

## Context Factors Affecting Cognition and Performance of Undergraduate Science Students

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### Abstract

*Individual differences play a vital role in learning, as they lead learners towards Field-Dependent and Field-Independent learning styles, assumed the perceptions of individuals. For learning science, perception, spatial orientation and analytical approach have been considered extremely essential. There are several context factors which have been reported to have connection with directly or indirectly cognitive learning styles. The present study explored the effects of context factors such as age, gender, academic achievement and mother's qualification of science students. For this study, 462 undergraduate science students were selected randomly from BS Physics, BS mathematics, and BS Computer Engineering programmes from four universities. The standardized test "SHAPES" was administered to recognize Field-Dependent-Field Independent learners. The regression analysis revealed that context factors such as gender, age, and grade point average significantly contribute to field contingent and field free thinking cognitive learning style.*

**Key Words:** Cognition, Context Factors, Learning Styles.

## Introduction

There are numerous individual differences that lead to different cognitive learning styles. Now learners like to learn innovative learning styles (Javed, Buraira and Asghar, 2019). Cognition deals with an individual's distinctive approach of recognizing, considering, recalling, or problem disentangling. Normally, cognitive learning approach is considered an individual's personality trait that impacts attitude, values and, social interaction. Pakistan is among the developing countries therefore science education is greatly indispensable to deal with the challenges for its sustainable development. For this reason, a considerable number of scientific research institutes and scientists in all disciplines is needed. In Pakistan, the elementary science curricula impart scientific knowledge and the educationists are trying to motivate the students to seek knowledge about science subjects (Malik, Shah, Iqbal and Rauf, 2010).

According to the perspectives of psychologists of science, the examination of the "psychological factors (such as personality or cognition) that underlie who becomes interested in science and what kind of attitudes people develop towards science" (Feist, 2012). Similarly, Park, Lubinski, & Benbow (2008) have found that "from social, psychological, and economic perspectives the question of how and when interest and talent for science develops is of great importance".

It is observed when the individuals are exposed to a learning activity, the perception of every individual has been different. Hence, the understanding of every individual is according to their unique learning style. In the literature, numerous learning styles are present with certain strengths and weaknesses. However, very few learning styles could get consideration of the researchers. Cognitive learning styles involve field dependent FD and field independent FIND, researched by many scholars in twenty first century (Bahar and Hansell, 2000; Chen & Macredie, 2002; Danili and Reid, 2004; Lusac-Stannard, 2003; McKenna, 2006; Musser 2002; 2006; Tsaparlis, 2005; Wyss 2002). McKenna (2006) has described that FD/FIND dimension of learning styles with cognitive,

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metacognitive and socio-affective side of learners. Field-Independent individuals ignore social or cultural contexts. While, Field-Dependent learners are sensitive to the social or cultural context while omitting necessary details of learning.

[Witkin \(1949, 1950\)](#) devised the concept of FD-FIND ([Feist, 2012](#), [Fyle 2009](#); [Lucas-Stannard, 2003](#)). Individuals attending visual cues were nominated as 'Field Dependent', whereas individuals attending postural cues were nominated as 'Field Independent'. Field independence (FIND) deals with the degree to which individuals focus at certain features of exposure and separate them from their background, however, field dependence approach is the inclination to be hinging on the total sward as it is difficult for them to perceive easily the embedded parts within the field([Soozendhfar, 2011](#); [Brown, 2000](#)).

[Liu and Ginther \(1999\)](#) has quoted [Witkin et al., \(1977\)](#) that both the approaches of Field Dependent and Field Independent models are considered as neutral and bipolar in construct and is considered as capability to discriminate important cues from "distracting or confusing background". The perception mode of Field Independents is mostly not affected by the surrounding of field whereas, Field-Dependents are mostly affected by the surrounding of field.

### Characteristics of Fields

Like other learning styles, this dimension has also. certain characteristics. [Fyle \(2009\)](#) have explained certain noteworthy characteristics of this dimension.

