

Does integrated approach to ESD affect critical thinking on sustainable development?

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ABSTRACT

The concept of Sustainable Development (SD) has been of great significance during the last couple of decades due to the exploitation of nature and natural resources in a drastic way. ESD (Education for Sustainable Development) emerged with an immediate urge to preserve and conserve our nature and natural resources for the future generations to come. The concept of ESD aims for a society that attains sustainability by merging the dimensions of environmental, economical, social and political dimensions. The paper discusses about the effect of an integrated approach to ESD on the students' critical thinking on SD. A curriculum was developed by integrating SD concepts into science and social science of VII standard of NCERT (National Council of Educational Research and Training) syllabus of India with various learning activities for their transaction by incorporating several pedagogical strategies that lead to constructing knowledge, keeping in mind the social perspectives or the context of students. The study was of quasi experimental in nature wherein a control and an experimental group were employed. A non equivalent control group design was used whereby the integrated curriculum was taught to the experimental group for about five months and the control group was exposed to the conventional curriculum and methodology during the same period of time. It was found that the experimental group taught by the integrated approach to ESD had a higher mean score on critical thinking test compared to the control group. On the basis of the findings, it was concluded to highlight the importance of integration of SD components in various disciplines at all levels.

Key words- Education for sustainable development, critical thinking on sustainable development, pedagogical strategies, integrated approach to ESD

The concept of sustainable development is against the human assumption that natural resources are ample

on earth. Man started to think about this concept seriously when he discovered that environmental issues are escalating day by day. Sustainable Development, which is a complex concept, has its basis in the Natural and Social Sciences that has been developed through international dialogue in retort to the challenges facing the world today. There are many views and definitions of Sustainable Development. The most acceptable definition is that Sustainable Development is "development which meets the needs of the present

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without compromising the ability of future generations to meet their own needs" (Brundtland Commission/ Our Common Future/ World Commission on Environment and Development 1987).

What is sustainable development?

Unless development needs and those of poverty in particular, are dealt with simultaneously, there could be neither protection of the environment nor success in the programmes to achieve development (Kartikeya, 2000). A core principle behind sustainable development is the idea that economic, social and environmental conditions play a major role. Without a proper ecosystem, it is impossible to maintain a better society and economic development for our own and future generation. Thus environmental dimension can be regarded as the ultimate boundary for Sustainable development. The social dimension is to meet the basic needs of all people without exceeding the boundaries of the ecosystem. The economic dimension is a means to realize the goal within the limits of a socially and environmentally sustainable manner. So Sustainable Development (SD) cannot be considered as having link only with environment. It is a development of social and economic aspect also. These "three pillars" of ESD are called as 'triple bottom line' or 'triad' of sustainable development.

Need for critical thinking on Sustainable Development

Education for Sustainable Development is intended to educate all the stakeholders including the students, community, corporate etc. about the importance and need for sustainable development in the present world. It needs a comprehensive approach to educational reform which extends beyond the boundaries of individual school subjects and requires the attention of teachers, educational administrators, planners and curriculum agencies. Integrating the objectives, concepts and learning experiences of sustainable development into syllabuses and teaching programmes is an important part of such reform, indeed: "A basic premise of education for sustainability is that just as there is a wholeness and interdependence to life in all its forms, so must there be a unity and wholeness to efforts

to understand it and ensure its continuation. This calls for both interdisciplinary inquiry and action. It does not, of course, imply an end to work within traditional disciplines. A disciplinary focus is often helpful, even necessary, in allowing the depth of inquiry needed for major breakthroughs and discoveries" (UNESCO 1997). Since ESD is a subject for creating awareness, necessary skills and values, so that the child can take his/her place responsibly in the society for sustainable development of the future, the pedagogical methods to be followed should be different. The pedagogical situations should be created in such a manner in order to make the child sensitive to the world around him and create meanings from the surroundings and from his own experiences.

Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by observation, experience, reflection, reasoning, or communication, as a guide to belief and action. In 1991, Pascarella and Terenzini compiled several definitions, stating that critical thinking "typically involves the individual's ability to do some or all of the following: identify central issues and assumptions in an argument, recognize important relationships, make correct inferences from data, deduce conclusions from information or data provided, interpret whether conclusions are warranted on the basis of the data given, and evaluate evidence or authority (p. 118)." According to Chafee (1988) critical thinking is "our active, purposeful, and organized efforts to make sense of our world by carefully examining our thinking, and the thinking of others, in order to clarify and improve our understanding" (p.29). According to Halpern (1989) critical thinking is "thinking that is purposeful, reasoned and goal directed. It is the kind of thinking involved, in solving problems, formulating inferences, calculating likelihoods, and making decisions" (p. 5). Critical thinking is the "reasonable and reflective thinking that is focused upon deciding what to believe or do" (Norris & Ennis, 1989, p. 18). In its exemplary form, it is based on universal intellectual values that transcend subject matter divisions: clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness. It entails the examination

of those structures or elements of thought implicit in all reasoning: purpose, problem, or question-at-issue; assumptions; concepts; empirical grounding; reasoning leading to conclusions; implications and consequences; objections from alternative viewpoints; and frame of reference.

There is an urgent need on an overall review of the existing approach in the education system with a sharper focus on attaining critical thinking on SD. There is a need to incorporate ESD in the entire curriculum starting from pre-schooling to higher education, which needs to be transacted in a meaningful manner. Iyengar (2007) suggested that reorienting the education towards ESD is a proposal that is useful, but require careful consideration in each country and differently. One will have to consider whether ESD should become part of curriculum or it should be taught separately. There is a danger for instance that if it is incorporated in the curriculum then its teaching would be left to the whims and fancies of the teacher. Dharmani (2007) suggested that at the primary level interdisciplinary approaches to be adopted and should be integrated into each subject area. Nakum and Patel (2007) stressed the importance of structuring and placing ESD in the curriculum. Behara (2007) in a study on Plea for sustainable learning through Vygotsky's approach of constructivism suggested that teaching-learning process should be linked with the development of problem solving, critical thinking, empathy, interpersonal relationships and communication skills which will help in SD. A Sustainable development model was prepared by employing the five E's ie. Engage, Explore, Explain, Elaborate and Evaluate. Hence due to the trend in the world's concern focussing on sustainable development, it was intended to research upon ESD. The present study attempts to develop an intervention programme by integrating ESD in the Science and Social science subjects of VII standard, which in turn measures the change in critical thinking on sustainable development as a result of the programme.

Definition of key terms:

The variables used in the study were operationally defined as follows;

□ Integrated approach to Education for Sustainable development:

Sustainable development is the development, which meets the needs of the present without compromising the needs of the future generations to meet their own needs (Brundtland Commission, 1987). The present study adopts the above meaning to sustainable development wherein the concepts of ESD were integrated meaningfully with the appropriate pedagogical techniques in the content of Science and Social science of class VII of NCERT textbook of India in order to develop the desirable understanding, skills and values in students towards sustainable future.

□ Critical thinking on sustainable development:

Critical thinking is recognized by Delphi report as "purposeful, self regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based" (Facione, 1990). The present study defines critical thinking as the ability of a person to further expand his/her knowledge about sustainable development on a situation through interpretation, analysis, evaluation, inference, explanation and self regulation to reach effective solutions and sound decisions on issues related to sustainable development.

Critical thinking is that mode of thinking - about any subject, content, or problem - in which the thinker improves the quality of his or her thinking by skillfully taking charge of the structures inherent in thinking and imposing intellectual standards upon them. Critical thinking of any kind is never universal in any individual; everyone is subject to episodes of undisciplined or irrational thought. Its quality is therefore typically a matter of degree and dependent on, among other things, the quality and depth of experience in a given domain of thinking or with respect to a particular class of questions.

Development of Critical Thinking Test on Sustainable Development (CTTSD):

Critical thinking is a valuable skill that, once learned, can be applied in many different disciplines; however, researchers have contended that there is a need to think critically within specific disciplines. According to Glaser, critical thinking is, in part, "attitude of being disposed to consider in a thoughtful way the problems and subjects that come within the range of one's experiences (1941, p. 5-6). Ennis advocates contextual, domain, or subject specific critical thinking for several reasons. First, background knowledge is necessary for making justified critical thinking judgments. Second, critical thinking varies from discipline to discipline and, third, a full understanding of a discipline requires the ability to think critically in the discipline (Ennis 1990).

