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SCIENTIFIC CREATIVITY AND MULTIPLE INTELLIGENCE OF SECONDARY SCHOOL PUPILS OF KERALA

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Abstract

Scientific Creativity is an important concept in the context of the emerging need for solutions of different scientific problems. The world is challengingly facing many environmental threats which demands scientific solutions. The rote learning methods are not sufficient to face such challenges. So the educated community should think about creative pupils who can come up with excellent ideas and machineries. It is necessary to be novel in ideas and creations. Multiple Intelligence is of more importance because one pupil may not come up with different capacities but a classroom contains pupils of different capacities. The teachers can train the pupils by identifying the dominating intellectual abilities. Nowadays many governmental and non- governmental parties are coming to school to extend their helping hands to make the ideas into reality. The present study is a trial to find out the correlation between Scientific Creativity and Multiple Intelligences among ninth standard pupils of Kerala. The sample collected for this contains 954 ninth standard pupils from randomly selected government and government aided schools of Kerala. The method used for this study is survey method. Psychological tools used for the present study were Scientific Creativity Test (SCT) and Multiple Intelligence Scale (MIS). Pearson's Product Moment Coefficient of Correlation has shown that there is significant positive correlation between Scientific Creativity (Total) and Multiple Intelligence (Total) and the seven components. Existential Intelligence is correlated with Scientific Creativity at 0.05 level of significance. There is no significant correlation between Scientific Creativity and Visual/Spatial Intelligence. The study proved that there exists significant correlation between components of Scientific Creativity (Fluency, Flexibility and Originality) and Multiple Intelligence.

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Introduction

The present era is giving importance in startup venture. Creating employers is more important, for a growing country, than creating employees. So it is of utmost importance to be novel. Scientific Creativity talks about novel ideas. In the present study the investigators gave importance to get novel ideas from pupils of ninth standard. Physics, Chemistry, Biology and Environmental Science are the major areas focused for the present study. The questions of Scientific Creativity Test were designed to get many ideas from many areas.

Multiple Intelligence is considered as "the capacity to solve problems or to fashion products that are valued in one or more cultural setting" (Gardner, 1983). Problem solving capacity is a cognitive ability. Yamamoto (1964) defined creativity as "the process of forming new ideas or hypothesis and communicating the results". According to Piaget (1952) the formal operational stage of intellectual development in children comes at the age of 12 and above. This is the stage when the child can think in abstract terms, follow logical propositions and reason by hypothesis. Pupil can isolate the elements of a problem and systematically explore all possible solutions to problem.

Scientific Creativity and Multiple Intelligence are cognitive abilities. So if we could identify the dominating intelligence among the nine intelligences and scientific creativity of children, then creating a group with members of various dominating intelligence and a highly scientific creative pupil in that group can come out with exciting ideas and creations. The present era is providing all information just a click away. Proper scaffolding from a teacher can let the pupils to get opportunities locally, nationally and even internationally.

Individuals who are free in their spirits and minds are vital for this century of globalization and knowledge economy. Freedom for thoughts and actions are necessary to be creative. Education is an endeavor which needs creativity. Pupils should be trained to be rational in thinking and moral in judgements. The uncommon and novel thoughts and ideas should be encouraged in classrooms and the conformist attitude of majority teachers of many of our educational institutions should be discouraged.

Humans have a natural capacity to inquire, to seek knowledge, to think rationally and to create amazingly new things. Scientific Creativity is a relevant psychological variable to be nurtured in schools. An expert teacher can help pupils to come up with wonderful ideas. Active knowledge is essential for intellectual development. Knowledge which is confined only to books is inactive. Schools have a sound system of education and well planned activities with the wholehearted participation of teachers, parents and students can contribute amazing ideas to society to make life easier. Smart work is needed rather than hard work.

All trends and approaches in educational arena should aim the betterment of pupils. It should not be for the political advantages or corruption. Money should be spend meaningfully and intelligently. We should learn to avoid outdated traditions and to accept novelty.

Relevance of the Study

The world of knowledge economy is a platform where knowledge and creativity play equally important role. The present study will be helpful to extend new suggestions and approaches in science education. Technological revolutions have the power to renovate our lifestyle. To make our life more comfortable and smooth, scientific knowledge plays a vital role. Scientific inventions are the golden key to uplift the standard of life. Now our world is like a village because of the advancement in science and technology. We can even go to space now. All these are possible because of some creative persons. Scientific Creativity can do wonders in this world. It can even change the face of the world. T.V, Radio, Rocket, Satellites, Computer etc. up to cloning and carbon nano tubes are all the invention of a creative mind.

