment". For that reason, attitude towards science is being considered an important factor for improving science education, particularly in designing curricula, encouraging learners, and choosing effective pedagogies. Hence, the current study was planned to explore association of undergraduate students' cognitive learning styles and attitudes towards science.

Objectives

Following were the study objectives:

1. To explore cognitive learning styles of undergraduate science students.
2. To explore the cognitive learning style of undergraduate science students in different disciplines.
3. To find attitude towards the science of undergraduate students with respect to Field Dependent - Field Independent cognitive learning style.
4. To identify the relationship between attitude towards science and Field Dependent - Field Independent cognitive learning style.

Research Design

This study utilized a survey method. The population is comprised of all undergraduate science students of basic sciences (Math, Physics, and Biology) programs. The study was delimited to undergraduate science students of BS Maths, BS Physics, and BS Biosciences programs of Islamabad only.

Sample Selection

A sample of 478 students was drawn through stratified random sampling technique using sampling frame. The students were randomly selected from 1st and 8th semesters of three

BS programs. The detail of sample is as follows:

Table 1

Age range of Sampled Undergraduate Science Students (N=478)

Variable	Range	Min	Max	Mean	SD	Variance
Age	4.00	18.00	22.00	20.64	.81	0.66

Table 1 shows that the minimum age of sampled students was 18 years and the maximum age was 22 years. Whereas, the mean age of students was *M*=20.64, *SD*=0.81.

Table 2

Gender wise Distribution of *Sampled Undergraduate Science Students (N=478)*

Programs	Gender		
	Male	Female	Total
BS Physics	74	65	139
BS Maths	25	106	131
BS Bio Sciences	59	149	208
Total	158	320	478

Table 2 shows the descriptive statistics of sampled science students. It shows that 74 male and 65 female students were randomly selected from BS Physics program, 25 male students and 106 female students in BS Mathematics, and from BS Bio science program, 59 male and 149 female students were randomly selected.

Table 3

Semester wise Distribution of *Sampled Undergraduate Science Students (N=478)*

Semester	Program			
	BS Physics	BS Math	BS Bio Sciences	Total
1st	79	81	120	280
8th	60	50	88	198
Total	139	131	208	478

Table 3 shows the semester wise detail of sampled students. As the sampled students consisted of 1st and last i.e., 8th semester only, therefore, the Table 3 shows that 139 students were selected from 1st semester whereas 131 students were selected from 8th semester.

Table 4

Descriptive Statistics of Scores on "SHAPES" test (N=478)

Sampled Students	*N*	Range	Min	Max	*Mean*	*SD*
	478	15.00	1.00	16.00	7.9142	3.8866

Table 4 shows the range of scores of sampled undergraduate science students. It shows that the minimum score obtained by students was 1.00 whereas maximum obtained score on the "Shapes" test was 16.00. The mean *M*=7.912 whereas *SD*=3.88.

Instruments

Science students' cognitive learning styles were identified using tests named "Hidden Figure Test (SHAPES)" was used. This test was developed by the Center for Science Education, Glasgow University. It is based on the work of Witkin and his followers. The Hidden Figure Test is a revised version revised by Dr.Peter McGuire. There were two figures as an example. However, there were 20 figures in total for the "SHAPES" test; four figures for practice and 16 complex figures for the actual test. Six simple shapes were embedded in the 16 complex figures. There was only one hidden simple shape in each complex figure. The students were required to identify that simple shape in each complex figure. The figures were arranged from low to high difficulty levels.

For the present study, an attitude towards science questionnaire was developed to find science-related attitudes of science undergraduate science students. It was based on Likert five-point ranging from strongly disagree to strongly agree. There were four constructs of this tool. Initially, there were 76 items in this tool. The validity of the tool was ensured by science teachers, whereas, after reliability was ensured in pilot testing. The final version of attitude towards science contained 40 items.

Reliability and Validity of Research Tool

SHAPES test is a standardized test; however, the test-retest reliability of the test was 0.94. Similarly, through pilot testing, the Cronbach's Alpha reliability of the "attitude towards science scale" was found as 0.87.

Inclusion Criteria

The undergraduate science students enrolled in the first and eighth semesters were included in this study.

Ethical considerations

It was assured that there should be no harm to the undergraduate sampled students mentally, physically, and emotionally.

