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SUSTAINABLE DEVELOPMENT GOALS IN MIDDLE SCHOOL SCIENCE CURRICULUM

Manisha Wadhwa nee Dabas [1], Mamta Singhal [2]

Corresponding Author

Manisha Wadhwa nee Dabas,
manisha.edu@gmail.com

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ABSTRACT

The Sustainable Development Goals (SDGs) are a set of 17 goals adopted by all United Nations (UN) member nations in 2015, aiming to achieve "peace and prosperity for people and the planet" by 2030, addressing issues like poverty, inequality, and climate change. It is one of the most significant agenda of policymakers, scientists, environmentalists and educationists all over the world. These goals provide a roadmap for a better and sustainable future for everyone. However, unless a common citizen is made aware of these goals and is equipped to take positive actions towards achieving them, we cannot hope to realize them in the near future. The education system has the potential as well as the responsibility for preparing the young minds to become torch bearers of the Sustainability Agenda-2030. The paper discusses the role of science education in this context. The main objectives include: (i) To locate the representation of SDGs in middle school science textbooks written post NCF-2005. (ii) To explore teachers' understanding of SDGs and pedagogical approaches used by them in classrooms with a specific focus on their relevance to sustainable development issues and practices.
The findings of this research have implications for curriculum and textbooks for middle school in the light of National Education Policy (NEP) 2020.

Keywords: Science Education, Sustainable Development Goals (SDGS), Pedagogy, Science Textbooks, NEP-2020

1. INTRODUCTION

A teacher of class VIII in an affluent school in Delhi asked her students how many of them have more than five pairs of shoes. She was shocked to find out that everyone has more than that and even some have more than ten pairs of shoes. She questioned, "Do you need those or want those?" Students, after some discussion and deliberations, understood the difference between 'need' and 'want.'

To quote Mahatma Gandhi, "The world has enough for everyone's needs, but not everyone's greed." Indian society has always believed and practiced sustainable ethos for living like not wasting food, conserving water, reusing and recycling materials. The agenda for sustainable development needs a real push in our education system for which National Education Policy (NEP-2020) is also committed to.

The World summit on sustainable development in Johannesburg, South Africa, 2002, made a declaration on sustainable development and a plan of implementation adopted for re-affirming the global community committed to the environment. The UN sustainable development summit in Sept 2015 adopted sustainable development goals (SDG). These are a collection of 17 sustainable development goals designed to "achieve a better and more sustainable future for all." The UN general assembly targeted the year 2030 for achieving these goals. Hence, known as the 2030 Agenda for sustainable development. These SDGs are interconnected and interdependent.

Out of the 17 goals, the following goals are directly related to the environment, were selected for the present study to understand their presence in middle school science classrooms.

SDG 6: CLEAN WATER AND SANITATION

This goal aims to ensure availability and sustainable management of water and sanitation for all. It is essential for health, and well-being. It focuses on issues like access to safe drinking water, and adequate sanitation and hygiene

SDG 7: AFFORDABLE AND CLEAN ENERGY

This goal seeks to ensure access to affordable, reliable, sustainable, and clean energy for all. The use of renewable energy sources like solar energy, hydro-electricity and wind energy is promoted, as energy is crucial for economic growth, and improvement of quality of life; hence, social development.

SDG 13: CLIMATE ACTION

This goal focuses on to take urgent action to combat climate change and its impacts. In contemporary context, climate change poses a significant threat to global sustainability. Thus, addressing climate change is essential for protecting ecosystems, economies, and societies.

SDG 14: LIFE BELOW WATER

This goal aims to conserve and sustainably use the oceans, seas, and marine resources for sustainable development and focussing on issues like reducing marine pollution, and protecting marine ecosystems.

2. REVIEW OF LITERATURE

The review of literature was done to locate studies done on science curriculum, policy frameworks, students and teachers understanding about sustainable development goals which have been emphasized by policy makers in education. Broadly the review of recent researches can be categorized under two categories: - Content Analysis and Experimental Studies.

