Research Article

Effect of EduSat Lectures on Scientific Creativity among High School Students in Haryana

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Abstract

The study attempted to explore the effect of technology-based teaching on improving the scientific creativity of high school students in Haryana. The sample comprised 200 class IX students studying in four government schools of the Sonipat district. This was an experimental study using a pre-test/post-test equivalent group design in which the control and experimental group were equated on socio-economic status and intelligence levels. The Verbal Test of Scientific Creativity by Sharma and Shukla was administered at the pre-and-post treatment phase. The results reveal that technology-based EduSat lectures were not more effective than the normal classroom teaching in enhancing the scientific creativity of high school students. It is suggested that while developing EduSat lectures immense power of multimedia should be utilized to stimulate divergent thinking of students. The study has implications for policymakers, media personnel, teachers, students, parents and experts involved in the EduSat lecture delivery system.

Keywords: Effect, EduSat, Scientific Creativity, High School, Haryana

Introduction

Scientific creativity has been defined by researchers in different manners and contexts. Besemer and Treffinger (1981) stated that novelty, resolution, elaboration, and synthesis are the distinguishing features of scientific creativity. Mansfield and Busse (1981), based on their review of literature, have identified five basic ingredients of a creative act: problem selection, best efforts for problem solution, dealing effectively with restrictions, facing varying obstacles, and authenticating and extending the work. Ochse (1990) conceptualized creative persons as those who contribute something original and valuable to society and culture. Guilford (1950), a major contributor in the field of creativity research, described "creativity as being grounded in the ability to manipulate ideas in fluent, flexible, elaborate, and original ways". His views are supported by Torrance (1967) maintaining that creativity is exogenous and transferable in mental manipulations while Sternberg (1988) linked creativity with the development of insight. According to Shively (2011), the four key abilities closely associated with the creative process are fluency, flexibility, originality, and elaboration.

Creativity plays a crucial role in the process of science. Problem-solving, hypothesis formulation, experiment planning, and technical innovation require a specific type of creativity peculiar to science. Kocabas (1993) stated that scientific creativity is composed of motivation for scientific work, ability to formulate a scientific problem, ability to search for the solution, ability to assemble and narrow the probable solutions to the problem, and keeping patience and stamina in view of the limitations imposed by circumstances. Hu and Adey (2002) argued that scientific creativity can be described in three domains namely product, trait, and process. The product part depends on scientific phenomena, scientific knowledge, and the nature of scientific problems while the trait is evaluated by three structures namely fluency, flexibility, and originality. Imagination and new thinking are the characteristics of the process domain. In view of Runco and Nemiro (1994), scientific creativity is closely associated with the problem-finding behaviour of an individual whereas Heller (2007) believed that if a person is capable of solving a scientific problem innovatively then he/she possesses a certain level of scientific creativity. Ugras (2018) explained scientific creativity as a phenomenon whereby something new and somehow valuable is formed in science. Mukhopadhyay and Sen (2013) argued that creativity in science education has emerged as an independent field of research, and is drawing increasing attention of science educators, while Adzliana et al. (2012) have treated scientific creativity as fundamental to the achievement of a person, organization or country.

The research has emphasised the role of creativity in education and especially in science education and schools are considered as the most appropriate place to foster it. Sternberg and Lubart (1996) think that schools must nurture creativity in students, making them bold to take risks and such behaviour may lead to innovations and discoveries. The prevalent educational system in India is based on a model that was evolved in Europe in the 19th century when the aim was to produce proficient workers and submissive civil servants. This system was intended to cater to the industrial requirements prevailing at that time, but the situation in the 21st century is quite different. The contemporary era needs persons with new thinking and flexible ideas since the requirements of society are changing on a day to day basis. This requires schools to be open to instill such skills and become a field for exploration, inquiry, and reflection of ideas. However, existing classroom practices in the Indian schools indicate that the problems and materials are given to the students by teachers. This prevents the development of new thinking among students. In such a situation, the students rarely get a chance to think and demonstrate independently. In most of the cases, the teachers used to narrate the scientific knowledge and theories from textbooks. In science classes, the students are hardly allowed to perform experiments freely to reflect on their thoughts and practices. This is more prevalent in government schools where there is also a lack of laboratory equipment and chemicals and other facilities. It has been experienced that independent thinking is rarely appreciated by the school world rather students are directed to follow monotonous steps decided and performed by the classroom teachers. This type of education not only diminishes the promotion of original, flexible, and divergent thinking but kills the student's instincts to explore the problems scientifically.

