6

Fostering Environmental Awareness in a Primary Grade Mathematics Classroom

A Critical Mathematics Education (CME) Approach

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Abstract

The most pressing environmental problem on our planet today is pollution and climate change. Accordingly, the concept of a circular economy is worthy of acknowledgement and advocacy within the school environment, starting from the foundational years of learning up to critical pedagogy. The National Curriculum Framework for School Education (NCF-SE) 2023 further emphasises the significance for students to learn and look after the environment as part of the global Agenda 2030 SDG 13 Climate Action. This study applies a Critical Mathematics Education (CME) approach to promote environmental consciousness and responsibility (Shimray, 2016), through the usage of plastic waste pollution data. The study aims to promote sensitivity to climate change by closing the distance between mathematics taught at schools and the environment through developing tasks on the principles of CME. These tasks include real data regarding plastic waste generation, and encourage the relation between mathematical concepts and environmental problems. The study further explores the role of mathematics in promoting sustainability and critical thinking. This qualitative study involved pre-task interviews, a week-long family survey of plastic use, and statistical evidence of plastic wastage in worksheets presented in both textual and graphic formats supported with post-task reflection for 18 fifth grade learners. The results indicated that students became aware of the scope of plastic pollution and how it affects the environment, and they accepted the large use of plastic in their lives, with many accepting that the reduction, reuse, and recycling of plastic is of utmost importance. Through making maths relatable to real-life situations, students enhance important problem-solving skills towards sustainability, aiding the development of eco-friendly future citizens in support of global climate action targets.

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Introduction

Over the previous few years, the urgency to fight climate change has increased and its effects are being experienced all over the world. Climate change can be defined as long-term changes and deviations in temperature patterns, precipitation, and other weather phenomena, mainly caused by human actions like industrialisation, deforestation, and the overconsumption of fossil fuels. In order to reduce the impact of these changes, it is essential to inculcate a sense of environmental responsibility in younger generations, so that they learn the right knowledge and skills in order to make informed decisions towards sustainability. In this context, education plays a pivotal role. The Sustainable Development Goals (SDGs) outlined in Agenda 2030, particularly SDG 13: Climate Action emphasises the need for climate-related education that can empower individuals and communities to engage in meaningful environmental action. The National Curriculum Framework for School Education (NCF-SE) 2023 also highlights the importance of 'Learning about and Caring for the Environment', underscoring the responsibility of schools in integrating environmental concerns into the curriculum. However, even with these efforts in schools, climate change education tends to remain siloed in disciplines, such as science and geography, with no consideration for its integration into other areas of study. This is where Critical Mathematics Education (CME) comes in. Mathematics has conventionally been thought of as an abstract subject, which tends to be isolated from real-life practical issues like climate change. The CME approach, however, challenges this notion by emphasising the use of mathematics to critically examine and address societal issues. In CME, students learn to apply mathematical concepts to analyse problems, such as environmental degradation, resource depletion, and the socioeconomic impacts of climate change. This critical pedagogy allows students not only to acquire mathematical skills and competence but also to expand a sense of responsibility in addressing global issues. The study seeks to investigate how the integration of CME in a mathematics classroom for Grade 5 students can foster awareness and sensitivity towards climate change. The study will focus on designing mathematical tasks that encourage critical thinking about climate issues, using data analysis and real-world problem-solving. By doing so, the research seeks to demonstrate how mathematics classrooms can serve as powerful spaces for developing both cognitive and affective responses to climate crisis.

Review of Literature

A brief description of the available research and studies in mathematics related to CME and sustainable mathematics education is stated below.

Li and Tsai (2021) in their article tried to establish the need for integrating education for sustainable development across all subjects. They talked about bringing transformation in the teaching and learning of mathematics, considering the twenty-first century priorities, such as pollution, climate change, global warming, etc. They identified that education for sustainability should be made part of mathematics teacher education so that efforts can be made to bring this to classroom scenarios.

Hamilton and Pfaff (2013) provide numerous examples where the conception of sustainability can be promoted among students in any mathematics classroom. They consider that it should be obligatory for educational institutes to produce an educated citizenry. According to them, using well-crafted, data-rich, real-world examples increases student engagement and gives them the chance to study mathematics while directing at least some efforts towards the most pressing societal issues.