The literature related to critical thinking was reviewed in order to identify the instruments that can measure critical thinking ability. From the review it was found that Ennis- Weir Critical Thinking Essay Test and the California Critical thinking Disposition Inventory were widely used by many researchers for this purpose. Many researchers have placed heavy reliance on multiple choice tests to measure critical thinking (Norris, 1988). The Watson- Glaser Critical thinking Appraisal (Watson and Glaser, 1980) is one of the oldest and most widely used critical thinking tests. It is reported to have served as a benchmark for judging the validity of other critical thinking tests and for evaluating the effectiveness of teaching for critical thinking development. But these tests were intended to measure general Critical thinking ability. The Watson- Glaser Critical thinking Appraisal consist of the dimensions like Inference, Recognition of Assumptions, Deduction, Interpretation and Evaluation of arguments. Since these tools were measuring general critical thinking and there was no critical thinking test available for measuring ESD, there was a felt need for constructing a critical thinking test on sustainable development.

A Critical thinking test on sustainable development suitable for students of VII standard was constructed to measure critical thinking test on sustainable development by giving due consideration to the age of students. The

items were prepared on the dimensions of sustainable development which were identified by UNESCO as coming under social, economic and environmental dimensions that includes Agriculture, consumption and Production patterns; Atmosphere and climatic change; biodiversity and forests; Water, fresh water, oceans and seas; Land management; Energy; Disaster reduction and management, desertification and drought; Toxic chemicals, hazardous wastes, radioactive wastes and solid wastes; Health and sanitation; Demographics, human settlement and poverty, International law and International co operation for enabling environment and decision making. The Cognitive skills given in the Delphi Report (1990) were adopted for the construction of the Critical Thinking Test on Sustainable Development, since the Delphi report was found to be an authentic document created through a consensus reached by eminent scholars in the field of Psychology, Philosophy, Science and Education. Delphi report contains detailed description of the cognitive skills and sub skills of Critical thinking.

METHODOLOGY

Identification of the components of sustainable development that can be incorporated in the contents of science and social science was identified based on various reviews and the recommendations of the United Nations Division for Sustainable Development. The areas identified coming within the scope of sustainable development are Agriculture, Atmosphere, Biodiversity, Biotechnology, Capacity-building, Climate Change, Consumption and Production Patterns, Demographics ,Desertification and Drought, Disaster Reduction and Management, Education and Awareness, Energy, Finance, Forests, Fresh Water, Health, Human Settlements, Indicators, Industry, Information for Decision Making and Participation, Integrated Decision Making, International Law, International Cooperation for Enabling Environment, Institutional Arrangements, Land management, Major Groups, Mountains, National Sustainable Development Strategies, Oceans and Seas, Poverty, Sanitation, Science, SIDS, Sustainable tourism, Technology, Toxic Chemicals, Trade and Environment, Transport, Waste (Hazardous), Waste (Radioactive) and

Waste (Solid) and water

The topics for the experimental treatment were selected from the Science and Social Science textbooks prescribed for seventh standard students of CBSE schools following the NCERT syllabus for the academic year 2010-2011. The contents from Science and Social sciences of VII standard were analysed for identifying the plug points where the concepts of sustainable development can be integrated meaningfully. After integrating the concepts of sustainable development into the existing curriculum of Science and Social sciences, it was validated by giving to the experts and teachers working in the area. Teachers were consulted to know more about the students' understanding level, suitability of the topics and to ensure that the units taught in the experimental groups would be the same as that are taught in the control group during the experimental period.

Science textbook of VII standard contained eighteen units out of which nine units had more scope of integrating the concepts of sustainable development (namely, Nutrition in plants; Fibre to Fabric; Heat; Weather, climate and adaptations of animals to climate; Wind, storms and cyclones, Soil, Water: A precious resource; Forests: our lifeline; Waste water story). These nine units were analysed to integrate the concepts of sustainable development meaningfully.