Procedure of the study

For the "SHAPES" test, the allowed time to identify the simple shapes was fifteen minutes. Five minutes were given to the students to read the instructions whereas, ten minutes were given to solve the test. Initially, instructions were given to the students. The students were required to outline the simple shape with a pen or pencil exactly of the same size and orientation. The total score of "SHAPES" is 16. One mark was assigned to a correct answer.

The following formula was used to identify the Field-Dependent, Field-Intermediate, and Field -independent cognitive learning styles of science students.

Field-Dependent	$\leq$	mean – 1 (S.D)
Field Intermediate	=	mean ± 1 (S.D)
Field-Independent	$\geq$	mean + 1 (S.D)

Based on the data presented in Table 4, the students who scored ≤ 4.08 were identified as Field-Dependents. The students who scored between 4.08 and 11.8 were identified as Field-Intermediate whereas the students who scored $\geq$ 11.8 were identified as Field-Independents. For the present study, only Field-Dependent and Field-Independent cognitive learning styles were used. After attempting the "SHAPES" test, the students were asked to give responses about their attitude towards science.

Data Analysis

The hypotheses were tested at a 95% level of significance. SPSS-26 software is used for data analysis.

Table 5
Gender wise Score of Hidden Figure Test of Science Students (N=478)

Cognitive Learning Style	HFT Score	Gender				Total	
		Male	%	Female	%		%
Field Dependent	0-4.0	49	10.3	62	13.0	111	23.2
Field Intermediate	4-11.8	76	15.9	183	38.3	259	54.2
Field Independent	11.8-16	33	6.9	75	15.7	108	22.6
Total		158	33.1	320	66.9	478	100

Table 5 reveals that Field Dependents were larger in percentage than Field-Independents. The Field-Intermediate were not considered in this study as per previous studies.

Table 6
Difference of Field Dependent and Field Independent Cognitive Learning Style regarding Gender (N=478)

Variables	*N*	$\chi^2_{(cal)}$	*p*
Male F.D	49 (10.3%)		
		1.523	0.217
Female F.D	62 (13.0%)		
Male F.I	33 (6.9%)		
		16.333	0.000
Female F.I	75 (15.7%)		

Table 6 reflects no significant difference among science students regarding Field Dependency whereas female science students were found highly Field Independent than male science students.

Table 7

Overall Attitude towards Science of Field Dependent - Field Independent Undergraduate Science Students (N=478)

Variables	*N*	Mean	*SD*	$t_{(cal)}$	*p*
Attitude towards Science of F.D	111	3.57	0.48	-3.44	0.001
Attitude towards Science of F.I	108	3.81	0.42		

p = Significance Value

Table 7 indicates a significant difference between responses of Field Dependents and Field Independents regarding attitude towards science. Where the Field Independents possessed greater than the mean value of attitude responses of Field Dependents.

Table 8

Difference of Cognitive Learning Styles with respect to Science Disciplines (N=478)

Program		Cognitive Learning Style		Total	χ^2 (cal)	*p*
		Field Dependent	Field Independent			
BS Physics	N	54	25	79	19.44	0.000
	% of Total	24.7%	11.4%	36.1%		
BS Math	N	17	39	56		
	% of Total	7.8%	17.8%	25.6%		
BS Biosciences	N	40	44	84		
	% of Total	18.3%	20.1%	38.4%		
Total	N	111	108	219		
	% of Total	50.7%	49.3%	100.0%		

df=2

Table 8 shows that there was a statistically significant difference in cognitive learning styles among three strata of science students. BS Physics students were found more Field dependent whereas BS mathematics students were found more Field Independent students. However, there was no statistical difference found between field-dependent and field-independent BS Bioscience students.

Table 9

Difference regarding Attitude towards Science of Field Dependent- Field Independent according to Gender (N=478)

Variables	*N*	Mean	*SD*	$t_{(cal)}$	*p*
Attitude towards science of F.D Male	49	3.6174	0.50436		
				-1.672	0.099
Attitude towards Science of F.I Male	33	3.8897	0.43168		
Attitude towards Science of F.D Female	62	3.5424	0.47069		
				-3.225	0.002
Attitude towards Science of F.I Female	75	3.8052	0.42422		

p = Significance Value

Table 9 reflects that female Field Independent science students possess significantly more attitude towards science than Field Dependent female science students whereas no significant difference regarding attitude towards science of male Field Dependent and Field Independent science students.

