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Biodiversity Conservation through Environmental Education for Sustainable Development - A Case Study from Puducherry, India

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Abstract

Promoting students commitment to protect local biodiversity is an important goal of education for sustainable development in India and elsewhere. The main focus of the biodiversity education was to create knowledge, interest and necessary skills to solve various biodiversity problems with reference to the local context. In order to develop the biodiversity consciousness among students, the action oriented biodiversity education methods were identified in this study such as active classroom sessions, hands-on-activities, experiential education, and field exposures that are vital to achieve sustainable biodiversity knowledge and motivate to protect and conserve local biodiversity. We developed a comprehensive framework to assess the efficacy of biodiversity education modules in enhancing teaching and training in biodiversity conservation at high school level. Since the pre-test indicated little lesser than average interest in the relevance of biodiversity, the observed increase in post-test phase could be attributed to our education for sustainable development efforts.

Keywords: Biodiversity conservation, environmental education for sustainable development, skills, knowledge, confidence, high school

Introduction

Sustainable development is seeking to meet the needs of the present without compromising those of future generations. We have to learn our way out of current social and environmental problems and learn to live sustainably, if we desire to survive as a species. Sustainable development is a vision of development that encompasses populations, animal and plant

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species, ecosystems, natural resources and that integrates concerns such as the fight against poverty, gender equality, human rights, education for all, health, human security, intercultural dialogue. Education for sustainable development aims to help students to develop the attitudes, skills and knowledge to make informed decisions for the benefit of themselves and others, now and in the future, and to act upon these decisions (United Nations Decade of Education for Sustainable Development 2005-2014 http://www.unesco.org/en/esd/).

Education for sustainable development addresses biodiversity by focusing on the interlinking issues of biodiversity and livelihoods, agriculture, livestock, forestry, fisheries, and more. The Decade of Education for Sustainable Development (DESD) offers an opportunity to better understand how consumption impacts biodiversity at local and global levels, to sensitize young people to their roles and responsibility in this process and to advance progress in human resource development, education and training to prevent habitat loss and degradation, species loss, and pollution (United Nations Decade of Education for Sustainable Development 2005-2014 http://www.unesco.org/en/esd/).

Everyone in the world depends on natural ecosystems to provide the resources for a healthy and secured life [Millennium Development Goal (MDG), 2010]. Humans have made unprecedented changes in ecosystems in recent decades to meet their expanding populations and booming economy. Human activities have taken the planet to the edge of a substantial wave of species extinctions, further threatening our own well-being. The pressures on water, air, and natural ecosystems will increase globally in coming decades unless human attitudes and actions change (MDG, 2010).

World Environment Day (WED) is one of the principal vehicles through which the United Nations stimulates worldwide awareness of the environment and enhances political attention and action. The agenda is to give a human face to environmental issues; empower people to become active agents of sustainable and equitable development; promote an understanding that communities are pivotal to changing attitudes towards environmental issues; and advocate partnership which will ensure all nations and peoples enjoy a safer and more prosperous future (World Environment Day http://www.un.org/depts/dhl/environment/).

The world is facing a biodiversity crisis (Wilson 2002). In response, schools, teachers and parents are being urged to prepare students to face the real life issues they will routinely encounter in efforts to sustainably manage the biosphere and integrate biodiversity conservation with other societal goals (Colker 2004, European Platform for Biodiversity Research Strategy, 2006, Noss 1997).

The evolution from nature conservation education to environmental education to education for sustainable development is one that can be

characterized by an increasing awareness of the need for self determination, democratic processes, a sense of ownership and empowerment, and, finally, of the intricate linkages between environmental and social equity (Hesselink, van Kampen & Wals, 2000; Jensen & Schnack, 1994; 1997).

Several authors have shown that academic coverage of environmental topics and ecological principles increases student awareness, and positively affects attitudes, behaviors, and values regarding conservation issues (Humston & Ortiz-Barney, 2005; 2007; Leeming, Dwyer, Porter & Cobern, 1993; Rickinson, 2001; Zelezny, 1999). It has been more difficult to create reliable instruments that correlate specific course teaching methods and learning objectives with changes in attitudes and values (Humston &Ortiz-Barney, 2005).