Social Science textbook of class VII is divided into three textbooks namely; History, Civics and Geography. No units were selected from History as the content become too crowded. Out of the ten units in Civics two units had the scope for integrating the concepts of sustainable development (namely, On Equality; Role of the Government in health). Geography had ten units out of which eight units had the scope for integrating concepts of sustainable development (namely, Environment; Inside our earth; Our changing earth; Air, Water, Natural vegetation and wild life; Human environment- Settlement, transport and communication; Human environment Interactions The tropical and the Subtropical Region). These ten units of Social science were selected for the integration of concepts of sustainable development.

The learning activities were planned for the selected

units of science and social science. The learning situations were visualized and created by posing several inquiry and problem based episodes that lead to group thinking, exploration activities, and reflection. Several pedagogical strategies that lead to constructing knowledge, developing social perspectives and analytical abilities were incorporated appropriately for transaction of content. Planning of a unit include the scope of the unit, issues to be raised, unit questions, learning objectives, resources needed, the activities that are planned and the projects if appropriate to the unit.

Sampling and design:

The population of this study consisted of pupils of Upper Primary schools which are affiliated to CBSE. Purposive sampling technique was used, which is a non probability sampling wherein the units are selected at the discretion of the researcher, where he may exercise his own judgement based on experience or expert judgement (Kalton G, 1983) for including a given student in the sample. Such a sample is arbitrarily selected because there is good evidence that it is a representative of the total population (Kaul Lokesh, 1984, p 106). The sample was drawn from the two intact divisions of standard VII of Chinmaya Vidyalaya, Taliparamba and Chinmaya Vidyalaya, Payyannur as Experimental group and Control group respectively. The sampling was of purposive sampling, since it was not possible to employ randomization, which would upset class schedules. The class as a whole in its natural settings was considered for implementing the study. The students of VII standard who belonged to the age group of 12- 13 years were chosen because VII standard is considered as the end of Upper Primary stage. Intact groups of 37 students in experimental group and 35 in control group were selected for the study.

The study was of Quasi- experimental in nature with Non equivalent control group design involving pre test and post test, wherein the effects of the treatments were judged by the differences in the pre test and the post test scores. The experimental group was taught by the investigator using the integrated content of ESD in science and Social science. The control group was taught the original Science and social science content prescribed

by NCERT by the regular teacher through regular methods of instruction which are usually followed by teachers in that school. The experimental and control group were equated on intelligence using the Standard Progressive Matrices.

In the Experimentation phase, there were mainly three stages; Administration of Pre tests, Experimental Treatment and Administration of Post tests

Administration of Pre tests

The developed/ adopted tools were administered as pre test for measuring intelligence and critical thinking on sustainable development. The tests were administered to the students belonging to the experimental and control group. Necessary permissions were obtained from the concerned Principals and the subject teachers of the two schools before starting the experimental treatment. Before administering the tests, the students were given necessary directions regarding the tests. After administering the above mentioned tests, it scored on the above said variables which served as the pre test scores of the sample students on the respective criterion measures.

Experimental Treatment:

The seventh standard students of division B studying in Chinmaya Vidyalaya, Taliparamba was selected as the Experimental group and seventh standard students of division A studying in Chinmaya Vidyalaya, Payyannur was taken as the control group. In the experimental group the integrated ESD content was taught by the investigator using various inquiry approaches and social learning strategies that lead to construction of knowledge related to ESD. The control group was taught the prescribed science and social science content of NCERT by the regular teacher using the conventional teaching practices that included more of explanatory methods. The contents which were in the textbook were transacted as such.

The lessons were taught to the experimental group in treatment for eighty four periods of 40- 45 minutes duration each. The experimental treatment lasted for five months excluding the vacation and all other school

holidays, term- wise examinations and other occasions during which the treatment could not be conducted. Thus the total duration of treatment worked out to be sixty three hours distributed over nearly five months. The experimental treatment was carried out during the school timings according to the time schedule, without disturbing the school schedule. Sometimes the co curricular activity periods were also made use for teaching the experimental group. The researcher also maintained a diary where the daily observations of classroom interactions and certain anecdotes were recorded regularly.