Teachers should try to foster creativity and to encourage questions of students. Today the teaching-learning process is changing, taking into consideration the principle of learning by doing. These activities aim to help child to engage in creative thoughts, giving them the ability to see connections and distinction between ideas, thoughts and solutions.Hands-on, minds-on activities reinforce children. Creativity and imagination inspired by the eternal quest for knowledge are necessities not luxuries.It are sure that the study will contribute a good flavor to the present educational context of Kerala. Teachers should try to foster creativity by providing ample opportunities to the pupils.

Parents can also play equal role to enhance the divergent thinking in children. School and home can provide complementary experiences to foster creativity among students.

Objective of the Study

The objective of the study is to find out the correlation between Scientific Creativity (Total and three components) and Multiple Intelligence (Total and nine components) of secondary school pupils of Kerala.

Method

The present study used survey method to collect data among secondary school pupils of Kerala regarding their Scientific Creativity and Multiple Intelligence

Sample

The investigators collected the necessary data using random sampling technique from 954 pupils studying in standard IX of selected government and government aided secondary schools.

Tools Used

The tools used for the present study are the Scientific Creativity Test (SCT) and Multiple Intelligence Scale (MIS) for secondary school pupils developed by the investigators. SCT is a test to assess the unusual thinking abilities based on Physics, Chemistry, Biology and Environmental Science and due importance was given to classify knowledge to bring order and meaning from a mass amount of information in the above mentioned disciplines of science. In the final form of SCT, four subtests were included. In each subtest three items were retained and thus a total of twelve items were included in the final form of Scientific Creativity Test (English and Malayalam versions). MIS is a rating scale to measure the score of Multiple Intelligence (total and nine selected components).The final tool contains 90 items.10 items for each selected intelligence (English and Malayalam versions).

Table 1: Details of Sub-tests for Multiple Intelligence Scale

Sl. No.	Components of Multiple Intelligences	Number of Items	Time in Minutes
1	Part 1-Verbal/Linguistic Intelligence	10	5
2	Part 2- Logical/ Mathematical Intelligence	10	5
3	Part 3-Musical/Rhythmic Intelligence	10	5
4	Part 4-Bodily /Kinesthetic Intelligence	10	5
5	Part 5-Visual/Spatial Intelligence	10	5
6	Part 6-Interpersonal Intelligence	10	5
7	Part 7-Intrapersonal Intelligence	10	5
8	Part 8-Naturalistic Intelligence	10	5
9	Part 9-Existentialistic Intelligence	10	5

Analysis

Preliminary Analysis

Table 2: Statistical Indices pertained to Scientific Creativity of Secondary School Pupils of Kerala

Variable	N	Range	M	Md.	Mo.	SD	SE_M	Sk.	Ku	$M_{POP.05}$	$M_{POP.01}$
Scientific Creativity	954	363	90.39	81.00	46	53.32	1.73	1.93	5.66	87.00 93.78	85.93 94.84
Fluency	954	159	46.97	43.00	40	24.09	0.78	1.50	4.06	45.44 48.50	44.96 48.98
Flexibility	954	58	15.55	14.00	12	7.09	0. 23	1.72	4.87	15.10 16.00	14.96 16.15
Originality	954	183	27.86	21.00	10	25.14	0. .81	2.391	8.32	26.27 29.46	25.76 29.97

Table 3 : Statistical Indices pertained to Multiple Intelligence of Secondary School Pupils of Kerala