Guimbal (2015) has observed in "The Indian Express" that "most of the students in the country are indulged in memorization of lessons, dates and other pieces of texts or information to be able to write in their exams". It means that students' main objective appears to be getting good marks by memorization of facts while diminishing the application of critical thinking in a solution to a problem. Google Chief Executive Officer Sundar Pichai (2017 cited in "The Times of India", 2018, March 12) also expressed his distress about Indians not being flexible and lacking original thinking in work. One of the key reasons for unemployment in the country has been cited as a lack of original thinking among aspiring candidates. Similar observations were made by Wozniak, the co-founder of Apple, in his interview with "The Times of India" in 2018. While extending this debate, Wozniak commented that Indians lack creativity and original thinking because of an ill-structured academic system. In 2014, India was ranked 66 out of 140 countries by the United Nations Development Programme in terms of innovation ("The Times of India", 2018, March 12).

The reports in newspapers and personal observations by eminent personalities of the 21st century suggest that the education system in India is not upto the mark and it lacks the promotion of innovative and original thinking among students. It has been noted that the focus of the existing school system is on preparing students to study hard and getting good jobs rather than motivating them to think critically. The use of technology for learning and innovations is minimum, especially in rural areas and government schools where the maximum school population exists. The outdated pedagogy, with a minimal or complete absence of technology, is among the probable reasons for the lack of critical thinking and new ideas. The conventional pedagogy discourages original thoughts and innovative thinking but promotes memorization and indoctrination. The unavailability of teachers and science laboratories, particularly in rural government schools, makes the situation worst. Therefore, it is important to work for a complete overhaul of the quality and method of teaching used in today's education system to inculcate and enhance scientific creative skills among school students. Brinkman (2010) stated that "teaching students to be creative is a task teachers do not take because most teachers only recognize approaches for teaching for the best learning results rather than teaching for the discovery of new knowledge and creative ideas". However, Park et al. (2006) argued that teachers should use curriculum transactions as an opportunity to develop creativity by practicing creative teaching in the classrooms.

The government of India in 2002 launched an Educational Satellite popularly called EduSat to serve the educational needs of all categories of learners including science students who may lack facilities, especially in remote and rural areas. In this mode, the school students, sitting at a distance, receive instructions through lectures pre-recorded by eminent experts which are later telecast through EduSat. This type of setting provides an opportunity for classroom teachers, sitting in remote-rural schools, to become more creative and instill creativity in students by using the latest technology of animation and visual effects while presenting abstract concepts. Visual experimentation is added as per the demand of the content. The use of animation and simulated experimentation facilitates the learning process to understand abstract ideas directly (Bates, 1998). The use of captions/ titles/ topics on the screen helps the students to read/ write/ note the learning points and move at their own pace. The pre-recorded lessons may be used time and again to understand the concept better and explore the issues minutely. The animation and experimentation used by experts make the lectures lively and generate interest among the students to think in a new and novel way. Research shows that EduSat not only increases the attendance and retention of school students but also helps the teachers in making their teaching more effective and innovative (Chaudhary & Garg, 2010).

In Haryana, the EduSat project was launched in 2007 to provide better education to all with a focus on rural and remote areas. Initially, 9000 schools were selected for the "Haryana EDUSAT Project" and the government established Utkarsh society under the aegis of the Education Department to implement it. Under this project, the curriculum-based pre-recorded videos are telecast from Panchkula Studio as per Time-Table. Currently, five channels, four Direct To Home (DTH) and one Satellite Interactive Terminal (SIT), are used for this purpose. These channels cater to the educational needs of elementary, secondary, technical, and higher education students. The government has also created a website www.haryanaedusat.com to help the students in this kind of learning.

However, doubts and concerns as regards the effectiveness of EduSat lectures have been expressed by many researchers at the national level. In a report by Azim Premji Foundation, it was put forward that EduSat lectures produced no robust evidence of improvement in the learning outcomes of students. The pedagogical model of education implemented via EduSat provided little opportunity for students to interact with teachers because pre-recorded lessons are transmitted through Receive-Only Terminals (ROTs) where students have no chance to ask questions. In a similar study, Dalal (2016) noted that the lack of trained manpower, improper monitoring, and missing administrative ethics had affected the performance of EduSat adversely. This argument is supported by the Comptroller and Auditor General (CAG) of India report in 2013 that 56 percent of the EduSat terminals in government schools in Haryana were non-functional (Siwach, 2013). Similarly, "The Indian Express" (2014, April 17) revealed that the EduSat has failed in

Haryana because of lapses and lack of monitoring.