The Science and social science teachers of the control group were consulted regarding the duration required for teaching the selected lessons, mode of teaching and assessment that they followed in that group. The teachers who were teaching Science and Social Science in the control group were rated as effective teachers by other teachers and students. Measures were taken to consider all these factors in order to avoid experimenter bias in the study.

Some of the lessons given by the science and social science teachers in the control group were observed to know the mode of transaction, whether the teacher is integrating any concepts of ESD and the strategies followed in that group to teach the selected units. The duration taken for teaching the selected units in the control group was approximately the same as that of the experimental group.

The Integrated approach to education for sustainable development was used in the experimental group for transacting selected units in science and Social science subjects. It was a combination of integrated concepts in ESD and also methodology to transact these concepts meaningfully. As mentioned earlier, the developed content and the lesson plans were used accordingly to transact the content. Precautions were taken to see that the textual content was not taken lightly, and both the textual content and integrated content were transacted without causing an extra burden for the students of the experimental group. The teachers and experts were also observed some of the classes to verify that the content was transacted as mentioned in the developed

material and also according to the lesson plans prepared previously

Administration of post test:

Immediately after the experimental treatment was completed, the subjects were administered the post tests for the dependent variables- critical thinking on sustainable development. Both experimental and control group were subjected to the post test.

Tools used in the study:

Two tools were used. Firstly Ravens Progressive Matrices Test (Raven, 1958) was used to measure non verbal intelligence of the students participating in the study and a critical thinking test on sustainable development was constructed to measure the students' critical thinking ability.

However, it was felt that there was a need to construct a Critical thinking test on sustainable development suitable for students of VII standard and therefore it was decided to construct a new critical thinking test on sustainable development as a part of this study, with due consideration to the age of students, nature and purpose of the study.

Development and standardisation of critical thinking test on sustainable development

Initially there were forty two multiple choice items and thirty two descriptive items based on the cognitive skills and sub skills as given in table 2. These items were discussed with subject experts and based on their scrutiny and criticisms, few items were modified and some were removed accordingly. The critical thinking test on sustainable development was administered to a small group of 10 pupils who were about to complete their VII standard following the CBSE syllabus. This was done to know the time duration, clarity of the items and to understand some words that are difficult to follow. The items were again modified based on the results obtained from these students who participated in the initial try out.

- i) **Validity of the test:** To establish the face validity, the items of the critical thinking test

were subjected to experts' evaluation. The experts confirmed that the items included in the critical thinking test are valid and relevant for measuring critical thinking of seventh standard pupils. The items that were asked to reject, modify or accept were done based on the opinion, criticism and suggestions obtained from the experts. The items that were present in each category in the initial stage and final stage are given in table 2.

- ii) **Reliability of the test:** A representative sample of one hundred students in three divisions of VIII standard were chosen for establishing reliability of the critical thinking test using test-retest method. Since the month of June was the beginning of the academic year and the students of VIII standard had just entered after their completion of VII standard, it was found that they are the right sample for conducting the final try out. It was conducted in three divisions of VIII standard from Kendriya Vidyalaya, Keltron Nagar (K.V.K.N), Kannur located in Kerala. Before the administration of the test, the purpose of the test was made clear to the students. The draft test material and response sheets in sufficient numbers were provided. All the necessary guidelines about the test and additional information needed were given. The retest was again conducted for the same sample with the same tool after a gap of fifteen days. The performance of both the test and retest were analysed for its reliability. The reliability of the critical thinking test was established using Test- retest method. The correlation coefficient of the two sets of scores was calculated by using the Pearson's Product Moment correlation. The coefficient of correlation was found to be 0.78. The obtained values of reliability suggest that the test has acceptable psychometric qualities to measure the critical thinking of VII standard pupils.

The category wise reliability was also found out wherein the test retest scores of each dimension were considered for their reliability coefficient. The category wise reliability coefficients are given in table 1.