3. RESEARCHES BASED ON CONTENT ANALYSIS OR DOCUMENT ANALYSIS

Vošnjak et.al. (2024) analysed Slovenian science education in Grades 6 and 7 (11- and 12-year-old students) to find out the integration of sustainable development goals in the science curriculum. It was found that the textual and pictorial material of the textbooks explained only a few environmental topics recommended by their national curriculum. Interestingly it was reported that pictures used in the textbooks were realistic. Another significant finding was missing of sustainability content from the textbooks; thus, curriculum reforms need to focus on integration of science-oriented sustainable development goals into the science curriculum in Grades 6 and 7. In another study, Chou and Wang (2023) conducted a content analysis of the social studies and natural sciences curriculum to explore the representation of SDGs in Taiwan's national curriculum in terms of selection and organization. It was found that only a minor part of sustainable development goals is represented in the textbooks. Such a poor representation called for re-examining underrepresented SDGs and dimensions and organizing them coherently thus, bridging the gap between the international framework and national Taiwanese curricula. Hoffman and Dicks (2023) presented a perspective on how principles of the Green chemistry in IB (International Baccalaureate) curriculum of high school chemistry incorporate the United Nations Sustainable Development Goals (UNSDG). The document analysis concluded that the green chemistry is an integral part of the SDGs. Kaplan, E. S. (2023) investigated the extent to which the Turkish national high school physics curriculum, included the dimensions of the sustainable development goals. The content analysis method used by the researcher focussed on the dimensions of the sustainable development goals and it was used as a conceptual framework for coding the curriculum objectives. Mongar (2022) conducted a document analysis of environmental textbooks, examination sample papers, and the curriculum framework of classes 9^{th} to 12^{th} to investigate the alignment of teaching learning with the sustainability in Bhutan. It was found that the textbooks and examinations were well aligned in knowledge focus, and the values related to utilization were more evident than the values on conservation. The community participation and the action-oriented content in solving environmental problems were found missing from the textbooks. Tatlılıoğlu, E. (2019) analysed the Middle School Science Curriculum and Science textbooks of grades 5th to 8th of the Middle East. In the qualitative case study was conducted to find out how the sustainable development goals (SDGs) are addressed in the textbooks. It was found that knowledge and understanding of scientific concepts, facts and principles were the primary focus of the textbook, with values and attitudes towards science at the periphery. In the

grade 8th textbooks, the most of SDGs were addressed, whereas in the grades 5th to 7th, six out of seventeen SDGs were discussed. Overall, it was found that in the textbooks, the environment dimension of the SDGs was stressed more. Andersen (2017) in a textbook analysis approach of Luxembourgish science textbooks for Grades 1–6 found that there is very little sustainability-related content in Luxembourgish primary science textbooks and most of the topics were indirectly related to SDGs. The researcher also investigated the action-based and task-based learning in the school tasks and found that the neither of the two was commonly found in school tasks in sustainability education. Vošnjak et.al. (2024), Chou and Wang (2023), and Andersen (2017) found a poor representation or an underrepresented SDGs in the Slovenian, Taiwanese, and Luxembourgish school textbooks respectively. On contrary, Mongar (2022) and Tatlılıoğlu, E. (2019) reported that SDGs were adequately addressed in the Bhutan and Middle East science curriculum respectively. Thus, the representation of SDGs in school curriculum is country specific. In this light, it is felt important to analyse the Indian School Textbooks for the SDGs representation. The studies conducted in the Indian context for instance, Mohanty et.al. (2024) critically analysed the interaction between education and sustainable development using indicators like the Social Progress Index (SPI) and the SDG India Index. It provided comprehensive assessments of societal progress. It also emphasized the transformative potential of education to act as catalysts for social, economic, and environmental progress. Mohanty (2018) examined the impact of Education for Sustainable Development in the Indian context. He concluded that ESD would build up a school culture that would improve learning among students. It would help them to become responsible individuals by fostering sustainable consumption, life-style and practices to protect our environment. On the similar lines, Pandey (2018) analysed different flagship programmes like Padhe Bharat Badhe Bharat, Beti Bachao Beti Padhao, Rashtriya Avishkar Abhiyan, Swachh Vidyalaya, Saransh (CBSE), Shaala Siddhi (NUEPA), e-Pathshala (NCERT) in the light of Education for Sustainable Development.