Despite a few discouraging pieces of evidence, it has been felt that in recent times, EduSat has tremendous potential to be utilized for inculcating new knowledge, scientific and creative temperament. It has been cited repeatedly in the literature that the use of technology increases student's motivation as well as engagement for learning and promotes the constructionist approach in teaching and learning (Godzicki et. al. 2013). Halatand Karakus (2013) suggest students who are facilitated with technology for teaching and learning are more likely to make meaning and construct their understanding of complex ideas with observed motivation. In a study, Li and Zeng (2017) found that online courses can stimulate students' interest in learning and improve their creativity through video teaching. Research evidence also suggests that exposure to modern technology enhances creativity and high order thinking skills which is not found in the conventional approach (Yushau, Mji & Wessels, 2005). The edge of teaching through technology in comparison to conventional methods has been reported by many researchers but whether it also helps in nurturing scientific creativity and new thinking is a question that must be answered through empirical investigations.

Significance of the Study

The main aim of implementing new technologies in education is to advance the quality of education and foster better interactivity between the teachers and learners. Embracing new technology is not a challenge but acclimatizing it to several educational, pedagogical, and social realities is a major challenge. It has been widely acknowledged by educators that creativity in science education is an important issue and educators must work on methods and techniques to improve it. Although creativity has been studied by researchers for many years, there are not many studies that suggest ways and measures for improving creativity in science. For all these reasons, scientific creativity is a subject that needs to be emphasized. Also, it is needed to investigate how students' scientific creativity is affected by teaching them through technology-based EduSat lectures. A great benefit of EduSat lectures is that it offers numerous opportunities for creative instructions. The presenter can facilitate animations, panel discussions, oral lectures, experimentation, brainstorming, and more. Although there are limitations, it brings the opportunity for better education especially in rural and remote areas where access and lack of facilities are an issue. It aims to energise the students taking them from passive mode to active mode using the expertise of scholars in the transaction of the curriculum in an enjoyable mode. Learning to be creative requires active engagement and stimulating divergent thinking. Therefore, it requires investigation whether the lectures transmitted through EduSat positively increase or inhibit the scientific creativity among high school students.

Objectives

Following were the objectives of the study:

1. To study the existing level of scientific creativity among high school students.
2. To study the effect of EduSat lectures on different dimensions of scientific creativity among high school students.
3. To study the effect of EduSat lectures on overall scientific creativity among high school students.

Hypotheses

The following hypotheses were generated for the study:

1. After the exposure to EduSat lectures, there is no significant difference between pre-test and post-test levels of scientific creativity among high school students.
2. After the exposure to EduSat lectures, there is no significant difference between the scientific creativity of experimental and control group students.

Methodology

Sample

A sample of 200 science students from the IXth class of two urban and two rural area government schools of the Sonipat district of Haryana was drawn randomly. In the first instance, 20 schools were approached for the experiment but finally, four schools agreed to cooperate. In total, 583 students were studying in the IXth class of those four schools. All the 583 students were administered to Jalota's (1972) Group Test of General Mental Ability (Hindi) and Socio-economic Status Scale by Kulshreshta (1972) to equate them on intelligence and Socioeconomic status parameters. Based on scores on the Test of General Mental Ability, these 583 students were further divided into three groups i.e. high, average, and low intelligence levels group, Similarly, all 583 students were also enlisted into three groups having a high, average, and low Socio-economic status based on their Socio-economic Status Scale scores. The further analysis showed that 42 students were common to the high intelligence as well as high socioeconomic status. These 42 common subjects/students were divided randomly into two groups equally i.e. 21 to the control group and 21 to the experimental group. The same procedure was followed while dividing the students into the control group and the experimental group from the average group (92 students) and the lower group (72 students) of intelligence and socio-economic parameters. Out of these 206 common subjects in high, average, and low groups of intelligence and socio-economic parameters, 200 were selected by weeding out two students from the high, average, and low groups. Hence, in this way, a sample of 200 students was obtained randomly divided into control and experimental groups 100 each. Through equating and matching of subjects, an attempt was made to eliminate systematic bias and minimize the effect of the intervening variables. Thereafter, dividing the subjects to the control and experimental group randomly, the measures of two intervening variables (intelligence and socio-economic status) between the control and the experimental groups were tested statistically, to ensure the equivalence of the two groups. The 't'-test was applied to find out the difference between intelligence and socio-economic status test scores of the experimental group and the control group. The results showed that the t-value between the groups was not significant. It means that no significant differences existed between the intelligence and the socio-economic status of control and the experimental group, indicating that they belonged almost to the same kind of intelligence range and socio-economic milieu.

