Relationship between Thinking Styles and Higher Order Thinking Skills

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Abstract

Thinking styles of students and higher order thinking skills are important aspects of teaching and learning process. The purpose of this study was to investigate the relationship between thinking styles and higher order thinking skills (HOTS) of secondary school students and also to find the gender-wise difference in the nature of this relationship. The population of this study was male and female chemistry students of grade 9 in Tehsil Rawalpindi. Random sampling technique was used to select the sample. The data were obtained using the Convergent and Divergent Test and Achievement Test of Chemistry; developed in the light of Bloom Taxonomy. A quantitative research method was used for collection, interpretation and analysis of data. According to results, the relationship between convergent thinking style and higher order thinking skills of students was negligible. However, the strength of this correlation between divergent thinking style and higher order thinking skills of students is positive. Therefore, the understanding of student's thinking styles can serve as initial guide in developing more effective and conductive teaching and learning environment for mastering higher order thinking skills (HOTS).

Keywords: Thinking Styles, Convergent Thinking, Divergent Thinking, Higher Order Thinking Skills.

Introduction

Thinking skill is a rational process which consists of concept development, applying, analyzing, synthesizing, and evaluating the collected information which is produced by experiences, observations and reflections (Ball & Garton, 2005).The ability of an individual to utilize both of his cognitive and affective domains for receiving and generating information, solving problems, and making decisions is

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known as thinking skill (Hashim & Yaakub, 2004; Muhammad & Hassan, 2005). According to Milvain (2008), the ability to complete a given task is called thinking skill of a person, it is a combination of cognitive processes. Thinking skills have a pivotal role in teaching and learning process because they can affect the capacity, efficiency and pace of learning of a student. Resnick (1987) associated thinking skills of an individual with his learning ability and found that a significant relationship exists between thinking skills and learning process. Human thinking skills have two major categories i.e., lower order thinking skills (LOTS) and higher order thinking skills (HOTS). First three levels of Bloom's taxonomy; remembering, understanding, and applying are lower order thinking skills whereas last three levels of Bloom's taxonomy; analyzing, evaluating, and creating are higher order thinking skills (Moore & Stanley, 2010).

Higher order thinking skills are important aspects of teaching and learning process. According to Kings, Goodson, and Rohani (2013), higher order thinking skills can be defined as the learner's ability of processing information; by using his mental capabilities more than just remembering and understanding it. Whenever a student comes across a new question, unknown problem, uncertain situation or dilemma; higher order thinking skills are the abilities that are activated. Pogrow (2005) mentioned that higher order thinking skills have the ability to enable the student to cope with the challenges of life in a better way and the requirement of educational activities. That's why they are given importance. Higher order thinking skills can be helpful for envisaging the upcoming performance of a student. According to the findings of a study conducted by Phillips (1997), the tasks which required cognitive and metacognitive ability are difficult for the students who are weak in higher order thinking skills. It is expected that students with good higher order thinking skills tend to be more successful in their studies because they have the ability to learn quickly, improve their performance and correct their weaknesses (Yee, Othman, Yunos, Tee, Hassan, & Mohammad, 2011).

In order to learn thinking skills, the ability of perceiving and processing information plays a vital role (Muhammad & Hassan, 2005). Everyone has different ability to perceive and process information (Joseph, 2000; Razak & Azman, 2012). This ability is known as thinking style (Rassool & Rawaf, 2007; Rogers, 2009). According to Ning & Downing (2010), Prashning (2004) and Vincent and Ross (2001), thinking style plays a vital role in creating various ways for the students to improve their thinking skills and enhance their academic achievement.

According to Armstrong (2000), the preferred way of a person to receive and judge the incoming information, to solve the problem, and make decisions is referred as thinking style. Thus the mode of receiving, processing, learning, and responding to a

stimuli is called thinking style. According to Priola, Smith and Armstrong (2004), the preferred and comfortable mode of an individual to process information is known as thinking style of a person; it is not the subject matter of a task rather the way of performing the task. Sternberg (1997) stated that the approach of the person which he uses to perform his routine life tasks and to manage his abilities is called thinking style. According to Sofo (2008), the way a person uses in order to perform his routine life activities and the way of dealing with the situation is defined as the thinking style of the person.