Mahida et.al. (2021) and Bangay (2016) focussed on establishing the need for education for sustainable development. Mahida et.al. (2021) recommended that to ensure a sustainable future and dignified life for all citizen of India, it is required that education is a means to mobilize scientific, technological, and social movements to address the challenges ahead. Bangay (2016) studied the gap between conceptual thought and idealistic rhetoric for education for sustainable development. The researcher emphasised on increasing the financial and human resources for educational institution so that learners are able to make informed and educated choices for the environment. The studies on textbooks and curriculum analysis suggests that an explicit focus on sustainable development goals is required and helpful in addressing the sustainability agenda.

4. EXPERIMENTAL STUDIES

The experimental research by Alexandar and Poyyamoli (2014) studied the effectiveness of Environmental Education for Sustainable Development (EESD) on 240 high school students of Puducherry and Cuddalore, India. Students were divided in the experiment and control groups with different curriculum and pedagogies. The study found that the active teaching methods like interactive sessions, field trips, and hands-on activities were more effective in fostering environmental awareness and sustainable practices among students. interactive sessions, field trips, and hands-on activities. Arur and Sharma (2019) explored how the Sustainable Development Goals (SDGs) can be used as semiotic resources in career guidance to help youth, like a 10th-grade boy in Delhi. It emphasized the importance of situating career choices within local and global contexts to promote sustainability and social justice. Lee and Yu (2022) conducted a specific study wherein they identified topics linked to Sustainable Development Goals (SDGs) in the dietary life unit of middle school technology and home economics textbooks and then conducted an experimental study wherein teaching-learning plans were developed and transacted. The themes of 'desirable eating habits of adolescents', 'food production', 'food distribution', and 'food consumption and disposal' were used in the research. The researchers analysed the connectivity to related SDGs, feasibility of teaching-learning plan was evaluated, and revised the learning plans on the basis of the assessment results.

These experimental studies established how SDGs can be mapped to curriculum and integrated in the pedagogies for enhancing the understanding of learners.

To summarize the above researches, it can be said that the research conducted at the international level involved detailed analysis of school textbooks, curriculum and policy documents. In contrast, research conducted in the Indian context either are position papers or perspective building papers highlighting the need for education for sustainable development.

The present research looks at science textbooks of class VI-VIII with reference to specific SDGs and teachers' awareness about them. The need was felt during observation of few science classes during internship supervision of B.El.Ed. (Bachelor of Elementary Education) course in government schools of Delhi.

5. OBJECTIVES

1) To locate the representation of SDGs (sustainable development goals) in the middle school science textbooks.
2) To explore teachers' understanding of sustainable development and pedagogical approaches used by them in the classroom with a specific focus on their relevance to sustainable development issues and practices.

6. METHODOLOGY

The study used qualitative framework for research and was conducted in eight government schools of Delhi. The selection of schools and teachers from these schools was based on convenience as the researchers were part of internship supervision of B.El.Ed. students in these schools. A total of 20 teachers teaching as T.G.T (trained graduate teacher) from 8 schools government schools of Delhi participated in the study. The study included 13 female and 7 male teachers with different numbers of teaching experience but the gender or teaching experience were not considered as variables impacting the nature of the responses.

7. THE RESEARCH USED QUALITATIVE TECHNIQUES FOR DATA COLLECTION AND ANALYSIS.

1) **Qualitative Content Analysis:** The SDG goals related to the environment were identified, and an attempt was made to locate them in specific chapters of NCERT science textbooks of class VI to VIII. These textbooks are written post NCF-2005 and have been in use for the last 18 years. A thorough content analysis of each chapter was done to establish its relationship with the SDG goal. The major concepts, activities, extended learning activities, and projects given in the chapter were analyzed to establish their relevance and ability to address specific issues. It is expected that sustainable development goals would not be directly mentioned in the textbooks, and hence the content analysis focused on the spirit of each chapter and not on the direct mention of any SDG.
2) **Semi-structured interviews:** A total of 20 science teachers from eight different schools of Delhi were interviewed to understand the following:
   1) Awareness about sustainable goals and their linkage with science education.
   2) Pedagogical approaches used by teachers to address the issues related to sustainable development.
   3) Assessment practices and their relevance to issues related to sustainable development.

