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LATERAL THINKING AND SCIENTIFIC CREATIVITY IN STUDENTS: A CORRELATION ANALYSIS

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ABSTRACT

Lateral thinking is an approach to problem solving that strives for creative solutions. Debate on whether creativity is the result of lateral or logical thinking, perhaps the most fundamental creative act occurs when we combine previously unrelated concepts, such a combination can occur when we think either laterally or logically. The key aim of lateral thinking is to deliberately and systematically create unrelated concepts forcing them together to see where it takes us. Scientific creativity is defined as the ability to perform novel and useful thoughts, ideas or behaviours pertaining to science. As science is a discipline that requires creativity, this research explored the relationship between Lateral Thinking Skills and Scientific Creativity of 400 Secondary School Students based on a survey analysis. Even though negative correlation was found outbetween the variables in the sample chosen, students were found to differ based on their gender and type of syllabus in terms of the variables.As lateral thinking does not work in a vacuum, considering a rounded approach is necessary to look at a more holistic and practical approach to foster such skills and improve scientific creativity.

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INTRODUCTION

Cognition is regarded as the mental action or process of acquiring knowledge and understanding through thought, experience and senses encompassing many aspects of intellectual functions and processes such as attention, memory, judgment and evaluation. Cognitive processes use existing knowledge and generate new knowledge analyzed and synthesized from different perspectives with in different contexts notably in the fields of logistics, anesthesia, neuroscience, psychiatry, psychology, education, philosophy, anthropology, biology, systemic, logic and computer science. These and other different approaches to the analysis of cognition are synthesized in the developing field of cognitive science, a progressively autonomous academic discipline, In psychology, the term 'cognition' is usually used within an information processing view of an individual's psychological sense and is the same in cognitive engineering; in a branch of psychology called social cognition, the term is used to explain attitudes, attribution, and group dynamics.Human cognition is conscious and unconscious, concrete or abstract, as well as intuitive like knowledge of a language. It encompasses processes such as memory, association, concept formation, pattern recognition, language, attention, perception, action problem solving and mental imageryto determine an intelligent behavior.

Theoretical Underpinnings

Creative Cognition and education: Creativity and innovative thinking have been a vast construct of questioning to scholars, psychologists, therapists and more lately neuroscientists (Jung *et al*., 2010). Creativity appears in various diverse models, tones, and shades (Feist, 2010: Perlovsky & Levine, 2012). The creative contributions of extraordinary artists, designers, inventors and scientists attract our greatest consideration as they express the foundations of their culture and provide breakthroughs influencing cultural development and progress. Understood as a multidimensional domain, creativity is a crucial operator of human progress. Nevertheless, not every person who is an artist, inventor or scientist is similarly creative, nor are all creative or innovative individual artists, inventors or scientists. Some are innovative in business, in communication with other individuals, or just in living. Torrance (1990) considered fluency, flexibility and original thinking as central features of creativity. Fluency means the number of original ideas produced, flexibility is the ability to change 'tack' not to be bound by an established approach after that approach is found no longer to work efficiently. Originality is interpreted as an answer which is rare, which occurs only occasionally in a given population. Guilford (1956) proposed creativity as the aggregate of mental abilities covered by divergent thinkingas part of a set of five operations applied in the Structure of Intellect (SoI) model extracting four fluency factors, namely associational, expressional, word and ideational and two flexibility factors namely spontaneous and