Teaching biodiversity has been practiced some hundred years ago, but due to low baseline level knowledge (Leather & Quicke, 2009), it had become a challenging educational task at least since the conference of Rio in 1992 (Gaston & Spicer, 2004; Weelie & Wals, 2002), and it has been emphasized again at the Conference of Bonn in 2008 . From an educational point of view, however, biodiversity is a rather ill-defined abstract and complex construct (van Weelie & Wals, 2002) which has to be transformed into small entities to enhance a sustained learning and understanding, especially in the context of high schools. The most common entity used by conservation groups are species (van Weelie & Wals, 2002). Therefore, basic knowledge about animal species, their identification and life history has been targeted as a fundamental aspect for learning and understanding biodiversity (Gaston & Spicer, 2004; Lindemann &Matthies, 2005; Randler & Bogner, 2002). This is true for plant species identifications skills too (Tessier, 2003), but baseline knowledge seemed to have declined significantly in recent decades (Leather & Quicke, 2009; Randler, 2008).

Teaching about animals and about biodiversity in general should give a preference to outdoor ecological settings (Killermann, 1998; Lock, 1998; Prokop, Tilling, 2004; Tuncer, & Kvasničák, 2007a,). Previously, a lot of outdoor educational lessons often dealt with more or less immobile taxonomic groups such as plants or some invertebrates (Killermann, 1998). Within the context of ecology, many educational researchers emphasized measuring psycho-logical constructs such as attitude, perception and other personality factors rather than knowledge (Bogner, 2002; Randler & Bogner, 2002). But assessing cognitive learning outcome should support the possible benefits of outdoor ecology education. Outdoor education must be enhanced and should be supported by previous learning within the classroom. This prepares the students for issues and tasks during outdoor field work and prevents them from novelty effects (Falk, Martin, & Balling, 1978; Falk, 1983 & 2005).

Statement of the problem

Concerned by the continued loss of biological diversity, the United Nations General Assembly declared 2010 the International Year of Biodiversity. The year coincides with the target adopted by governments in 2002 to achieve, by 2010, significant reduction in the current rate of loss of biodiversity (Convention on Biological Diversity 2009).

The most important threats to biodiversity have long been habitat loss, due to large scale conversion of land to agriculture and urban centers, introduction of invasive alien species, overexploitation of natural resources, and pollution. Climate change is now adding its effects to the cumulative pressures (Convention on Biological Diversity 2009).

In considering these issues, the objectives of study are to assess the student's knowledge, interest and skills towards biodiversity conservation, local issues pertaining to protection and conservation of biological resources and to investigate the changes before and after implementing the biodiversity education programme/curriculum implementation with middle school students.

We report on the results of developing and piloting an active biodiversity education for sustainable development that measures and assesses learning gains in biodiversity education. We use this framework to evaluate the effectiveness of content learning gains, along with changes in students' interest in biodiversity, student perceptions of changes in process skills, and shifts in ecological worldview.

Methodology

Population and Sample

The study was conducted during July 2009 to April 2010 with Chevalier Sellane Government Higher Secondary School (CSS), Kalapet, Puducherry and Javagar Navodya Vidyalaya School (JNV), Kalapet, Puducherry region, India. The selected schools, located 15-18 km North of Puducherry town on the East coast road (ECR), have sufficient and diverse vegetative cover to conduct field exposure and hands-on-training to investigate biodiversity. In addition, the schools represented a diverse student population with urban and suburban settings. The experiment with control group design was used for this study. The participants in this study were chosen from age group between 13 to 15 middle school standards as these students are much free from regular curriculum and more time available for extracurricular activities than the high and higher secondary level. A total of 140 students, 70 from CSS School and 70 students from JNV School were randomly selected based on their interest, motivation and commitment. Each school had 35 students each in experimental and control groups. Experimental group with 35 students were exposed to active biodiversity education program. The students participating in the program

were then compared with control group in order to assess the student's confidence in biodiversity knowledge, interest in biodiversity and skills in biodiversity conservation.