Design and procedure

The study employed a pre-test/post-test equivalent group experimental design. The study included an experimental group and a control group. In this, true experimental design equivalence of the groups was provided by the matching of subjects, on two confounding variables i.e. intelligence and socio-economic status, to the experimental and control treatment. The experimental group was taught through pre-recorded EduSat lectures and the control group through the conventional lecture method.

Tools for Data Collection

The study employed three tools namely Socioeconomic Status Scale by Kulshreshta (1972), Group Test of General Mental Ability (Hindi) by Jalota (1972) and Verbal Test of Scientific Creativity by Sharma and Shukla (2005) for data collection.

The Socioeconomic status scale by Kulshreshta (1972) was used because this is a standardised scale with high reliability and validity, which especially measures the socio-economic status of the subjects belonging to the urban and rural areas. Moreover, in order to establish the relevance of the scale by Kulshreshta (1972) in the present context; the reliability and validity of the scale were rechecked. The scale was administered on a sample of 50 students. The test-retest method was used to check the reliability, and the coefficient of correlation was found 0.72. Construct validity was calculated by comparing the scale with the socio-economic status scale by Bhardwaj (2001). The coefficient of correlation was found to be 0.63. These values showed that the test is reliable and valid in present times also.

Similarly, the Group Test of General Mental Ability (Hindi) by Jalota (1972) was found appropriate in current times because no other standardised test with such high reliability and validity was available for subjects whose medium of instruction and examination was Hindi. Moreover, it is still considered as the most referenced and widely used tool to measure intelligence of Hindi speaking subjects.

The Verbal Test of Scientific Creativity by Sharma and Shukla (2005) was used to assess the scientific creativity of subjects before and after the experimental phase. It had 12 items. Each item was scored for the "fluency, flexibility, and originality" dimension of scientific creativity.

Analysis and Interpretation of Results

In the first phase, the existing level of scientific creativity among class nine government high school students was determined. The scientific creativity test was administered to both groups. The results of the pre-test of both the groups for overall and dimension-wise scientific creativity are presented in Table 1.

Table-1: Difference in the Mean Scores of Experimental and Control Group on Scientific Creativity Pre-test

	Test	Group	N	Mean	S.D	't' value	Level of Significance
Overall Scientific Creativity	Pre-test	Experimental	100	40.39	14.71	0.09	Not significant at 0.05 level
		Control	100	40.30	14.87		
Dimensions of Scientific Creativity							
Fluency	Pre-test	Experimental	100	17.26	5.86	0.56	Not significant at 0.05 level
		Control	100	17.47	5.30		
Flexibility		Experimental	100	12.83	4.49	0.79	Not significant at 0.05 level
		Control	100	13.11	4.88		
Originality		Experimental	100	10.05	6.70	0.21	Not significant at 0.05 level
		Control	100	9.98	6.41		

Table-1 indicates that the overall scientific creativity mean scores of the experimental and control group on the pre-test are 40.39 and 40.3 respectively (obtained t = 0.09, not significant at 0.05 level). Further, the calculated 't' values 0.56, 0.79, and 0.21 for different dimensions of scientific creativity test namely fluency, flexibility, and originality respectively were also not significant at 0.05 level. This shows that before the exposure to EduSat lectures, the two groups started from essentially the same level of overall scientific creativity and almost similar levels of different dimensions of scientific creative ability.

The first phase was followed by the treatment phase. In the treatment phase, the control group was taught by the traditional lecture method and the experimental group by pre-recorded EduSat lectures. After the treatment phase, the results of pre-test and post-test on overall and dimension-wise scientific creativity level of the experimental group were calculated and the same is presented in Table-2.