Table 1 Category wise reliabilities of CTSD

Sl No.	Category of critical thinking skill	No. of items	Reliability coefficient
1	Interpretation	9	0.47
2	Analysis	7	0.47
3	Evaluation	5	0.39
4	Inference	19	0.73
5	Explanation	22	0.68
6	Self regulation	5	0.41

The category wise reliability values were found to be relatively low. But, because of the less number of items in these categories, these values were treated as satisfactory. The Cronbach's α (alpha) which is a coefficient of reliability was also used to measure the internal consistency and the reliability coefficient was found to be 0.88. Cronbach's alpha is widely believed to indirectly indicate the degree to which a set of items measures a single uni-dimensional latent construct.

The details of the finalised critical thinking test is given in table 2

Table 2: Details of critical thinking test

	Skill	No.	Sub skill	No. of questions		Question No.	Total
				initial	Final		
1	Interpretation	1.1	Categorization	4	3	1,2,3	9
		1.2	Decoding significance	2	2	4,5	
		1.3	Clarifying meaning	5	4	6,7,8,9	
2	Analysis	2.1	Examining ideas	3	2	10,11	7
		2.2	Detecting arguments	3	3	12, 13, 14	
		2.3	Analysing arguments	2	2	15, 16	
3	Evaluation	3.1	Assessing claims	3	2	17, 18	5
		3.2	Assessing arguments	3	3	19, 20, 21	
4	Inference	4.1	Querying evidence	13	12	22.1, 22.2, 22.3, 22.4, 23.1, 23.2, 23.3, 23.4, 24.1, 24.2, 24.3, 24.4	19
		4.2	Conjecturing alternatives	5	5	25, 26 (a), 26 (b), 26(c), 26 (d)	
		4.3	Drawing conclusions	2	2	27, 28	
5	Explanation	5.1	Stating results	4	3	29, 30, 31	22
		5.2	Justifying procedures	17	17	32, 33(a), 33(b).1, 33(b).2, 33(c).1, 33(c).2, 33(c).3, 33(c).4, 33(d), 34(a), 34(b).1, 34(b).2, 34(c).1, 34(c).2, 34(c).3, 34(c).4, 34(d)	
		5.3	Presenting arguments	2	2	35, 36	
6	Self regulation	6.1	Self examination	3	2	37, 38	5
		6.2	Self correction	3	3	39, 40, 41	
TOTAL				74	67		67

The final Critical Thinking test consisted of nine items from the skill Interpretation, seven from Analysis, five from Evaluation, Nineteen from Inference, twenty two from Explanation and five from Self regulation. Finally, the Critical Thinking Test on Sustainable Development consists of sixty seven test items which include thirty five multiple choice items and thirty two descriptive items and the duration of the test was one and a half hours.

Data analysis and interpretation

H₀1 There is no significant difference in critical thinking on sustainable development of experimental and control group when pre test on critical thinking and intelligence were taken as covariates

The mean scores of the critical thinking test on sustainable development (the maximum score was 67) of the total sample in the experimental and control group (both pre test and post test) are tabulated in table 3.

To test the statistical significance of the mean scores, the ANCOVA was performed on the post test scores taking pre test scores and intelligence as covariate, the result of which is presented in table 4.

Table 4: Analysis of covariance associated with critical thinking on sustainable development of experimental group and control group with pre test scores and intelligence as covariates

Dependent Variable: Post test score on CTSD

Source	Sum of Squares	Df	Mean Square	F	Sig.
Intelligence	219.699	1	219.699	1.989	.163
Pre test on critical thinking	1549.864	1	1549.864	14.029	.000
GROUP	4668.476	1	4668.476	42.258	.000
Error	7512.343	68	110.476		
Total	97900.000	72			
Corrected Total	14259.500	71			

a R Squared = .473 (Adjusted R Squared = .450)

Table 5: Adjusted Mean scores of critical thinking of experimental and control group when pre test and intelligence was taken as covariates