No.	Variable	N	Range	M	Md.	Mo.	SD	SE_M	Sk.	Ku	$M_{POP.05}$	$M_{POP.01}$
MI-1	Intrapersonal	954	15	13.87	14.00	14	2.66	0.086	-.186	-.093	26.27 29.46	25.76 29.97
MI-2	Interpersonal	954	18	12.60	13.00	14	3.14	0.101	-.410	.170	12.41 12.80	12.34 12.87
MI-3	Bodily-Kinesthetic	954	20	11.41	11.00	10	3.59	0.116	-.186	-.275	10.91 11.37	10.84 11.44
MI-4	Musical	954	20	12.38	13.00	14	3.95	0.128	-.247	-.396	12.13 12.63	12.05 12.71
MI-5	Existential	954	20	12.22	12.00	12	3.78	0.122	.025	-.472	11.98 12.46	11.90 12.53
MI-6	Natural	954	20	11.58	12.00	14	4.03	0.131	-.214	-.349	11.33 11.84	11.24 11.92
MI-7	Linguistic	954	19	10.11	10.00	10	3.69	0.120	-.050	-.455	9.88 10.35	9.80 10.42
MI-8	Spatial	954	20	10.79	11.00	11	3.93	0.127	-.183	-.352	10.54 11.04	10.47 11.12
MI-9	Mathematical	954	20	10.16	10.00	11	4.10	0.133	-.041	-.321	9.90 10.42	9.81 10.50
MI-Total	Multiple Intelligence	954	143	104.86	105.0	95	22.98	0.744	-.103	-.171	103.40 106.32	102.94 106.78

Table 4 : Relationship between Scientific Creativity and Multiple Intelligence of Secondary School Pupils of Kerala (Total Group and Sub groups)

Group	Sample	N	R	SE_r	r_{POP}	
					.05 level	.01 level
Whole Sample	Total Sample	954	0.148**	0.032	0.09 – 0.21	0.07 – 0.23
Gender	Boys	553	0.131*	0.042	0.05 – 0.21	0.02 – 0.24
	Girls	401	0.120*	0.049	0.02 – 0.22	-0.01 – 0.2
Socio-Economic Status	High	147	0.213**	0.079	0.06 – 0.37	0.01 – 0.42
	Average	306	0.057	0.057	-0.05 – 0.17	-0.09 – 0.20
	Low	501	0.147**	0.044	0.04 – 0.26	0.00 – 0.29

*** Significant at 0.01 level* **Significant at 0.05 level*

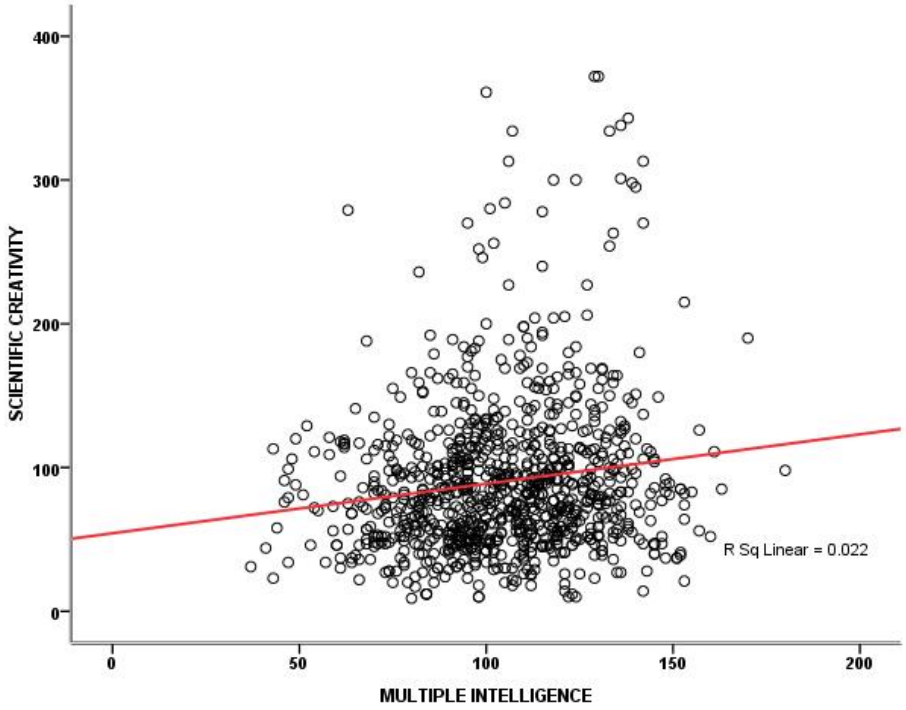

Figure 1: Scatter plot with Regression Line Output:

Scientific Creativity X Multiple Intelligence

Table 5 : Relationship between Component Abilities of Scientific Creativity and Multiple Intelligence of Secondary School Pupils of Kerala