adaptive. Guilford's exploration (1956) of indicators of creativity through factor analytical studies showed fluency, flexibility, and originality as measurable units. Creativity is the ultimate answer of man's problems leading to innovation of new ideas, things and ultimately the civilization of life. Students rarely have the opportunity to call into play such abilities such as fluency, the ability to think different and originality to think about unusual solutions and inquisitiveness. The future of our nation depends upon the creative talents of future citizens of society. Creative insights occur in consciousness. Given the view that the working memory buffer of the pre-fontal cortex holds the content of consciousness, each of the four distinctive neural loops terminates there. When creativity is the result of deliberate control, as opposed to spontaneous generation, the prefrontal cortex also instigates the creative process. Both processing modes, deliberate and spontaneous, can guide neural computation in structures that contribute emotional content and in structures that provide cognitive analysis, yielding the four basic types of creativity (Dietrich, 2004). Advancing research on creativity provides anintegrative framework by assembling the neural, cognitive, motivational and emotional correlates of creativity. Furthermore, computational approaches such as neural network models could assist to provide a predictive perspective for this integrative framework for creativity. The field of Creative Cognition deals with the understanding of the cognitive processes underlying creative performance. Having a creative mind is one of the gateways for achieving fabulous success and remarkable progress in professional, personal and social life (Khalil *et al*, 2019). Several recent studies in the cognitive neuroscience of creativity have explored this cognitive balancing act, focusing particularly on the types of attention involved in acts of creativity, and the role that our brain's executive functions, control process that regulate one's thoughts and behaviors , play in the creative process (Mc Donald, 2018). He found connection between attention and creativity indicating "real-world" creative achievement (as opposed to laboratory measures of creativity such as divergent thinking tests) as associated with diffused or leaky attention. In '*Attention and Creative neuroscientist'* Dr. Darya Zabelina lists a veritable Who's Who of creative people who were overly sensitive to sensory stimuli and describes the elaborate measures to which they resorted to trying to block out distractions.

Scientific Creativity: Scientific Creativity is regarded as the attainment of new and novel steps in realizing the objectives of Science. It involves an active interaction of the person with his surroundings, whatever the individual creates in the fruit of the various stimuli provided by his surroundings. Being a multifaceted construct it requires motivation an access to a body of systematic knowledge, an ability to correctly formulate research problems and to define a comprehensive problem space. Scientific Creativity is a kind of intellectual trait or ability producing or potentially producing a certain product that is original and has social or personal value, designed with a certain purpose in mind, using given information. It is viewed as the attainment of new and novel steps in realizing the objects of science. It manifests itself in the conception of new ideas contributing to scientific knowledge itself, in the formulation of new theories of science, in the devising of new experiments to probe nature's law, in the development of scientific ideas applied to particular domains of practical interest, in the realization of new organizational features of scientific research and of scientific community, in the novel implementation of plans and blueprints for scientific outlook into the public mind, and in many other realms (Moravesik, 1981).Scientific Creativity is the type of problem solving that necessarily involves situations concerning the solutions of mechanical and social problem with a touch of abstract creativity which helps in scientific inventions.

Lateral Thinking Skills: Thinking Skills from an integral part of the school curriculum and should not be regarded as an isolated aspect of learning. Thinking involves mental processes in which sorting and organizing of information takes place. It is not a method that can be learned but is a process of the mind, an ability to consider various descriptions of problems and situations. Therefore thinking skills should be integrated within subjects and across different levels. Thinking includes different perspectives of others to frame ideas. DeBono speaks about two types of thinking: vertical thinking and lateral thinking. Vertical thinking is a high probability thinking whereas lateral thinking is low probability thinking. Lateral thinking is the process of using information to bring about creativity and insight restructuring. Such techniques involve usinganalogies, fractionation, generation of alternatives, brainstorming and dominant ideas. Thinking is the best tool to equip the mind with elevated concepts (De Bono 1995). Lateral Thinking can be learned, practiced and used. It is possible to acquire skill in school subjects. Vertical thinking training is being provided to the students nowadays. Lateral thinking skills help the students to achieve the aspirations. Lateral Thinking is the genesis of insight, creativity and humor, which happens to be the goal of present day education for changing perceptions and flexibility and better idea generation.The mind with lateral thinking attitude always shows willingness to look at things from various points of views. The purpose of Lateral Thinking is to provide more deliberate means for pattern switching than relying on mistake or accident: it maximizes the personal-self of the person. Hence, it is necessary for learners to break the old patterns and form new pattern to create new attitude which would induce them to try with all possible ways to attain effective proficiency and create ways to develop the scientific ability. Lateral Thinking is needed to break the tentative pattern/structure set up by sequence of experience. Without Lateral Thinking Ability it would be impossible to repair the existing concepts and perception. A unique educational framework to empower thinking skills is needed to increase the balance between mind and the real world. Thinking skills are a valuable component in the development of our students: motivate learners to learn and increase better learning of the subject. The teachers are not aware of the importance of developing Lateral Thinking ability in students.Proper training for developing Lateral Thinking Skills should be provided to the students. It is time that we implement these skills into our teaching as wellas into our curriculum.