Barwell (2013) says that one of the most urgent problems of the twenty-first century is climate change. Every aspect of comprehending climate change, including its definition, prediction, and communication, involves mathematics. This suggests that mathematics education has a role in preparing the present and future citizens to participate in the necessary discourse. He further contends that critical mathematics education provides a framework for imagining how mathematics instruction and learning could fulfil this function.

Sharma et al. (2022) in their study attempted to highlight the gap between environmental awareness and environmental sensitivity. They claimed that environmental sensitivity is promoted in students through active action and meaningful participation in environment-related issues. Their study shows that schools can create opportunities for learners where they are engaged in environment conservation and related activities, which resulted in a positive impact on students' sensitivity towards the environment.

Renert (2011) says that the goal of sustainable mathematics education is to use modern mathematics to perceive the world in a different light. In addition to feeling big numbers, it also focuses on feeling the worldwide circumstance. It transforms mathematics into an open-ended state of world observation rather than a collection of items or a set of skills. It strives for a more comprehensive

and suitable mathematics, and from this stance, it exhorts us to take moral action to mend the world.

Wolfmeyer and Lupinacci (2017) in their article highlighted a new perspective of Critical Mathematics Education where mathematics can be taught for the environment. They discussed that mathematics can be grounded in the idea of ecojustice and critical pedagogy. They promote the development of students' ecological consciousness and civic responsibility through the lens of mathematical investigations. They highlight the need for encouraging learners to interrogate dominant narratives and question how mathematical knowledge is used.

Abtahi et al. (2017) conducted a study with the Canadian and Norwegian school mathematics teachers to understand the teaching of climate change as a social issue. The theoretically grounded climate change issues draw the idea of critical citizenship and critical mathematics education. They view that bringing the issue of climate change into the classroom is certainly considered as the ethical and moral responsibility of teachers but their own understanding about this in daily practices is a complex one. They also acknowledge that teachers should be supported in facing these ethical challenges because of climate change because of two reasons; climate change is an urgent issue and students are the future decision makers. Further, mathematics teachers can help students evolve as critical citizens to reflect on the different challenges of climate change and to become active participants of democratic societies.

These studies are certain that there is a huge potential in transforming mathematics classroom and mathematics teacher education in the direction of sustainable mathematics education with interplay of critical mathematics education. In this attempt critical mathematics education serves as a lens in understanding the environmental issues, and sustainable mathematics education provides a way forward for the same.

Rationale of the Study

Mathematics tends to be viewed as a distant and abstract discipline and is regularly regarded as being irrelevant to real-world problems such as climate change. CME, however, has the ability to utilise mathematical ideas to study and tackle difficult, real-world problems such as climate change and sustainability. Utilising CME, mathematics classrooms can be used as environments in which students acquire numerical and analytical abilities while also gaining an appreciation for and sensitivity towards environmental problems. In addition, programmes like Indian Green Building Council's (IGBC) Green School Initiative and Centre for Science and Environment (CSE) promote schools to embrace sustainable approaches and provide students with environmental education (Varish & Sharma, 2023). By incorporating the values of

Indian Knowledge Systems (IKS) and inculcating them into the structure of the National Curriculum Framework for School Education (NCF-SE) 2023 and the New Education Policy (NEP) 2020, it can be guaranteed that the students are not only provided with contemporary scientific information but are also rooted in the age-old, sustainable practices that do not harm the environment. Thus, integrating CME to inculcate sensitivity to climate change addresses national as well as universal requirements.

Definition of Key Terms

This study aims to promote environmental awareness by designing a task grounded in CME. Critical Mathematics Education (CME) is an approach that views mathematics as a tool for empowerment, critical thinking, and social justice. It promotes students to use a mathematical perspective to examine and evaluate real-world problems concerning politics, inequality, and environmental concerns. In this study, CME is being considered as an approach in developing the idea of environmental consciousness (Wolfmeyer and Lupinacci, 2017) through tasks based on environmental problems.