Component Ability	N	R	SE_r	r_{POP}	
				.05 level	.01 level
Fluency	954	0.146**	0.032	0.08 – 0.21	0.06 – 0.23
Flexibility	954	0.130**	0.032	0.07 – 0.19	0.05 – 0.21
Originality	954	0.138**	0.032	0.08 – 0.28	0.06 – 0.22
Scientific Creativity (Total)	954	0.148**	0.032	0.09 – 0.21	0.07 – 0.23

** *Significant at 0.01 level*

Table 6 : Relationship between Scientific Creativity and Multiple Intelligence Components of Secondary School Pupils of Kerala

No.	Components of Multiple Intelligence	N	R	SE_r	r_{POP}	
					.05 level	.01 level
MI-1	Intrapersonal	954	0.129**	0.032	0.07 – 0.19	0.05 – 0.21
MI-2	Interpersonal	954	0.107**	0.032	0.04 – 0.17	0.02 – 0.19
MI-3	Bodily/Kinesthetic	954	0.100**	0.032	0.04 – 0.16	0.02 – 0.18

MI-4	Musical/Rhythmic	954	0.098**	0.032	0.04 – 0.16	0.02 – 0.18
MI-5	Existentialistic	954	0.074*	0.032	0.01 – 0.14	-0.01 – 0.16
MI-6	Naturalistic	954	0.116**	0.032	0.05 – 0.18	0.03 – 0.20
MI-7	Verbal/Linguistic	954	0.143**	0.032	0.08 – 0.21	0.06 – 0.23
MI-8	Visual/Spatial	954	0.059	0.032	0.00 – 0.12	-0.02 – 0.14
MI-9	Mathematical/Logical	954	0.118**	0.032	0.06 – 0.18	0.04 – 0.20
MI-Total	Multiple Intelligence	954	0.148**	0.032	0.09 – 0.21	0.07 – 0.23
*** Significant at .01 level*						** Significant at .05 level*

The estimation of Pearson's product moment coefficient of correlation between Scientific Creativity (total) and Multiple Intelligence (total) for the total sample of secondary school pupils of Kerala, generated r-value which is significant at .01 level ($r = 0.148$; $p<.01$), the r-value between Fluency and Multiple Intelligence is 0.146, which is significant at 0.01 level, the r-value between Flexibility and Multiple Intelligence is 0.130, which is significant at 0.01 level and r-value between Originality and Multiple Intelligence is 0.138, which is significant at 0.01level, as shown in Table 5.

The estimation of Pearson's product moment coefficient of correlation between scientific creativity (total) and components of multiple intelligence for the total sample of secondary school pupils of Kerala, generated r-values (Table 6) reveals that significant correlation(0.01 level of significance) exists between Scientific Creativity and Intrapersonal (0.129), Interpersonal (0.107), Bodily/Kinesthetic (0.100), Musical/Rhythmic (0.098), Naturalistic (0.116), Verbal/Linguistic (0.143), Mathematical/Logical (0.118) Intelligences. The r-value between

Scientific Creativity and Existentialistic Intelligence (0.074) is significant at 0.05 level of significance. There is no significant correlation between Scientific Creativity and Visual/Spatial Intelligence.

The hypothesis formulated in this context, *there is no significant correlation between Scientific Creativity (total and three components) and Multiple Intelligence (total and nine components) of secondary school pupils of Kerala),* is rejected.

Results and Discussion

The study reveals that there is significant positive correlation (at 0.01 level of significance) between Scientific Creativity (Total) and Multiple Intelligence (Total) and all the seven components except visual/spatial intelligence. Existential intelligence is correlated with Scientific Creativity at 0.05 level of significance.

The correlation coefficient between Scientific Creativity (Total) and Multiple Intelligence (Total) is 0.148. This is greater than the value set for significance at 0.01 level (viz., 0.084). Hence the obtained correlation coefficient between Scientific Creativity (Total) and Multiple Intelligence (Total) is significant at 0.01 level.

The correlation coefficient between Fluency and Multiple Intelligence (Total) is 0.146. This is greater than the value set for significance at 0.01 level (viz., 0.084). Hence the obtained correlation coefficient between Fluency and Multiple Intelligence (Total) is significant at 0.01 level.