### Restructuring Skills

Field Dependency-Field-Independence reflects an individual's capability to restructure knowledge through essential cues and association of fields ([Weller, Repman, & Rooze, 1995](#)). Field-Independent persons can facilitate arrangement and organization of knowledge solitarily ([Myers and Dyer, 2006](#)). Field Independent individuals have better learning and remembering ability as compared with Field-Dependent individuals. [Altun and Cakan \(2006\)](#) quoted [Daniels \(1996\)](#) that FD learners rely on "perceptual field surrounding" and it is difficult for them to give recognition and giving structure to the field. Therefore, the staging of FID learner is better on indistinct tasks as compared with FD learners ([Vacas, Pérez, Couñago, Fernández, 2011](#)). FD learners can inefficiently separate an element from its background ([Danili and Reid, 2004](#)). [Alamolhodaci \(2009\)](#) had quoted Sowder (1985) that "the cognitive restructuring aspect of field dependence/independence is found to be related to problem solving ability". Learners with scoring high on the basis of cognitive approach of learning in reorganizing tasks were found better in problem solving as compared to low scoring learners ([Zaman, 1996](#)). Similarly, [Tinajero and Paramo \(1998\)](#) had quoted that FIND individuals have the ability towards self-directed and self-motivated, successful and possess better skills in certain tasks requiring cognitive restructuring skills in lifelong learning ([Zaman, 1996](#), [Liu, Ginther, 1999](#)).

### Stability

[Witkin \(1977\)](#) found that FD-FIND cognitive style gets stable with the passage of age. "Individual differences in the expressions of articulated functioning in a field are related to expressions in other fields and will not change for months and years". [Musser \(2002\)](#) revealed that "age" factor affects the Field Dependence-Independence construct. Young individuals are generally found Field-Dependent, while adults become. Field- Independence with the passage of age ([Sisco, Leventhal, 2007](#)). Subsequently, Field -Independence gradually reduces for the remaining life; older individuals become more FD than young individuals ([Witkin et. al., 1971](#)).

### Global and Analytical Approaches

[Maghsudi \(2007\)](#) described that the resemblance exists among FD, FIND and global-analytical style because it shows the "degree to which an individual's processing information is affected by the contextual field". FID individuals are found to be more analytical ([Myers and Dyer, 2006](#)) and prefer analytical domains such as sciences because much restructuring skills are required for these domains ([Witkin et. al., 1977](#)). [Hall \(2000\)](#) has considered . FID individuals as "analytical, competitive, individualistic, task oriented, internally referent,

intrinsically motivated, hypothesis testing, self-structuring, linear, detail oriented, and visually perceptive”, while, Field Dependent individuals are found as “group-oriented, global sensitive to social interactions and criticism, extrinsically motivated, externally referential, notvisually perceptive, non-verbal, and passive learners who prefer external information structures ([Hall, 2000](#), p. 6)”. Field Dependent individuals rely on social input and external help for the interpretation of clues fabricated in a specific learning activity ([Angeli, 2013](#); [Handal and Herrington, 2004](#)). Field-Independent individuals are better capable to create and structure their knowledge without relying other’s knowledge. FD individuals are slow problem solver and have global perception in this regard ([Myers and Dyer, 2006](#), [Ronning et al., 1984](#)). Field-Dependents observe the world globally, whereas Field-Independent observes it analytically ([Heywood, 2005](#)).

### **Social Orientation**

In literature, a strong association has also been found among FD, FIND cognitive approach and social interaction. Altun and Cakan (2006) have found that FD individuals are superior in remembering social relationship ([Myers and Dayer, 2006](#)). Witkin has found that FD learners have the capability to work in collaboration in groups, while FIND learners prefer to work individually ([Lucas-Stannard, 2003](#)). Field-dependent individuals are very much social, expressive, very friendly, pleasant and warm. Field-Independent learners are recognized as task oriented and impersonal. Similarly a close association is found between job description and Field Dependence- Field Independence. The performance of field dependents is very low under highly structured domain. FD performs better in open-ended questions than Field-Independents (Encyclopedia, 2013).

### **Concept Attainment**

“Field-Independent learners are generally better than Field-Dependent learners in concepts attainment tasks and quickly learn concepts” ([Goodenough, 1976](#)) described that FD individuals exhibit more readiness than FIND while sufficient relevant elements are present in a concept.