Table-2: Difference in the Mean Score of Experimental Group on Scientific Creativity Pre-Test and Post-Test

Variable	Group	Test	N	Mean	S.D	't' value	Result
Overall Scientific Creativity	Experimental Group	Pre-Test	100	40.39	14.72	16.47	Significant at 0.01 level
		Post-Test	100	47	13.96		
Dimensions of Scientific Creativity							

Fluency Dimension	Experimental Group	Pre-Test	100	17.26	5.86	12.66	Significant at 0.01 level
		Post-Test	100	20.02	4.90		
Flexibility Dimension		Pre-Test	100	12.83	4.49	12.51	Significant at 0.01 level
		Post-Test	100	14.92	4.36		
Originality Dimension		Pre-Test	100	10.05	6.70	10.46	Significant at 0.01 level
		Post-Test	100	12.3	6.36		

Table-2 shows that the mean and standard deviation values of the experimental group on overall scientific creativity pre-test and post-test were 40.39 ± 14.72 and 47± 13.96 respectively. The 't' value obtained was 16.47, which shows a significant difference in scientific creative levels of the experimental group before and after the treatment. As indicated by the higher mean value of the post-test, there was an increase in scientific creativity among subjects exposed to Edusatlectures. The obtained 't' values between the pre-test and post-test mean scores of the experimental group on fluency, flexibility, and originality dimension of scientific creativity were 12.66, 12.51, and 10.46respectively. This indicates that EduSat assisted instructions had registered significant improvement in the selected dimensions (fluency, flexibility, and originality) of scientific creativity. Based on the results, the first null hypothesis, "After the exposure to EduSatlectures, there is no significant difference between pre-test and post-test levels of scientific creativity among high school students" was thus rejected. Therefore, it can be concluded that teaching through EduSat lectures is effective in enhancing scientific creativity among high school students.

Post-testing of the control group on the scientific creativity variable was done to analyse the effect of traditional classroom teaching without utilizing EduSat lectures on these particular variables. Results of the pre-test and post-test scores of the control group, regarding overall scientific creativity and its dimension, are presented in Table-3.

Table-3: Difference in the Mean Score of Control Group on Scientific Creativity Pre-Test and Post-Test

Variable	Group	Test	N	Mean	S.D	't' value	Result
Overall Scientific Creativity	Control Group	Pre-Test	100	40.3	14.88	17.4	Significant at 0.01 level
		Post-Test	100	47.71	13.13		
Dimensions of Scientific Creativity							

Fluency Dimension	Control Group	Pre-Test	100	17.47	5.30	11.11	Significant at 0.01 level
		Post-Test	100	19.71	5.09		
Flexibility Dimension		Pre-Test	100	13.11	4.88	7.85	Significant at 0.01 level
		Post-Test	100	14.99	4.42		
Originality Dimension		Pre-Test	100	9.98	6.41	9.03	Significant at 0.01 level
		Post-Test	100	12.62	5.88		

Table-3 shows that concerning the overall scientific creativity of the control group, the t-value was 17.4 which indicates a significant difference in mean scores of the control group during the pre-test and post-test stage. Table 3 also indicates that the calculated 't' values of the control group on different dimensions viz. fluency, flexibility, and originality were 11.11, 7.85, and 9.03 respectively. All these obtained 't' values reveal a significant difference between the pretest and post-test scores of the control group on varied dimensions of scientific creativity. The mean scores indicate an increase in the post-test scientific creativity level in comparison to the pre-test level of students who were taught using the normal chalk and talk method.

The results reveal that both the groups experienced significant improvement in fluency, flexibility, originality, and overall scientific creative ability from the beginning of the intervention to the end of it.

To analyse which method was more effective in enhancing the scientific creativity among high school students, post-test scores of the experimental and control group were compared and tested statistically as presented in Table-4.

Table-4: Difference in the Mean Scores of Control and Experimental Group on Overall Scientific Creativity Post-test

Test	Group	N	Mean	SD	t-value	Result
Post-test	Experimental Group	100	47	13.95	0.83	Not Significant at 0.05 level
	Control Group	100	47.71	13.12		

Table-4 demonstrates that after the exposure of the experimental group to EduSat lectures, the mean and standard deviation scores came to be 47 ± 13.95 while the scores of the control group for the mean and standard deviation for overall scientific creativity were calculated to be 47.71 ± 13.127. The obtained 't' value between the two groups was 0.83, which was not significant at the 0.05 level. It means that after the treatment phase, there was a marginal edge to the control group for overall scientific creativity. However, scientific creativity was increased in both groups after the treatment phase.