Biodiversity module

Basic constructs of the active biodiversity education model for the successful study of ecology and biodiversity conservation, an innovative model of environmental education, is composed of three constructs – didactic, conceptual and technological. It was developed using the conceptual models provided by Kostova (2003 and 2004). The main objectives of the environmental education module are to foster the acquisition and transfer of knowledge, skills and affective attributes concerning the environment and its problems (UNESCO-UNEP International Environmental Educational Program, 1985). The didactic construct ensures contemporary educational process in which all achievements of pedagogy and psychology are put into practice. The conceptual construct comprises the biodiversity conservation concepts and reveals them from different aspects: cognitive, value and action. These three constructs of the innovative model of EE proposed by Kostova (2003) taken together provide the possibilities for close interaction of psychology and pedagogy with ecology and conservation on the basis of continuous research and improvement. Through the innovative model of biodiversity education (Figure 1), the systems of approaches are put into practice.

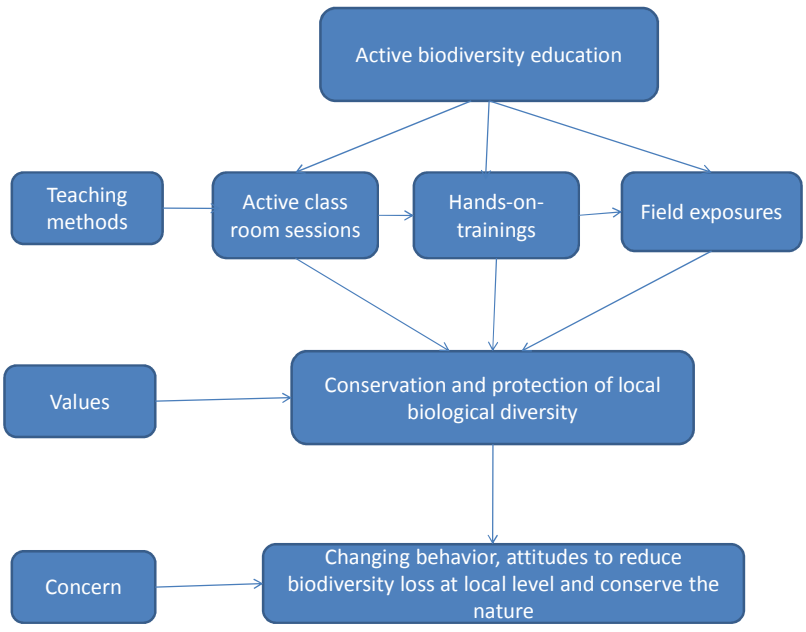

Figure 1. Conceptual diagram of the teaching methods and concerns in biodiversity education for school students used in the present study (modified and adopted from Lee & Tong Ma, 2009)

Instruments

A self administered questionnaire was used to determine students' understanding, knowledge, and skills assessment of various issues on biodiversity and its conservation. Questionnaires are quantitative measurement instruments. For example, a Likert scale (in which respondents circle a number between one and five) was used to measure agreement with certain statements regarding biodiversity. Both in pre and post tests with control groups questions were grouped into three categories to compare overall reported changes in learning: biodiversity knowledge confidence, biodiversity interest, and biodiversity process skills as suggested by Hagenbuch et al (2009) (Table 2).

Table 1

Questions used in the present study grouped into three categories (modified and adopted from Hagenbuch et al 2009)

Biodiversity Knowledge Confidence- assessed the student's confidence in:
1. Defining biodiversity
2. Identifying threats to biodiversity
3. Providing examples of the importance of biodiversity
4. Describing methods and strategies used in conservation
5. Identifying issues in a conservation controversy
6. Analyzing/synthesizing information on an issue
Biodiversity Interest- assessed the student's interest in:
1. Understanding the relevance of biodiversity to real world issues
2. Taking additional courses related to biodiversity and conservation
3. Majoring in a related subject
4. Exploring career opportunities
5. Considering changes in lifestyle choices
Biodiversity Process Skills- assessed the student's confidence in:
1. Oral communication
2. Written communication
3. Identifying underlying conservation problems
4. Gathering credible information to support a thesis
5. Sorting and filtering diverse sources of information
6. Predicting potential outcomes
7. Applying critical thinking
8. Collecting data and managing information
9. Working collaboratively with and in a group

Assessment Framework

We evolved a comprehensive outcomes framework (modified and adopted from Hagenbuch et al 2009) to assess the efficacy of biodiversity education modules in enhancing teaching and training in biodiversity conservation. The framework measured changes in conceptual understanding,

improvements in self-perceptions of process skills, confidence in biodiversity knowledge, interest in biodiversity topics, and changes in environmental orientation. The methodology adapted and integrated three types of evaluation instruments in a pre-module exposure test/post-module exposure test format: To assess student learning outcomes; A self-reporting instrument measures changes in student confidence, interests, and process skills.