### **Working Memory**

There also exists a difference between Field Dependent- Field Independent individuals regarding working memory, performance, and efficiency of working memory. Field-Independent individuals are also different from Field-Dependent individuals regarding recalling information, stored in the working memory ([Altun and Cakan, 2006](#)). As compared to Field-Independents, Field Dependents cannot easily retrieve data from the long-term memory in order to perform accurately.

### **Information/Data Processing**

[Hall \(2000\)](#) has found that dissimilarity between FD and FIND persons regarding processing the information. Both FD and FIND individuals are differ in problem solving approach under complex learning environment ([Wang, Wang and Ren, 2003](#)). Field Independent learners can easily develop a clear map of motion than Field-Dependent learners. Another difference exists regarding “varying information processing skills such as selective attention, short-term memory encoding, and long-term recall at which Field-Independent individuals are more accurate and efficient” (p.72).

### **Context Factors Influencing Field Dependency-Field Independency**

There are certain factors which can affect the degree of FD and FIND individuals

### **Brought Up**

[Musser \(2002\)](#) cited Witkin that parental control during brought up of children may affects the tendency of being Field Dependent-Field Independent ([Korchin, 1986](#)). Witkin described that when children give

importance to external control of desires and parental authority, they found to be Field Dependent. Whereas, grown ups tend to be FIND when receive encouragement to perform autonomously.

**Socioeconomic status:** Field Dependence-Field Independence is also affected by socioeconomic status (Musser, 2002). Researchers found substantial difference in scores among Field Dependents and Field Independents regarding socioeconomic status (Forns-Santacana, Amador-Campos, & Roig-Lopez, 1993).

## Gender

There are mixed research findings regarding gender on FD and FIND towards cognitive learning style or approach (Musser, 2002; Pithers, 2002). However, no significant difference was also found in the learners, however, variation has been reported on the basis of research conducted on adult learners (Desanctis & Dunikoski, 1983; Doucette & Kelleher, 1997; Murphy,; McRae & Young, 1988; Murphy and Casey, 1997; Wieseaman et al., 1992). Male have been reported as field independent. Few researches have provided consistent gender differences regarding FD and FIND, especially in sciences, education, engineering and business studies (Wieseaman et al., 1992). Field Independent male are found to perform better than female Field-Dependents in all subjects (Tinajero & Paramo, 1998).

## Research Questions

- Is there any association between cognition and gender?
- Does socioeconomic status affect cognition?
- Does working memory associated with cognition?

## Research Methodology

This research is descriptive in nature. For the present study, 462 undergraduate science students from BS Physics, Electrical Engineering and Mathematics were randomly selected. For the identification of FD and FIND approach of cognitive learning style, a standardized tool named “SHAPES” was administered. It was developed in Glasgow and consisted of twenty shapes; the first four pictures were for practice purpose. The maximum score could be sixteen.

## Data Analysis

In the following tables, data analysis has been presented.

**Table 1.** Detail of Sample

Gender	F	%
Male	260	56.3
Female	202	43.7
Total	462	100.0

There were 56.3% male and 43.7% female in this study.

**Table 2.** Age wise Detail of Sample

Age	F	%
14-15	2	0.4
16-17	19	4.1
18-19	188	40.7
20-21	137	29.7
More Than 21	116	25.1

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The above table shows age wise detail of sampled students. There were 41% students within the age range 18-19 years.

**Table 3.** GPA Detail of Sample

Grade	F	%
A	43	9.3
B	220	47.6
C	169	36.6
D	15	3.2
F	15	3.2
Total	462	100.0

The table reflects that 47% students obtained “B” grade, whereas 37% students obtained “C” grade.

**Table 4.** Valid and Cumulative Percentages of Learning Styles

Learning Style	f	%	Valid Percent	Cumulative Percent
FD	141	30.5	69.8	69.8
FIND	61	13.2	30.2	100.0
Total	202	43.7	100.0	
FINT	260	56.3		
Total	462	100.0		

Out of 462 science students, 141 students were found Field Dependent (FD), 61 students were found Field Independent (FIND), whereas 260 students were found Field Intermediate (FINT). For the present study, only FD and FIND science students were considered. Therefore the sample of this study constituted of 202 FD and FIND students.