Related Studies: Educational experts have recognized the importance of creativity in Science learning. The study by Gupta (1979) found that general creative tests are not necessarily going to do well on tests constructed to measure creativity in different specific fields such as Science, Music and Art. More and Jagadeesh (2017) found that significant and positive correlation exists between academic achievement and lateral thinking ability of students of secondary schools. Wulansari *et al* (2009) describes the influence of Scientific Creativity and Critical Worksheet (SCCW) to the creative thinking and scientific critical as well as students cognitive ability, creative thinking skill and critically scientific students with applied model of project-based learning integrated with SCCW and conventional student worksheet (CSW). This study was based on one of the 21st Century Partnership Learning Framework which contains the skills that must be possessed by learners in the 21st century, focused on scientific creative thinking skills and critical scientific thinking skills. The research method used was pre-experimental research with randomized control group pretest-posttest design. It was concluded that implementation of SCCW on project-based learning can improve creative thinking skills and critical scientific and cognitive abilities of students with greater improvement than the application of SCW on project-based learning.

METHOD AND MATERIALS

Survey method was used for the study. The sample wasdrawn from Secondary Schools of Kerala from Pathanamthitta and Alappuzha districts with size 400.Tools used for the study were: Test of Lateral Thinking Skillscontaining 26 multiple choice items pertaining to four different components: random entry, generation of alternatives, analogies and puzzles; and the Test of Scientific Creativity comprising five parts: fluency, flexibility, originality, redefinition and sensitivity to problems following the guidelines given by J. P. Guilford, 1956. Statistical techniques used for the study were Percentage Analysis, Karl Pearson's Product Moment Coefficient of Correlation, and Test of significance of difference between means for large independent samples.

ANALYSIS AND DISCUSSION

The results indicate that there is not much variation in the three measures of central tendencies of the two variables Lateral Thinking Skills and Scientific Creativity in the students. The values of skewness and kurtosis of the variable Lateral Thinking Skills are 0.44 and -0.39 respectively. This suggests that the distribution is slightly positively skewed and leptokurtic. For the variable Scientific Creativity the values are 0.89 and 0.22 indicating that the distribution is positively skewed and platykurtic. Percentage analysis of the scores on Lateral Thinking Skills and Scientific Creativity for the total sample was done to classify the sample into three categories namely, high, average and low group by calculating the mean and SD of the scores.

The critical ratio obtained is 2.37 for the subsample gender and 2.71 for students of two different type of syllabus, which is found greater than the limits set for significance at 0.05 level. This reveals that there is significant difference in Lateral Thinking Skills among secondary school students based on the respective subsamples. The critical ratio obtained for the subsamples show that there is significant difference in scientific creativity among secondary school students, the value is greater than the limit set for 0.05 level of significance. The Coefficient of Correlation obtained is -0.921 which shows that there exists a negative relationship between Lateral Thinking Skills and Scientific Creativity, a positive change in one variable will be accompanied by negative change in the other variable. The variables tend to move in opposite directions in a nearly identical move showing a near perfect relationship, the minus sign simply indicates that the line slope inwards.

Table 1. Important statistical constants of the two variables

Variables	Mean	Median	Mode	SD	Skewness	Kurtosis
Lateral Thinking Skills	7.55	7	8	4.44	0.44	-0.39
Scientific Creativity	23.78	18.5	14	18.41	0.89	0.22