Biodiversity modules have been prepared to expose the definition, importance of biodiversity and threats to Biodiversity. Each module includes an interactive PowerPoint lecture slides with notes and discussion questions, a detailed topical synthesis paper, and a series of hands-on exercises and field exposures in which students collect, in order to analyze, and synthesize biodiversity data from multiple sources. Each module component contains specific learning objectives to assist faculty teaching the material.

We have used power point presentations to introduce and discuss topics and applied the exercises as complements to lectures. We introduced the activity and answered questions at the end of the lecture, allowed students to work on the problems and then discussed the results in the following class. Based on the feed back received /identified problems, a series of activities were planed and executed and this was continued for the whole year. Variability in use and adaptation was allowed in this study since we were testing the proposed assessment framework rather than applying a quasi-experimental design.

Content Knowledge Tests

Content knowledge assessments measure student learning from the module component used. These assessments include true/false questions, multiple choice, matching, short answer, problem sets, and short essays (Hagenbuch *et al,* 2009). In addition to measuring knowledge recall, assessments focus on higher-order learning, including comprehension and application of material and problem solving in new situations. The biodiversity module used a written content knowledge test, consisting of twenty multiple-choice, true/false, and matching questions that were selected from the three modules, to measure changes in students' knowledge of biodiversity. Pre-tests were given prior to classroom use of the modules. The post-test was administered immediately after teaching the modules.

Student Assessment of Learning

The Student Assessment of Learning is a self-reporting survey instrument that measures students' perceptions of their knowledge, attitudes, and skills The questionnaire was created to assess changes in students' confidence, interest and involvement in scientific modes of inquiry (Seymour & Hewitt, 1997). The specific questions covering the following

areas were developed and implemented 1) confidence in knowledge and understanding of biodiversity conservation; 2) interest in the field of conservation biology; 3) confidence in process skills; and 4) preferred learning styles. Questions used a standard five-point Likert scale ranging from 1 (not at all confident) to 5 (extremely confident).

With regard to confidence in process skills, biodiversity module identified thirteen skills that are important within the conservation biology profession, including: professional oral and written communication; public communication and outreach; problem and question definition; information gathering, critical inquiry, and research skills; sorting and filtering diverse sources of information; predicting potential outcomes and consequences; critical thinking for decision-making; data collection and management; data analysis and interpretation; graphical expression and interpretation; collaborative working skills; and project coordination and management skills. Biodiversity module exercise emphasizes at least one of these process skills. Because the module emphasizes active-learning approaches, we developed the questionnaire to allow students to rank their preferred learning styles. Choices ranged from traditional lectures to hands-on activities and outdoor field experiences. The standard Likert scale ratings ranged from strongly disagree to strongly agree. demographic information, including gender, ethnicity, class standing and major, as well as reasons for enrolling in the course were also collected.

Analysis of the Data

Paired-sample two-tailed t-tests compared pre- test and post- test means for each question on the content knowledge test for all respondents. Questions were grouped into three categories to compare overall reported changes in learning: confidence in biodiversity knowledge, interest in biodiversity, and skills in biodiversity. Paired-sample t-tests assessed differences across pre- and post- tests for each of these measures.

Reliability and Validity of Instruments

The questionnaire we followed was the student's assessment of learning gains prepared and tested by Hagenbuch et al (2009). This questionnaire was used to measure the perceptions of students in five areas: 1) confidence in knowledge and understanding of biodiversity conservation; 2*)* interest in the field of conservation biology; 3) confidence in process skills. Questions used a standard five-point Likert scale ranging from 1 (not at all confident) to 5 (extremely confident).