8. DATA COLLECTION AND ANALYSIS

The chapter-wise content analysis for each class is presented below. The researchers identified the major concepts, activities and projects represented in each chapter and analysed whether the content and activities cater to the selected SDG.

Class VI

Chapter 7: Getting to know plants

SDG 13: Climate Action

Major Concepts and Activities Represented in the Chapter:

Types of plants- herbs, shrubs, trees, creepers, climbers etc., Functions of different part of plants and variations in leaf, flower etc.

Activities and exercises are given to help the children make observations of plants around them and understand the concepts given in chapter.

Analysis: The chapter is meant only to know the various types of plants around them. The for ecosystem. The chapter does not help in connecting the learners with the plants and understand their importance extended learning activities and projects are not mentioned. The chapter may not be helpful in fostering sensitivity towards plants. The

chapter should have projects and activities that can help children understand the importance of plants. They may be encouraged to grow plants in their community. They can conduct interviews with the older people and find out how the vegetation around them have changed over the years and if they witnessed any environmental concerns over the years. The chapter is primarily focussed on developing conceptual knowledge but more activities should be added to develop skills and values that can help children understand the importance of plants around them and their relationship with issues such as pollution and climate change.

Chapter 14: Water

(SDG 6: Clean Water and Sanitation and SDG 14: Life Below Water)

Major concepts and activities represented in the chapter:

Importance of water, Water cycle, floods and droughts, conservation of water.

Extended learning activities and projects include activities that would save water, save water competitions, collect pictures of droughts and floods.

Analysis: The chapter mainly focuses on importance of water and processes involved in water cycle. It also addresses the issue of water scarcity at a conceptual level but real examples from different cities are missing. Children's and societal experiences related to water related issues like scarcity of water, floods and droughts should be given enough importance. Although these issues are touched in the chapter but children may not give them enough importance beyond the examination. Attempt should be made to relate these issues to children's lives. The extended learning activities mentioned in the chapter are useful in building an understanding of challenges of people due to droughts and floods but not necessarily but the sensitivity as these activities are limited to collecting pictures and knowing facts. Teachers must encourage discussion on the causes and roles of citizens in such situations. Community based projects to observe the scarcity and unequal distribution of water should be taken up and made part of assessment also. The interviews with teachers revealed that extended learning activities and real-life projects are not taken up seriously due to lack of time and its relevance for CBSE examination. This indicates need for the re-orientation of teachers to think of the purpose of teaching science beyond examination.

Chapter 16: Garbage in garbage out

(SDG 6: Clean Water and Sanitation and SDG 13: Climate Action)

Major concepts and activities represented in the chapter

Types of garbage, Different ways of managing garbage and which ones are better.

Reduce, Reuse and Recycle

Activities and projects include making compost, separating wastes of different types, focusing on reducing the waste and practice reuse and recycle.

Analysis: The chapter is helpful in making the children aware of issue related to garbage management and how out actions impact the environment. Although the SDG 6 and 13 relate to clean water and sanitation and climate change and may not be directly linked to garbage management but garbage management is extremely important for ensuring clean and healthy environment to live. It was noticed that the schools selected for research had separate bins for different types of waste but neither the students nor the teachers understood the importance of waste segregation in daily life and didn't use separate bins for garbage management. The extended learning activities mentioned in the chapter are related to SDGs but the reflection and action were missing from the culture of the school and hence none of these activities or projects were taken up.

Class VII

The NCERT textbook of science of class VII has two chapters those can be linked to SDGs. The detailed analysis is presented below:

Chapter 16, Water: A Precious Resource

(SDG 6: Clean Water and Sanitation)

Major Concepts and activities represented in the chapter:

Availability of water, scarcity of water and water management.