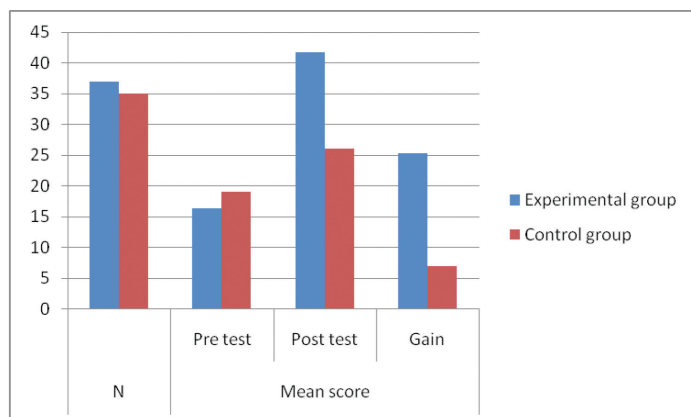
Name of group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Experimental group	42.271(a)	1.767	38.746	45.796
Control group	25.428(a)	1.819	21.799	29.057

a Covariates appearing in the model are evaluated at the following values: Score on Raven's Progressive Matrices = 44.15, Pre test score on CTSD = 17.68.

Table 4 reveals that the difference in the mean post test scores in critical thinking test on sustainable development of the experimental group and control group is significant with F=42.258, p<0.01. Hence the null hypothesis (H₀1) stating that there is no significant difference in critical thinking on sustainable development of experimental and control group when pre test on critical thinking and intelligence were taken as covariates is rejected. Hence the alternative hypothesis i.e there is a significant difference in critical thinking on

Table 3: Mean scores in critical thinking test on sustainable development of experimental and control group

Group	N	Mean score		
		Pre test	Post test	Gain
Experimental group	37	16.35	41.68	25.33
Control group	35	19.09	26.06	6.97



Graph 1: Bar diagram showing Mean scores in critical thinking test on sustainable development of experimental and control group

sustainable development of experimental and control group when pre test on critical thinking and intelligence were taken as covariates is accepted. Also it was seen in table 5 that the mean score on critical thinking test of experimental group (mean= 42.27) is significantly higher than that of the control group (mean=25.428), indicating that the integrated approach to education for sustainable development is effective in improving the critical thinking on sustainable development among upper primary school students.

H₀₂ There is no significant difference in critical thinking on sustainable development with respect to gender in the experimental group when pre test on critical thinking and intelligence were taken as covariates

To test the statistical significance of the mean scores, the ANCOVA was performed on the post test scores of critical thinking among gender by taking pre test scores and intelligence scores as covariates, the result of which is presented in table 6

Table 6 reveals that the difference in the mean post test scores in critical thinking test on sustainable development of boys and girls in the experimental group is not significant with $F=0.833$, $p>0.05$. Hence the null hypothesis (H_02) stating that there is no

significant difference in critical thinking on sustainable development with respect to gender in the experimental group when pre test on critical thinking and intelligence were taken as covariates is not rejected, which means that boys and girls in the experimental group were equally benefitted from the intervention.

Discussion

The integrated approach to education for sustainable development was effective in improving the critical thinking on sustainable development among upper primary school students. Improving critical thinking is one of the major objectives of ESD. There was no significant difference in critical thinking on sustainable development of male and female students in the experimental group when the pre test on critical thinking and intelligence was taken as covariates. Furst (1948) has found that critical thinking and intelligence have number of features in common. Behara (2007) on Plea for sustainable learning through Vygotsky’s approach of constructivism suggested that teaching-learning process should be linked with the development of critical thinking. The findings support the study of Pellicer (2007) who also designed a methodology for developing critical thinking among young children to address air quality issues.

Table 6: Analysis of covariance associated with critical thinking on sustainable development with respect to gender of experimental group with pre test and intelligence as covariates

Dependent Variable: Post test score on CTSD

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Intelligence	289.119	1	289.119	2.311	0.138
Pre test on critical thinking	730.402	1	730.402	5.839	0.021
GENDER	104.150	1	104.150	0.833	0.368
Error	4127.816	33	125.085		
Total	70062.000	37			
Corrected Total	5798.108	36			

a R Squared = 0.288 (Adjusted R Squared = 0.223)

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