Results and Discussion

A comparative assessment of student's preference in teaching learning methods in active biodiversity education was done. The results obtained from the experiment on teaching and learning exercises are presented in (Figure 2).

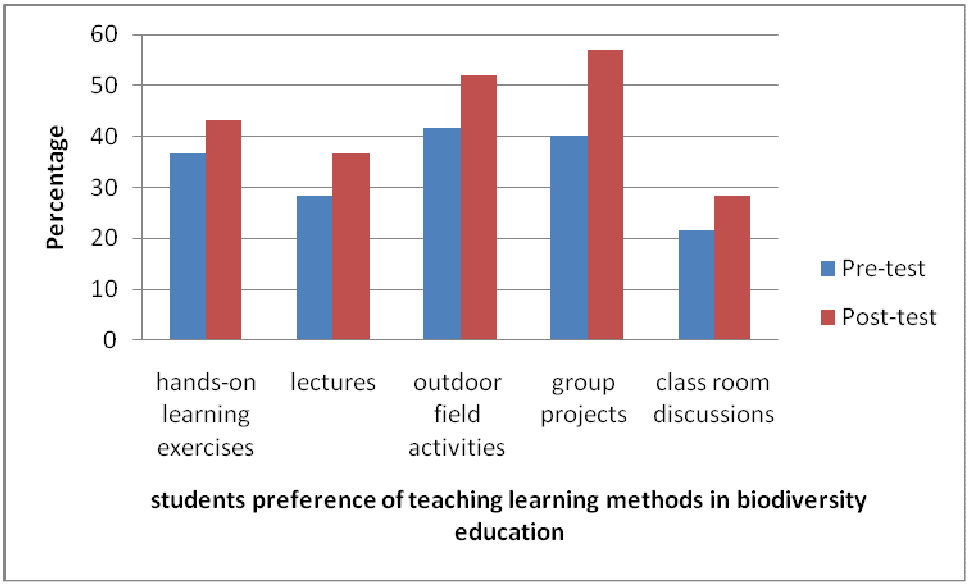

Figure 2. Students preference of teaching learning methods in biodiversity education
Students learning gains in biodiversity knowledge, interest and skills

Students in the post test phase significantly increased their confidence in biodiversity knowledge: defining biodiversity between pre- and post- testing, identifying principal threats, providing examples of how biodiversity is important to human society, describing methods and strategies used in conservation, identifying underlying issues in a conservation controversy, analyzing/synthesizing information on an issue (CSS $t = 0.122$, $p < .005$) (Figure 3) (JNV $t = 2.481$, $p < .005$) (Figure 4).

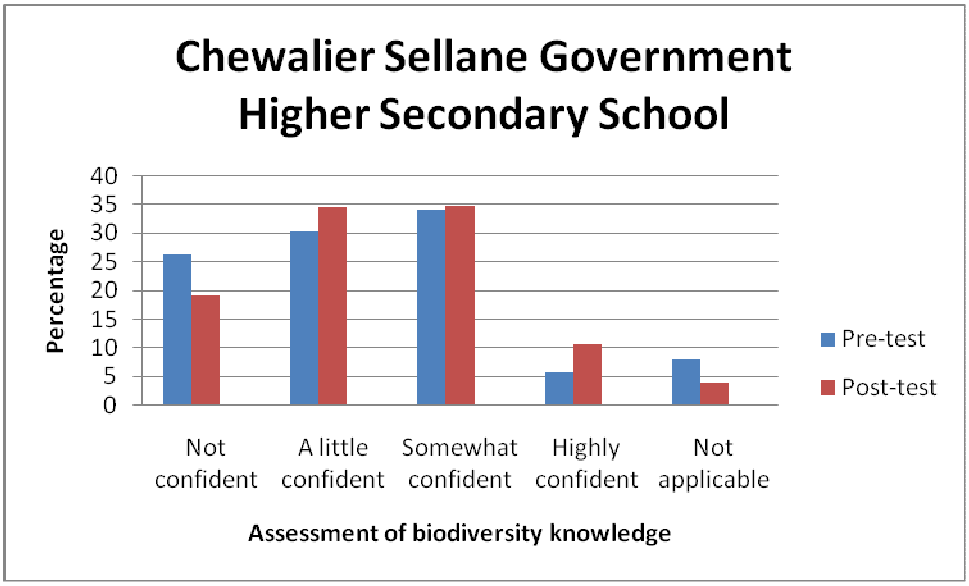

Figure 3. Assessment of biodiversity knowledge before and after with CSS School students