Activities and projects include case studies of successful initiatives to save water. Water saving projects, rain water harvesting and other techniques for saving water are emphasized.

Analysis: The chapter includes suitable content, activities and projects that help children to appreciate importance of water. If the teacher takes up water saving campaigns with children, they are likely to contribute towards sustainable development.

Chapter 17, Forests: Our Lifeline

(SDG 13: Climate Action)

Major concepts and activities represented in the chapter

Visit to a forest, different living and non-living components in a forest and their co-existence, Importance of forests

Activities and projects include visit to forest and understand the flora and fauna present there and appreciate their inter-relationship

Analysis: The chapter is well written with experiences of children visiting the forest with a scientist and appreciate the importance of forests for all forms of life. Out of the eight schools selected in this research only one had provided opportunity to students to visit a biodiversity park. Two other school teachers took the students to the nearby park to provide the students some exposure about the flora and fauna. Although such opportunities are present in Delhi and also videos of other areas could have been used but teachers did not find it important enough to complete their syllabus.

Class VIII

The NCERT textbook of science of class VIII has two chapters that can be linked to SDGs. The detailed analysis is presented below:

Chapter: Conservation of Plants and Animals

(SDG 13: Climate Action)

Major concepts and activities represented in the chapter

Deforestation, Conservation of forest and wildlife, Flora and fauna- endemic and endangered species, Wildlife sanctuary and National parks, Recycling of paper.

Extended learning activities and projects include growing and nurturing plants, visit to the biodiversity park, finding out about saving the animals projects launched by government.

Analysis: The chapter helps in creating awareness about significant aspects related to sustainable developmental goals especially goal 13. If the extended learning activities and projects are taken up by the learners, it would help in developing sensitivity among learners about issues related to deforestation and its impact on various species of plants and animals. They are encouraged to take suitable action to protect the flora and fauna around them.

Chapter 18: Pollution of Air and Water

(SDG 13: Climate Action)

Major concepts and activities represented in the chapter

Air Pollution- How air gets polluted; Problems due to air pollution

Case study of Taj Mahal, Global Warming, Water Pollution, Case study of Ganga, Reduce, Reuse and Recycle

Extended learning activities and projects like survey of school to investigate environment related activities, Vehicle checked for pollution in their locality, field visit to nearby river are given.

Analysis: The chapter is very much related to SDG 13 and is helpful in creating awareness about environmental issues. It helps the learners understand the causes for environmental degradation and its impact on all forms of life for today and future. As the schools selected for research were located in Delhi where pollution is huge problem, a lot of action is desirable to understand the causes as well as our roles and responsibilities. Though some discussion through newspaper articles about poor AQI and related health challenges was taken up by teachers, however not much of action was taken up through surveys and possible solutions or even creating awareness.

In all, only seven chapters could be linked to the SDGs, which showed that SDGs are under-represented in the middle school science curriculum. Also, there is no explicit mention of terms like sustainable development of SDGs due to which the teachers may also not treat SDGs as their teaching objective.

9. INTERVIEWS WITH TEACHERS

The interviews were conducted with 20 teachers teaching classes 6 to 8 from different government schools of Delhi. The interviews were semi-structured in nature and aimed to explore the following broad questions. Each question was probed with the help of further questions that emerged during the interviews.

1) What is the level of awareness about sustainable development goals (SDGs) and their relationship with science education among school teachers?
2) How the chapters mentioned in Table 1 were transacted in the classroom?
3) How many projects and extended activities are mentioned in textbooks?
4) What ways of assessments were used to assess the goals related to sustainable development?

The responses of the all the 20 teachers were analysed using grounded theory approach. The content analysis included thoroughly reading the response to each question to identify predominant themes from the data. This helped the researchers to categorize the data into three main themes- level of awareness about SDG goals, pedagogical strategies and assessment practices adopted for teaching specific chapters selected for the research.

1) Teachers' level of awareness of SDG goals

Out of the 20 teachers interviewed, only 12 were partially aware of SDGs, and the rest had not heard of these goals. The teachers who had heard of sustainable development goals and SDG agenda -2030 could partially articulate what does sustainable development mean. Following are some of the responses of teachers about what are sustainbale development goals and why these are important.