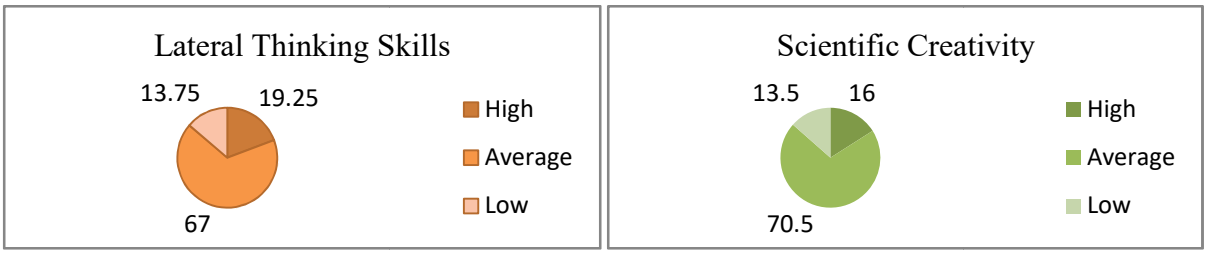

Figure 1. Pie diagram of percentages of the two variables on 3 categories

Table 3. Data and results of t-test on Lateral Thinking Skills for the subsamples

Sub-sample	N	Mean	SD	t-value
*Gender • Boys • Girls	 202 198	 8.044 7	 4.483 3.48	2.37
*Type of syllabus • CBSE • State	 200 200	 8.125 6.93	 4.419 4.418	2.71

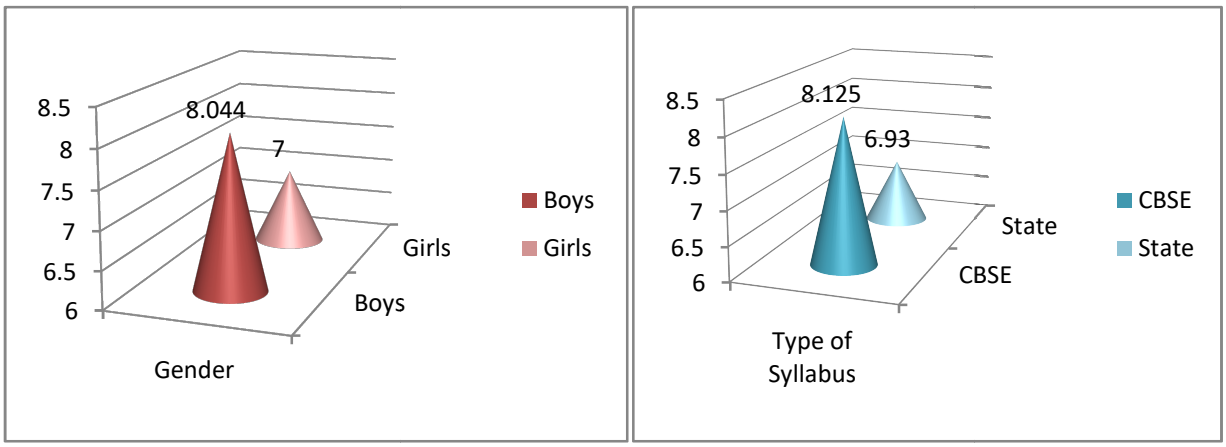

Figure 2. Mean distribution of Lateral Thinking Skills for subsamples

Table 4: Data and results of t-test on Scientific Creativity for the subsamples

Sub-sample	N	Mean	SD	t-value
*Gender • Boys • Girls	 202 198	 27.306 20.075	 18.08 18.07	3.99
*Type of syllabus • CBSE • State	 200 200	 27.405 20.05	 18.144 17.981	4.07