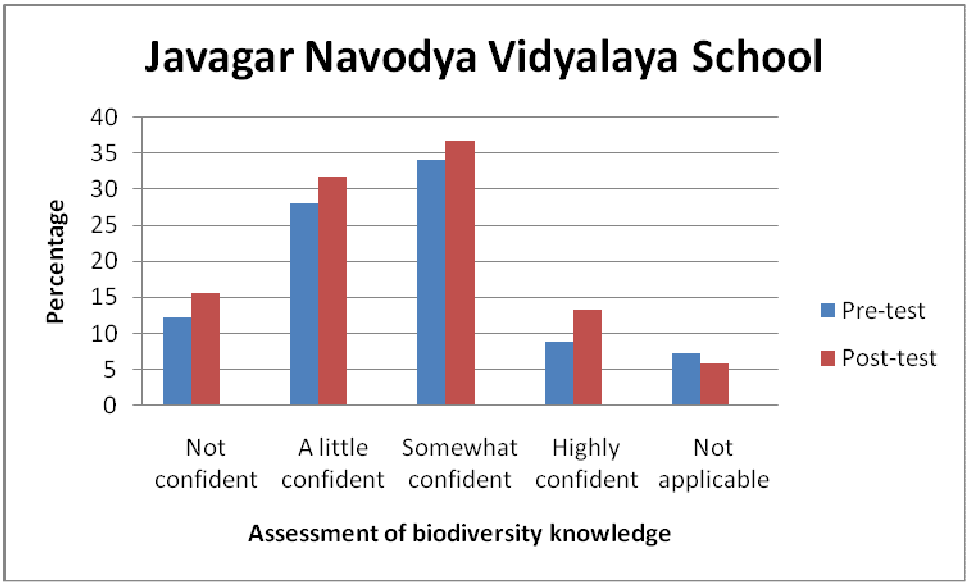

Figure 4. Assessment of biodiversity knowledge before and after with JNV School students

Students showed their interest in biodiversity conservation between pre- and post- testing phases: the questionnaire in order to test the students understanding and the relevance of biodiversity to real world issues explore their interest in taking additional courses related to biodiversity and conservation, majoring in a related subject, exploring career opportunities, onsidering changes in lifestyle choices. (CSS t = 4.768, $p < 0.005$) (Figure 5) (JNV $t = 3.677$, $p < .005$) (Figure 6).

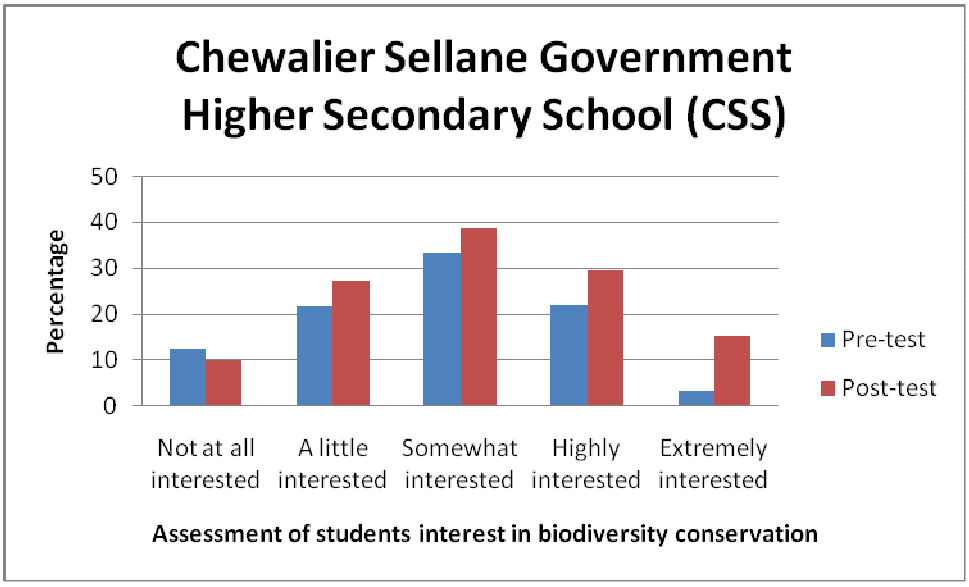

Figure 5. Assessment of student's interest in biodiversity conservation with CSS School students