Teacher 1: Sustainable development means thinking of future generations while doing any development like setting up industries etc. There is a list of sustainable development goals and India lags behind in achieving those.

Teacher 2: SDGs are related to environmental concerns due to development of science and technology. We need to have a balance and understand the negative aspects of development also.

Teacher 3: I believe that our ancient practices of taking care of the environment, ways of farming, ways of living were more sustainbale in the long run and India must try to revive those through education.

Although they did not know all the goals but could talk about how environmental degradation is a cause for concern for future generations. Even the teachers who said that they do not know about SDGs could discuss issues related to water scarcity, global warming, deforestation and climate change etc. Most of them (15 out of 20) believed that the present generations need to take affirmative actions to make the world a better place for the future. Only a few (5 out 20) believed that the issues related to sustainable development are to be addressed by the government, and the citizens, especially school students, have very little role to play in that. They argued that children are very young and have to focus on building their future (meaning employment) rather than wasting their energy in doing community service.

2) Pedagogical approaches used by teachers

The teachers use textbooks as the prime source of knowledge for all the topics. They ask students to go through each and every line of the chapter, discuss and clarify the concepts theoretically and help students note down the significant aspects. The in-text and chapter-end questions are discussed, and their answers are written in the notebooks. According to teachers, this is very important from the examination point of view and gives the parents and authorities an assurance that children are learning well. The extended activities and projects were not considered part of the curriculum, especially from the chapters which were taken for research in this study. Only teachers in one school mentioned that they had taken students for a visit the biodiversity park a few years back, and students enjoyed the visit. The teachers were not very clear about the purpose of this visit and how that could have been related to environmental issues and sustainable development.

3) Assessment

The assessment is based on written examination and project work provided by the teachers as per Central Board of Secondary Education (CBSE) guidelines. It was surprising to find that none of the students had taken project work from the chapters related to environmental issues. The projects usually centred on ideas related to conducting experiments with verifiable results or making models.

The analysis of the teachers' responses shows that teachers lack understanding about the sustainable goals. While listing all the goals may not be important, it is important that teachers appreciate the need for sustainable development

and their role as teachers in developing values and attitudes related to sustainable development. Even though certain chapters in the middle school textbooks have the potential to address sustainable goals but most teachers treat all chapters as means for passing the examination. They hardly take up project work or field visits even though it is mentioned in the textbook. The extended activities and projects are not part of the examination and hence not considered significant by the teachers. The teachers lack necessary orientation and resources to incorporate SDGs in their classroom discussions and assessment practices.

10. FINDINGS

1) The textbooks of all classes (VI to VIII) had a few chapters related to sustainable development goals. The same textbooks are being used since 2007. India became a part of the sustainable development agenda in 2015, and hence the textbooks do not mention the SDGs explicitly. The teachers treat textbooks as the prime source of knowledge and fail to bring updated knowledge in the classroom, especially because the examinations are textbook-centred.
2) The content, extended learning activities and projects given in the textbooks have a good potential to create awareness among the students about issues related to sustainable development. However, the action and accountability need to be focused through suitable activities, discussions, community surveys and projects.
3) The schools lack orientation and funds for supporting field visits and community-based projects that may be taken by schools to address issues related to sustainable development.

11. IMPLICATIONS FOR SCIENCE EDUCATION

1) Science education has an important role in creating awareness, fostering values, and encouraging sustainable action through textbooks, classroom discourse, and projects. However, both teachers and students need orientation and support in planning and implementing such activities.
2) As the current textbooks lack the explicit focus on sustainable development goals (SDGs), there is need to focus on SDGs in new textbooks being prepared in the light of National Education Policy (NEP-2020). The textbooks should have content, activities and projects to cater to various sustainable development goals in a systematic manner.
3) The pedagogical and assessment practices in schools should not be limited to providing conceptual knowledge about issues related to sustainable environmental goals but also foster values, action and accountability.

CONFLICT OF INTERESTS

None.

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