Research Questions

The present study seeks to answer the following research questions:

1. How to instil and strengthen Grade 5 students' understanding and sensitivity towards climate change in the mathematics classroom through tasks grounded in the principles of Critical Mathematics Education?
2. What is the effect of integrating climate change issues into Grade 5 mathematics classrooms?

Objectives of the Study

The objectives of the present study were:

1. To plan and design mathematical tasks grounded in the principles of CME that incorporate data on real-world plastic waste generation and thus the issue of climate change
2. To explore the impact of integrating environmental issues into the mathematics classroom on students' behaviours towards sustainability and environmental responsibility

Methodology

The study was conducted as a small attempt to understand whether different environmental issues can be brought into the classroom. This study used an interventionist approach.

Research Design

This was a qualitative exploratory study. An exploratory study tries to explain a phenomenon under investigation. Swedberg (2020) states that exploratory research is an attempt to discover something new and interesting by working through a research topic and is the soul of good research. In this research, innovation lies in the designed tasks, which were

based on the environmental issues such as single use plastics and climate change.

Sample of the Study

A group of Grade 5 learners were made part of this study. These students were selected through a convenient sampling approach. Creswell (2007) defines convenient sampling as an approach where the matter of convenience can be the time constraint and accessibility of the sample. In this scenario, the sample was easily accessible to the researcher, as the researcher herself was teaching mathematics to the class. There were 18 students in the chosen class.

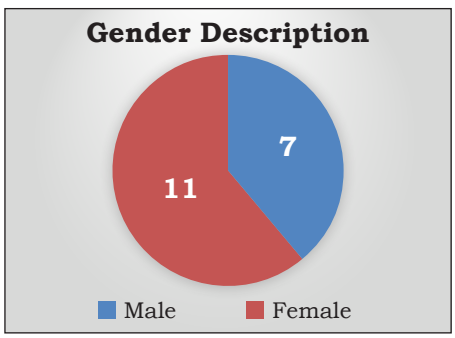


Figure 1: Description of the sample

Tools and Techniques of Data Collection

The tools used for data collection are listed here.

1. *Pre-task semi-structured interview:* This semi-structured interview was designed to explore various notions and perspectives that students had about various environmental issues, particularly plastic pollution, before engaging in the main task. There were three questions in this area.
2. *Tasks on environmental issues:* The researcher planned the following two tasks to promote environmental consciousness in students:
   - Worksheets of Plastic Waste Generation: The researchers designed worksheets to engage students with statistical data on waste production at both the national and international levels. Worksheets contained statistical data on international as well as India's annual plastic waste generation, and large-scale measurement units like tons and metric tons were used.

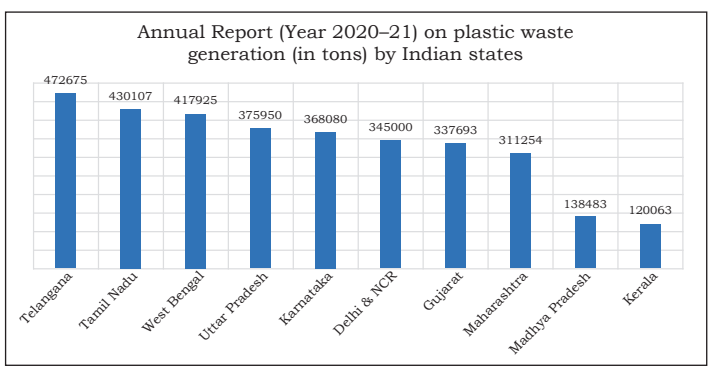




Figure 2: Infographics used in the worksheets

There were questions on analysing the data and answering questions aimed to assess the student's ability to interpret large-scale data, recognise patterns, and draw comparison between regions to gain insights into how well students understood the global and national scope of plastic waste generation and their ability to apply their understanding to real-world environmental issues.

- Survey Sheets of Plastic Waste: A week-long family survey in which the students were to record the amount of plastic waste produced by each member of the family, including food packaging, sachets, bottles, straws, polythene bags, and Styrofoam plates was conducted. There were questions on how much plastic their families are producing in a year.

3. *Post-task interviews:* After the completion of the task, followed by reflection-based interview questions on personal awareness on consumption of the single use plastic, its effect on the environment and alternatives that can be used in its place was also conducted.