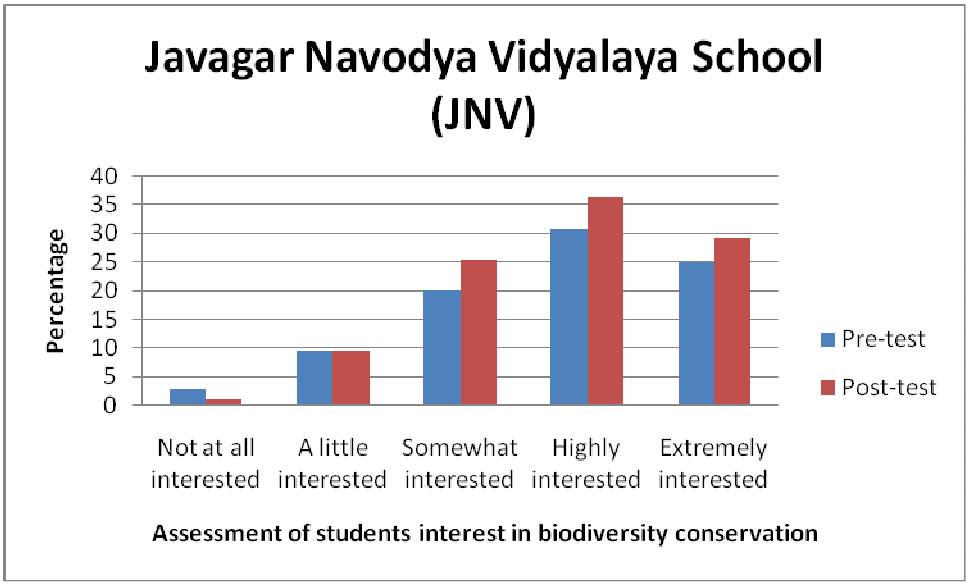

Figure 6. Assessment of student's interest in biodiversity conservation with JNV school students

In terms of biodiversity process skills, students reported significant gains between pre- and post- testing phase in confidence in their skills in identifying conservation issues such as oral communication, written communication, identifying underlying conservation problems, gathering credible information to support a thesis, sorting and filtering diverse sources of information, predicting potential outcomes, applying critical thinking. (CSS t = 0.949, p < .005) (Figure 7) (JNV t = 1.796, p < .005) (Figure 8).

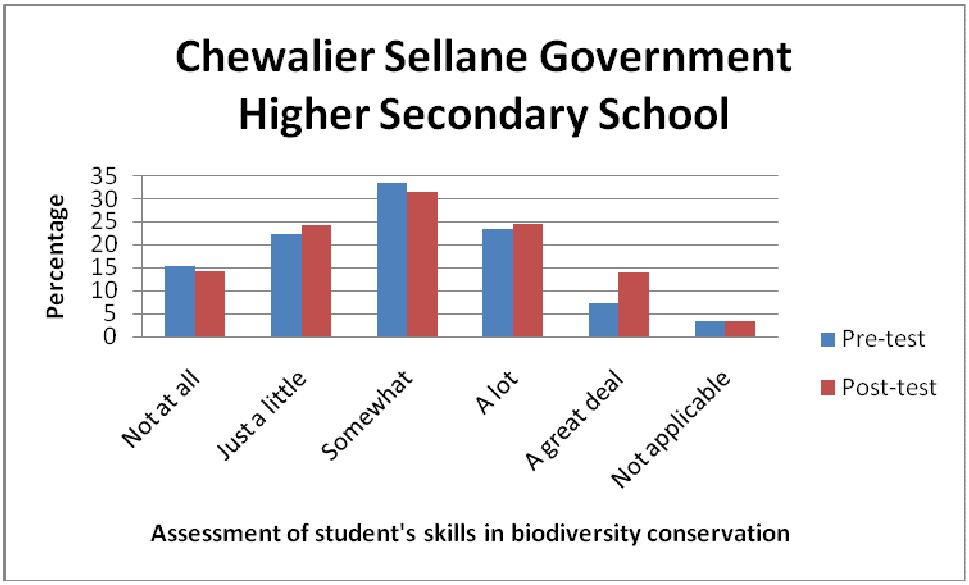

Figure 7. Assessment of students biodiversity process skills in confidence with CSS school students