The most common types of thinking styles are convergent and divergent thinking styles. Barnett (1999) argued that individuals basically have two types of thinking styles. Convergent thinkers have concrete thinking. They can easily adapt in new situation. As opposed to them, the divergent thinkers are more comfortable with abstract ideas and concepts. Nezhad (2013) confirmed that convergent thinkers give emphasis to well-known solutions of the problems, they prefer to apply the predetermined methods to new situations and gathering knowledge. In contrast to this, divergent thinkers prefer to produce creative and innovative ideas. They are able to establish unpredicted relationships between the phenomena. Fatt (2000) described the characteristics of convergent and divergent thinkers in such a way that convergent thinking style is rational and diagnostic while the divergent thinking style is creative, dynamic and imaginative. They can solve a problem by multiple solutions.

Many students are good at memorizing but weak in using higher order thinking skills (Yamin, 2007). In exam centered education system, it is not possible to teach higher order thinking skills (Jones, 2010; Mustaffa, 2007). Keeping examinations in mind, most of the teachers focus on syllabus coverage and content delivery (Mladenovic, 2001). As a result, the students remain weak in higher order thinking skills (Graham & McKenzie, 1995). Therefore, the understanding of thinking styles of students can be used as an initial guide in order to develop effective teaching and learning environment, to help students in learning higher order thinking skills.

Statement of the Problem

Thinking style plays a vital role in creating various ways for the students to improve their thinking skills and enhance their academic achievement. For this reason, this study aims to identify the thinking styles of the students and determine the relationship between higher order thinking skills and thinking styles. The specific objectives of this study are to: (i) identify the thinking styles of secondary school students; (ii) find the relationship of convergent thinking style and higher order thinking skills of secondary school students; (iii) find the relationship of divergent thinking style and higher order thinking skills of secondary school students; and (iv) determine the

gender-wise relationship between thinking styles and higher order thinking skills of secondary school students.

Methodology

Participants

The population of this study included all Chemistry Students of Grade 9 from Male and Female Secondary Schools of Tehsil Rawalpindi in academic year 2018-2019. Random sampling technique was used to select the chemistry students from male and female secondary schools of Tehsil Rawalpindi. The total number of students selected as sample was 368 students. In which 184 students were boys and 184 students were girls.

Instruments for Research

There were two instruments used in this research.

1-*Convergent/Divergent Test*:

This test is based on a test developed by Hudson (1966). It was developed and evaluated by Bahar (1999) at the Center of Science Education, University of Glasgow. According to Zamman (2006), this test was used by Bahar (1999), Danili (2004), Hindal (2007) and Bhatti (2013) in their research studies. This test was used by the researchers to separate Convergent and Divergent thinkers. It consisted of six subtests.

The first subtest assessed the ability of the respondent to write as many synonyms of a given word as possible. Three words, i.e., "strong, clear and dark", were given to the respondent. To facilitate understanding, an example was given in the beginning of the test. Four minutes were given to attempt this test.

The second subtest assessed the ability of the respondent to produce as many sentences as possible that come to mind involving four given words. The sequence of the words was to remain constant while making sentences. The words given were "write, words, long, enough" and "friend, man, year, catch". Only meaningful sentences received marks. An example was given at the start of the test. Four minutes were given to attempt this test.

The third subtest was a nonverbal test. This test assessed the ability of the respondent to draw diagrams and pictures according to the idea given in question. The words given were "energy, happiness, technology, and silence". At the start of the test, an example was provided. The time allocated to this test was five minutes.

The fourth subtest assessed the ability of the respondent to think of as many things as possible which are similar in one way or the other. The word "round" was given and the respondent had to write the names of objects that are round in shape. At

the start of the test, an example was provided. The time allocated to this test was two minutes.

The fifth subtest assessed the ability of the respondent to think of as many words as possible which start with the letter G and end at T. the respondent was not allowed to write the names of places or persons. To facilitate understanding, an example was provided at the start of the test. The time allocated to this test was two minutes.

The sixth subtest assessed the ability of the respondent to formulate as many ideas as possible related to a given phrase. The respondent had to write the ideas that came to mind related to the phrase "working in laboratories" that was given in the question. At the start of the test, an example was provided. The time allocated to this test was three minutes.