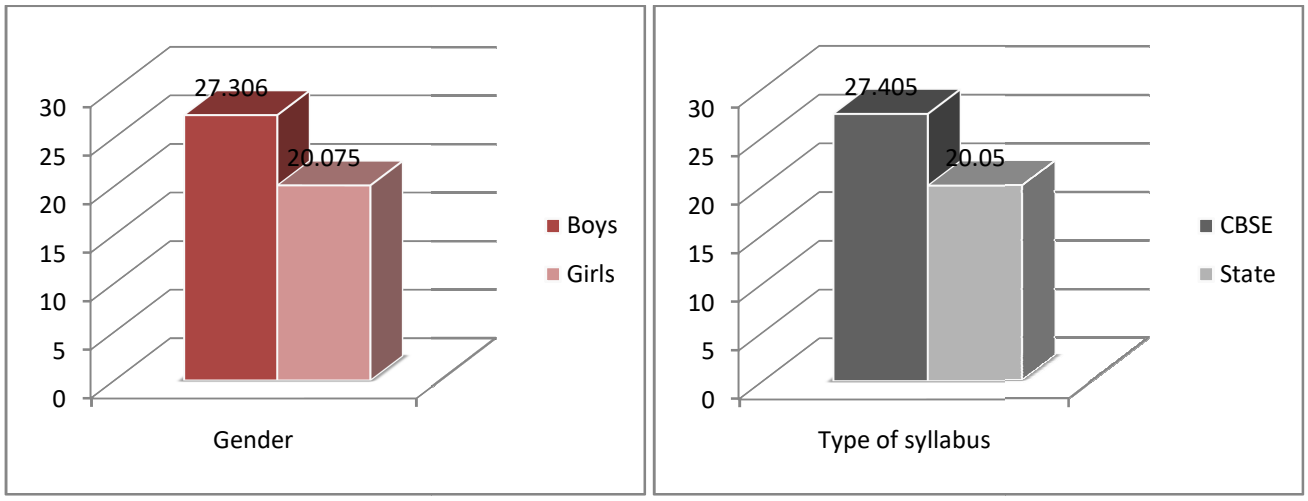

Figure 2. Students' level of Scientific Creativity based on sub-samples

Table 4. Data and results of correlation analysis of the total sample

Variables	Mean	Standard Deviation	Pearson Coefficient (r)	SEr
Lateral Thinking Skills	7.55	4.44		
			-0.921	0.007
Scientific Creativity	23.78	18.41		

CONCLUSION

Previous researches examining the effects of various educational practices on creative thinking and scientific process skills of students have been found positive (Lestari, Sarvi &Sumarti, 2018). There are also studies that have examined the relationship between scientific creativity which consist of both creativity and scientific knowledge, and scientific processing skills and have found them positively correlated (Dhir, 2014). In the book, *Creativity beyond the myth of genius*, Robert Weisberg claims there is very little evidence for this kind of lateral thinking in the works of creators, creative people differs from non-creative people not in their use of lateral thinking but in possessing different knowledge and skills. De Bono describes lateral thinking as both a habit and attitude of mind which can be fostered by practicing lateral thinking techniques such as challenging assumptions, suspended judgment, brainstorming, and analogies. However, although some scientific thinking skills and scientific creativity do seem to develop simultaneously in students, it is necessary to develop these sets of skills further and support them in appropriate learning processes equipping students with 21st century skills. In this context discovering relationships may reveal new perspectives on the link between the nature of lateral thinking skills and creativity for creating suitable environments for nurturing scientific creativity in learners and that the results of this study may not be generalisable for other populationsand cause and effect relationships could be investigated.

Implications and Suggestions: The basis of scientific study is critical thought. Science strives to provide objective, testable answers to questions naturally arising from observation. It avoids subjective questions and answers better addressed by religion and society. Although scientific theories often spark controversy in human societies, a scientific hypothesis is meant solely to provide a testable, falsifiable explanation for observed natural phenomena. Science education does not necessarily involve scientific thinking. The use of scientific thinking helps us make sense of the world. Learning skills to support scientific thinking helps us make sense of the world. Learning skills to support scientific thinking is an important part of young child's development. Scientific thinking skills include observing, asking questions, making predictions, testing ideas, documenting data and communicating thoughts. As lateral thinking can be learned, practiced and used, it is possible to acquire skill in it just as it is possible to acquire skill in school subjects. Teachers have a key role to play in enhancing scientific creativity.

Teacher must be creative in the classroom and the style of presentation should be unique. This should involve the mind of every student. Teaching should be so designed to develop original and novel thoughts of students.The teacher must be dynamic enough to teach Science subjects: there should be a good science laboratory for experiments Physics and Chemistry and a good botanical garden to study plant life. Students should be encouraged to develop good hobbiesin maintaining botanical garden. Motivation should be given by teachers to students to be original in thinking. In schools provision should be made to bring out the talent in them by arranging extracurricular activities like science exhibitions or science fairs. It is recommended to examine opportunities provided by schools to develop these skills and design studies that relate with educational activities favoring thinking skills and creativity in science.

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