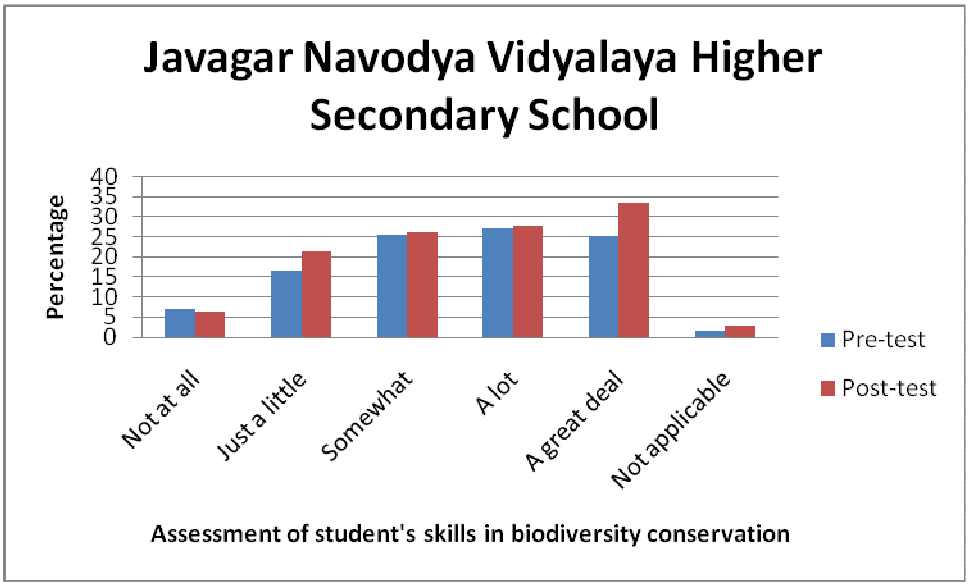

Figure 8. Assessment of students biodiversity process skills in confidence with JNV school students

The reported gains in the knowledge/skills are related to understanding the relevance of biodiversity to real world issues, taking additional courses related to biodiversity and conservation, majoring in a related subject exploring career opportunities, considering changes in lifestyle choices to conserve and protect the biological diversity. There are no significant changes in any of the learning: knowledge, interest and skills on biodiversity conservation issues with control group students between pre and post test analysis since they have no exposure to active based biodiversity education.

Statistical analysis revealed there are significant differences with respect to overall changes in content knowledge tests and the students learning - reflecting changes in confidence in biodiversity knowledge, interest in biodiversity conservation, and confidence in biodiversity skills in compared with control group (non exposure group). There are no significant differences in control group between pre-test and in post-test ($t = 0.637$ $p <$ .005).

Conclusion

The proposed active learning participatory methods for biodiversity education for sustainable development encompasses comprehensive aspects of students cognitive, affective-and behavioral-development related to the perception and understanding of local biodiversity conservation. These types of experiments can make learning about their local biodiversity practical and meaningful potentially having long term impacts on student's attitudes towards local biodiversity and also in shaping their future life. The results obtained from these experiments reflects the student's experiences and actions in their homes, school and community as this will

get them pondering about everyday habits and happenings in biodiversity dimension. These biodiversity education programs help students to acquaint with the local biodiversity problems, and create an interest, motivation, commitment and action.

From the analysis it is apparent that active biodiversity education program increases the student's knowledge, interest and skills in order to protect and conserve local natural resources and biodiversity. This study therefore, stresses the need to extend teaching and learning activities into the immediate environment (natural/built) of the students beyond the classroom for inculcating a culture of biodiversity conservation.

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