Every subtest had different time limits and the total time allowed for this test was 20 minutes. For each question, the students were asked to give a maximum number of answers. Every single correct answer received one point. The highest possible score for this test was 130**.**

To separate the male and female students into convergent, divergent and normal (all-rounder) thinkers, the responses of the students were assessed and formula; which was used by Hudson (1966), Bahar (1999), Zamman (2006), Hindal (2007) and Bhatti (2013); was applied to the results of students in convergent and divergent test.

- The Convergent ≤ Mean - 0.25 Std. Deviation
  The Convergent ≤ 42.58- 0.25 (11.56)
  The Convergent ≤ 42.58 - 2.89
  The Convergent ≤ 39.69
- Normal (all-rounder) = Mean ± 0.25 Std. Deviation
  Normal (all-rounder) = 42.58 ± 0.25 (11.56)
  Normal (all-rounder) = 42.58 ± 2.89
  Normal (all-rounder) = 39.69 - 45.47
- The Divergent ≥ Mean + 0.25 Std. Deviation
  The Divergent ≥ 42.58 + 0.25 (11.56)
  The Divergent ≥ 42.58 + 2.89
  The Divergent ≥ 45.47

The students who had scores less than or equal to 39.69 were identified as convergent. The students who had scores between 39.69 and 45.47 were identified as normal (all-rounder) and the students who had scores more than or equal to 45.47 were identified as Divergent.

2-*Chemistry Test for Higher Order Thinking Skills:*

Chemistry test was constructed from the first five chapters of Chemistry textbook (Punjab Textbook Board, 2018-2019); which were; (a) Fundamentals of Chemistry; (b) Structure of Atoms; (c) Periodic Table and Periodicity of Properties; (d) Structure of Molecules; and (e) Physical states of Matter.

The researcher followed the higher thinking skill levels of cognitive domain of Revised Bloom's taxonomy of educational objectives (2001) for the construction of test items in order to measure the skills of the students in analyzing, evaluating, and creating. Test consisted of Short- Answer Questions.

Validity and Reliability

Bahar (1999), Danili (2004), Zamman (2006), Hindal (2007) and Bhatti (2013) have all made productive use of the convergent and divergent tests that's why no need was felt to further validate convergent and divergent test. A panel of veteran teachers carefully examined the chemistry test to examine its content validity and minor adjustments in the test were made to improve its content validity. Reliability was ensured after pilot study in two secondary schools. Cronbach's alpha coefficient was used to calculate reliability of chemistry test. The alpha coefficient was 0.81. That's why the test was considered acceptably reliable and was taken to schools for data collection from students.

Procedure

With the permission of District Education Officer, District Rawalpindi and school administration, the researcher conducted a survey in eight selected secondary schools, with four being schools for girls and four being schools for boys. The Convergent and Divergent Test and Chemistry Test for Higher Order Thinking Skills were administered and the responses of students in both tests were recorded.

Results

The frequencies of the students in each thinking style category are as follows: 142 Convergers, 144 Divergers and 82 all-rounders. Among the 184 male students, the frequencies of males in each thinking style category and their respective percentages of the male subsample are as follows: 92 Convergers (50%), 50 Divergers (27.17%) and 42 All-rounders (22.82%). Among the 184 female participants, the frequencies of females in each thinking style category and their respective percentages of the male subsample are as follows: 50 Convergers (27.17%), 94 Divergers (51.08), and 40 All-rounders (21.74%). The present study focused on the convergent and divergent thinking styles, therefore, all-rounders were not taken into consideration.

A Pearson product-moment correlation coefficient was computed to find the relationship between convergent and divergent thinking style and higher order thinking skills of students. According to Table 1, it is found that there is a weak positive correlation between convergent thinking style and higher order thinking skills of whole sample, at the significance level of 0.01, r = 0.194, N = 142, p = 0.021.According to Table 2, it is found that there is a moderate positive correlation between divergent thinking style and higher order thinking skills of whole sample, at the significance level of 0.01, r = 0.335, N = 144, p = 0.001.

According to Table 3, it is found that there is a weak positive correlation between convergent thinking style and higher order thinking skills of male students, at the significance level of 0.01, r = 0.095, N = 92, p = 0.370. According to Table 4, it is found that there is a moderate positive correlation between divergent thinking style and higher order thinking skills of male students, at the significance level of 0.01, r = 0.413, N = 50, p = 0.003.