**Table 5.** Gender wise Field Dependence-Field Independence

Learning Style	Male	Female	Total
FD	98	43	141
FIND	29	32	61
	127	75	202

The above table shows that more number of students was Field Dependent while majority of female were found Field Independent.

**Table 6.** GPA of Field Dependents and Field Independents

Learning Style	GPA					
	A	B	C	D	F	Total
FD	5	60	63	7	6	141
FIND	11	28	20	0	2	61
	16	88	83	7	8	202

The above table reflects that majority of FIND individuals obtained A grade. Similarly there were more FD students in “F” category of GPA. However there was no FIND in “D” category.

**Table 7.** Model Summary

Model	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Std. Error of the Estimate
1	.326 <sup>a</sup>	.106	.088	4.63004

a. Predictors: (Constant), GPA, Age, Gender, Education of Mother

b. FD-FIND.

In above table the correlation between the explanatory variables is 0.326 which is not very much significant. Hence all predictors have their separate importance in the model. Learning style therefore is predictable with these variables.

**Table 8.** Analysis of Variance of Predictor Variable

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	500.900	3	125.225	5.841	.000 <sup>a</sup>
Residual	4223.145	197	21.437		
Total	4724.045	201			

a. Predictors: (Constant), GPA, Age, Gender, Education of Mother

b. Dependent Variable: FD-FIND

In the above table the F-value 5.841\*indicates that the contribution of Predictors is significant and Field Dependent –Field Independent learning style would show obvious change with respect to change in the independent variables.

**Table 9.** Coefficient Analysis of Predictor Variables

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Gender	2.023	.346	.169	2.994	.003
Age	.862	.676	.202	2.494	.013
GPA	.954	.409	.159	2.334	.021
Edu. Of Mother	-0.13	0.016	-0.55	-0.808	0.420

a. Dependent Variable: FD-FIND

The above table shows that gender, age and GPA of undergraduate students significantly contribute to the FD and FIND approach learning style. The t-Statistic against coefficient of Gender is 2.994\*which is the highest among other repressors i.e. Age and GPA. This predictor has major impact on learning style. Secondly, Age’s t-statistic 2.494 then GPA’s t-statistic for the model is 2.334\* suggesting their respective contribution in the model in order. However, Mother’s education does not affect the learning style of her children.

## Discussion

Cognitive learning styles are individuals' specific styles for learning. There are several context factors which may contribute in particular learning style. This study explored the impacts of different factors such as age, gender, grade point average GPA, and mother's qualification for possessing FD and FIND approach of learning style. Regression model summary showed to some extent, context factors are predictors of learning style. A strong correlation exists between Field-Orientation and gender. [Goldstein & Blackman, \(1978\)](#) found a minor but constant difference regarding learning style among genders (female tended field dependent). [Witkin et al. \(1977\)](#) and [Goodenough \(1986\)](#), found women as Field-Dependent, while they found men as Field-Independent. [Jarvis \(2005\)](#) found that age factor also plays role in cognitive ability and motivation. [Musser \(2002\)](#) also found that "age" also has effect on field dependency-field independency. Usually, youngsters are more field dependent; However, Field Independence increases with the age. Grownups are more FIND ([Sisco, Leventhal, 2007](#)). Subsequently, the Field Independence gradually declines for the remaining ages of life. That is the reason the older are more FD than youngsters ([Witkin et. al., 1971](#)). The ANOVA analysis showed the change of learning style with predictor context factors. However, further analysis of coefficients shows that out of other context factors, mother's qualification does not have much impact on the establishment of cognitive learning style. Therefore, it may be established from analysis that all predictors have significance contribution in the prediction of learning style except Mother's Education.

## Conclusion

1. Cognitive learning styles are affected by context factors.
2. Female are Field Independent while male are Field Dependent.
3. The scores of FID learners are better than the scores obtained by Field Dependent learners.
4. There may be some others factors which may contribute for establishing certain learning styles.

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