It can, therefore, be concluded that both the methods seem to be equally good in enhancing overall scientific creativity and the effect of EduSat lectures was not at all visible when compared to the conventional method. Based on results obtained from the analysis of the data, the second null hypothesis i.e. “After the exposure to EduSat lectures, there is no significant difference between the scientific creativity of experimental and control group students”, is thus accepted. The analysis leads to the conclusion that EduSat lectures were not more effective than the normal classroom teaching in enhancing the scientific creativity of high school students. Further, the post-test scores of both groups were analyzed on various dimensions of scientific creativity and presented in Table-5.

Table-5: Difference in the Mean Score of Control and Experimental Group on different Dimensions of Scientific Creativity Post-test

Dimensions Scientific Creativity	Test	Group	N	Mean	S.D	‘t’ value	Level of Significance
Fluency	Pre-test	Experimental	100	20.02	4.90	0.98	Not significant at 0.05 level
		Control	100	19.71	5.09		
Flexibility		Experimental	100	14.92	4.36	0.22	Not significant at 0.05 level
		Control	100	14.99	4.42		
Originality		Experimental	100	12.30	6.36	0.91	Not significant at 0.05 level
		Control	100	12.62	5.88		

Table-5 shows the dimension-wise effect of enhancing scientific creativity. The calculated ‘t’ values are 0.98, 0.22, and 0.91 for different dimensions of the scientific creativity test. Based on the difference in mean scores on different dimensions of the scientific creativity test, it can be inferred that students of the experimental group and control group had shown an almost equal increase. It can be concluded that EduSat lectures and traditional methods were equally effective in increasing all three dimensions of scientific creative ability.

Discussion and Conclusion

The results indicate that EduSat lectures were not more effective than the normal classroom teaching in increasing the scientific creativity of high school students. In the absence of direct empirical research studies on the effect of EduSat lectures on scientific creativity, the present findings seem in agreement with the studies conducted on the effect of television on creativity. The study by Runco and Pezdek (1984) falls completely in line with the findings of the present study as they argued that the effect of watching television and listening radio on children's creativity is not different. Another study conducted by Keyne (2003) showed that television viewers with large screen time scored lower than moderate viewers on the creativity test. Also, Kant (2012) found an insignificant relationship between creativity and viewing of television by secondary school children. In contrast to the findings of this study, MacBeth (1996) observed that watching television increases children's imagination and creativity. Singer and Singer (2001) found that technology improved the quality of creative products and it had a positive impact on the creativity of children. The present findings also do not support Yushau, Mji, and Wessels (2005) who found that exposure to modern technology enhances creativity and high-order thinking skills which are absent in the conventional pedagogy.

The results revealed that EduSat lectures proved to be not more effective than traditional classroom teaching in enhancing the scientific creativity of high school students. The possible reasons may be that the content presented and the methods adopted in the presentation were not able to enhance the divergent thinking of the students which is the foremost essential of scientific creativity. Science lectures transmitted through EduSat failed to assist the development of scientific creativity more than the normal chalk and talk method. Therefore, it is essential to make use of different learning approaches, methods, and techniques to ensure the development of scientific creativity among high school students. It was expected to achieve these objectives through the use ofEduSat technology, but the results are contrary to the expectations. The failure of EduSat lectures in bringing desired results for developing scientific creativity in comparison to the conventional method may be due to the reason as noted by Dalal (2016) that EduSatlacks trained manpower and proper monitoring. One other reason for the present findings might be the lack of two-way communication between students and the resource persons delivering the lectures. Usually recorded lectures are transmitted and there is no scope of students' active participation during the transmission of the lecture, which is very much needed to stimulate divergent thinking among the students. Moreover, scientific creativity requires motivation (Kocabas, 1993) but this study indicates that this component might be missing in EduSat lectures. It can be suggested that while developing these lectures immense power of media and technology should be utilized to stimulate divergent thinking of students along with developing their convergent thinking. Pedagogical changes in these lectures can make them helpful in inculcating scientific creativity among students.

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