According to Table 5, it is found that there is a weak positive correlation between convergent thinking style and higher order thinking skills of female students, at the significance level of 0.01, r = 0.214, N = 50, p = 0.135. According to Table 6, it is found that there is a moderate positive correlation between divergent thinking style and higher order thinking skills of female students, at the significance level of 0.01, r = 0.311, N = 94, p = 0.002.

Discussion

Majority of male students are convergent thinkers and majority of female students are divergent thinkers. There is a positive correlation between convergent thinking style and higher order thinking skills of whole sample. Similarly, there is a positive correlation between divergent thinking style and higher order thinking skills of whole sample. But the strength of the relationship between convergent thinking style and higher order thinking skills of the whole sample is weak whereas strength of the relationship between divergent thinking style and higher order thinking skills of whole sample is moderate.

There is a positive correlation between convergent thinking style and higher order thinking skills of male students. Similarly there is a positive correlation between divergent thinking style and higher order thinking skills of male students. But the strength of the relationship between convergent thinking style and higher order thinking skills of the male students is weak whereas strength of the relationship between divergent thinking style and higher order thinking skills of male students is moderate.

There is a positive correlation between convergent thinking style and higher order thinking skills of female students. Similarly, there is a positive correlation

between divergent thinking style and higher order thinking skills of female students. But the strength of the relationship between convergent thinking style and higher order thinking skills of the female students is weak whereas strength of the relationship between divergent thinking style and higher order thinking skills of female students is moderate.

Results reveal that a positive relationship exists between thinking styles and higher order thinking skills. According to previous researches, thinking style plays a vital role in creating various ways for the students to improve their thinking skills and enhance their academic achievement (Ning & Downing, 2010; Prashning, 2004; Vincent & Ross, 2001). An individual can perform well in every field if he has the understanding of his potentials and weak points (Tan & Samyudia, 2009; Zulfa, 2006; Dunn & Griggs, 1993). According to Emamipour and Esfandabad (2010) and Tapsir, Rahman, Saat, Wahab, Boon, Ahmad, & Mahmood (2010), students should be introduced to thinking skills and thinking styles in order to produce an effective and fruitful learning environment for them.

Conclusions

This study studies the relationship between thinking styles and higher order thinking skills, keeping in mind the importance of both variables in teaching and learning process. The results revealed that majority of male students were convergent thinkers and majority of female students were divergent thinkers. Moreover, thinking styles had weak relationship with higher order thinking skills. Thus, it is suggested that future studies should be conducted to determine the relationship of other factors to higher order thinking skills because there are many independent variables whose effect and relationship to higher order thinking skills is not yet studied.

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Annexures

Table 1:*Relationship between convergent thinking style and higher order thinking skills (HOTS) of whole sample:*

Variables	**N**	**Mean**	**Correlation coefficient**	**Level of significance**
Scores in Con/Div. test	142	31.11	0.194	0.021
Scores in HOTS	142	6.94		

Note: α=0.01

Table 2: *Relationship between divergent thinking style and higher order thinking skills (HOTS) of whole sample:*

Variables	N	Mean	Correlation coefficient	Level of significance
Scores in Con/Div. test	144	54.20	0.335	0.001
Scores in HOTS	144	18.10		

Note: α=0.01

Table 3:*Relationship between convergent thinking style and higher order thinking skills (HOTS) of male students:*

Variables	**N**	**Mean**	**Correlation coefficient**	**Level of Significance**
Scores in Con/Div. test	92	29.73	0.095	0.370
Scores in HOTS	92	5.64		

Note: α=0.01

Table 4:*Relationship between divergent thinking style and higher order thinking skills (HOTS) of male students:*

Variables	N	Mean	Correlation coefficient	Level of Significance
Scores in Con/Div. test	50	53.70	0.413	0.003
Scores in HOTS	50	16.90		

Note: α=0.01

Table 5:*Relationship between convergent thinking style and higher order thinking skills (HOTS) of female students:*

Variables	N	Mean	Correlation coefficient	Level of Significance
Scores in Con/Div. test	50	33.66	0.214	0.135
Scores in HOTS	50	9.30		

Note: α=0.01

Table 6: *Relationship between divergent thinking style and higher order thinking skills (HOTS) of female students:*

Variables	N	Mean	Correlation coefficient	Level of Significance
Scores in Con/Div. test	94	54.47	0.311	0.002
Scores in HOTS	94	18.74		

Note: α=0.01