The correlation coefficient between Flexibility and Multiple Intelligence (Total) is 0.130. This is greater than the value set for significance at 0.01 level (viz., 0.084). Hence the obtained correlation coefficient between Flexibility and Multiple Intelligence (Total) is significant at 0.01 level.

The correlation coefficient between Originality and Multiple Intelligence (Total) is 0.138. This is greater than the value set for significance at 0.01 level (viz., 0.084). Hence the obtained

correlation coefficient between Originality and Multiple Intelligence (Total) is significant at 0.01 level.

The correlation coefficient between Scientific Creativity (Total) and Verbal /Linguistic Intelligence is 0.143. This is greater than the value set for significance at 0.01 level (viz., 0.084). Hence the obtained correlation coefficient between Scientific Creativity (Total) and Verbal/Linguistic Intelligence is significant at 0.01 level.

The correlation coefficient between Scientific Creativity (Total) and Logical/Mathematical Intelligence is 0.118. This is greater than the value set for significance at 0.01 level (viz., 0.084). Hence the obtained correlation coefficient between Scientific Creativity (Total) and Logical/Mathematical Intelligence is significant at 0.01 level.

The correlation coefficient between Scientific Creativity (Total) and Musical/Rhythmic Intelligence is 0.098. This is greater than the value set for significance at 0.01 level (viz., 0.084). Hence the obtained correlation coefficient between Scientific Creativity (Total) and Musical/Rhythmic Intelligence is significant at 0.01 level.

The correlation coefficient between Scientific Creativity (Total) and Bodily/Kinesthetic Intelligence is 0.100. This is greater than the value set for significance at 0.01 level (viz., 0.084). Hence the obtained correlation coefficient between Scientific Creativity (Total) and Bodily/Kinesthetic Intelligence is significant at 0.01 level.

The correlation coefficient between Scientific Creativity (Total) and Visual/Spatial Intelligence is 0.059. This is less than the value set for significance at 0.05 level (viz., 0.063). Hence the obtained correlation coefficient between Scientific Creativity (Total) and Visual/Spatial Intelligence is not significant.

The correlation coefficient between Scientific Creativity (Total) and Interpersonal Intelligence is 0.107. This is greater than the value set for significance at 0.01 level (viz., 0.084). Hence the

obtained correlation coefficient between Scientific Creativity (Total) and Interpersonal Intelligence is significant at 0.01 level.

The correlation coefficient between Scientific Creativity (Total) and Intrapersonal Intelligence is 0.129. This is greater than the value set for significance at 0.01 level (viz., 0.084). Hence the obtained correlation coefficient between Scientific Creativity (Total) and Intrapersonal Intelligence is significant at 0.01 level.

The correlation coefficient between Scientific Creativity (Total) and Naturalistic Intelligence is 0.116. This is greater than the value set for significance at 0.01 level (viz., 0.084). Hence the obtained correlation coefficient between Scientific Creativity (Total) and Naturalistic Intelligence is significant at 0.01 level.

The correlation coefficient between Scientific Creativity (Total) and Spiritual/Existentialistic Intelligence is 0.074. This is greater than the value set for significance at 0.05 level (viz., 0.063). Hence the obtained correlation coefficient between Scientific Creativity (Total) and Spiritual/Existentialistic Intelligence is significant at 0.05 level.

Conclusion

The present study reveals that there if significant positive correlation (at 0.01 level of significance) between Scientific Creativity (Total) and Multiple Intelligence (Total) and the seven components. Existential Intelligence is correlated with Scientific Creativity at 0.05 level of significance. There is no significant correlation between Scientific Creativity and Visual/Spatial Intelligence. The study proved that there exists significant correlation between components of Scientific Creativity (Fluency, Flexibility and Originality) and Multiple Intelligence. The educational system can identify the dominating intelligences of the pupils among multiple intelligences. Ability identification will be helpful in motivating the pupils to create new ideas and machines. Now it's the age of robotics and biometrics. If the student has novel ideas many organizations are ready to extend their helping hands. Central government is popularizing the Atal Tinkering Labs to develop the scientific, technological, engineering and mathematical skills of pupils in school level. The findings of this study can be used to develop studenteprenours with

the abilities in science processing, engineering, commercialization and empathy. If the teachers can develop an intelligent team work among pupils, they can fly beyond the existing horizons.

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