Table 10

Relationship Between Attitude towards Science and Field Dependent - Independent Cognitive Learning Style (N=478)

Variables	Coefficient of Correlation	*p*
Field Dependent-Field Independent Cognitive Learning Style		
	0.24	0.001**
Attitude Towards Science		

**$p<0.01$

Table 10 reflects a statistically significant correlation between Field Dependent-Field Independent cognitive learning style and attitude towards science.

Discussion

This study revealed that female science students were Field Independent while male undergraduate science students were identified as Field Dependent. This outcome is coherent with Yim's research finding (2009). Yim revealed that females obtained much higher as compared to males on the Group Embedded Figure Test. Moreover, female students obtained nine percent greater in science subjects compared to scores obtained by male science students. It reflects that female students have more analytical skills than male students. Yim further elaborated that it might be due to the social-economic status of families or developments of the countries. At present times, females are more anxious about their studies to get better employment opportunities. Females travel to reach educational institutions for their studies. It indicates that female wants to be successful, therefore, they are independent.

On the other hand, Bellard (2001), Bieri (1960), Loader et al. (1982), Healy et al. (2010), Li (2011), Torres and Cano (1995), Waber (1977) found males as Field Independent. Hansson et al. (1986) revealed that females were more Field Dependents compared to males. Furthermore, Onyekuru (2015) cited Goodenough (1980) that "cultural stereotypes" lead males to be Field Independent and females to be Field Dependent. Moreover, Witkin and Goodenough (1980) revealed that "liberated" females are inclined to be more Field Independent as compared to traditional females. Above and beyond numerous matches and contrasts, the question arises of how these contrary results can be described. Zhang & Sternberg (2001) explained that these inconsistent or mixed results of the relationships between gender and cognitive styles are because of many contextual factors (e.g., different subject matters and demographical areas where research was carried out). Furthermore, the diverse results could be because of the different age groups of participants.

Moreover, both male and female Field Independent undergraduate science students possessed a higher attitude towards science as compared to Field Dependents. However, Altun and Cakan (2006) claimed that the attitude towards computers works independently of cognitive learning styles. This finding agrees with Cellar et al. (1989) as mentioned by Schuler et al. (2013) that females exhibited a higher level of accurateness and hence, identified as Field Independent. This finding matches with the results of Mutlu and Temiz (2013) showing females as Field Independent in Mathematics, Biology, and Physics as compared to male science students. It may be due to the reason that with the increase in preference for field independence, the inclination in analytical and abstract fields also increases. That is why, Field Independents are persuaded towards careers (doctor, biologists, engineering, etc.) (Witkin, 1976). The study revealed a positive relationship between attitude towards science and Field Dependent-Field Independent cognitive learning style of undergraduate science students. Contrary to this, Altun and Cakan (2006) found no association between learners' attitudes towards computers and Field-Dependency, even at controlled levels. However, Altun found that attitude towards computers is independent of cognitive styles.

Conclusion

Field Dependents undergraduate science students are larger in percentage than Field-Independents. Male science students are not significantly Field Dependent as female science students. However, female undergraduate science students are more Field Independent than male students. Field Independent science students possess a greater mean value of attitude towards science than Field Dependents. No significant difference exists between male Field Dependent and male Field Independent regarding attitude towards science. Female Field Independent science students have more attitudes towards science than Field Dependent female science students. A statistically significant correlation exists between attitude towards science and Field Dependent - Field Independent cognitive learning style. Cognitive learning styles impact the attitude of science students and hence a positive relationship prevails between cognitive learning styles and science-related attitudes. Moreover, the science-related attitude of Field Independent was found more than the science-related attitude of Field Dependent science students.

Recommendations

Therefore, it is recommended that teachers must know the cognitive learning style of students so that students of diverse cognitive

learning styles can be facilitated and motivated to learn science. The curriculum developers must develop curricula keeping in view the individual differences. Trainings are also recommended for in-service and pre-service teachers.

Contribution of Author

Farkhunda Rasheed Choudhry: Conceptualization, Investigation, Methodology, Data Curation, Formal Analysis, Writing- Original draft, Writing - Reviewing & Editing

Conflict of Interest

There is no conflict of interest declared by the author.

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