Delimitation of the Study

The study was delimited to a single Delhi-based school only. It was conducted with Grade 5 learners only.

Limitations of the Study

There were certain limitations of this research work as it lacked statistical generalisation due to its small sample size.

Findings and Discussion

The data from multiple tools is presented here after analysis and theme-based synthesis. Findings from the research are presented by being classified under different research objectives.

Objective 1: To plan and design mathematical tasks grounded in principles of CME that incorporate data from real-world plastic waste generation and issues of climate change

The data analysis from the pre-task interview highlighted the following issues related to understanding of climate change.

1. *Recognition of plastic pollution:* A majority of students had a basic understanding of pollution caused by plastic use. The students recognised plastic pollution as plastic waste being thrown away carelessly. This indicated a solid graph of basic plastic pollution-related facts, which is important for understanding the broader importance of adopting sustainable habits. The students recognised that plastic waste was a challenge for the environment but their awareness was shaped largely by what they saw in their surroundings.

2. *Lack of ability to understand the magnitude of environmental impact:* Students showcased a broad understanding of the harms caused to the environment by plastic. But they were not able to understand its magnitude and grasp the severity of its consequences like disruption of natural habitats especially marine life, contamination of soil and water, and thus, contamination of food chain because of microplastics. Around 50 per cent of the students did demonstrate an awareness that plastic is non-biodegradable and persists in the environment for hundreds of years. When asked about its effects, they still described more visible or commonly observed consequences, such as drain blockages, waterlogging (61 per cent). Thirty-eight per cent of students mentioned that plastic harms animals—causing them to choke from ingesting plastic. All of them said that it made the ground dirty, and that burning plastic releases smoke and hazardous gases (83 per cent). These observations were likely shaped by real-life encounters and rote memorising what is taught in classrooms.
3. *Ignorant of personal contributions:* Another important finding before the CME task was that students underestimated their personal role in plastic waste generation. During interviews, students mentioned waste from factories, industries, and polythene bags as the origin of plastic waste. Most of the students believed that plastic waste only resulted

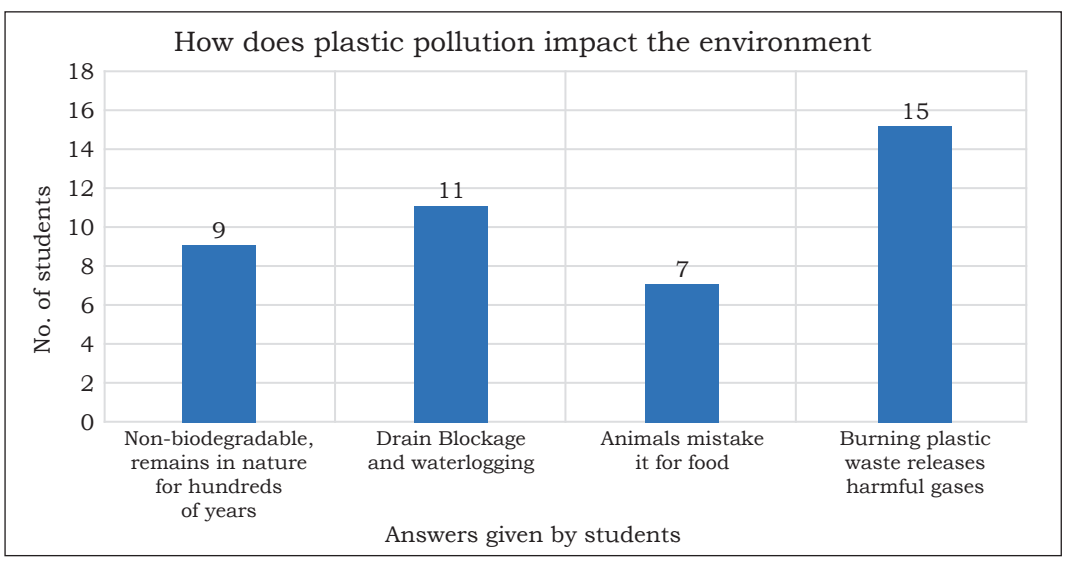


Figure 3: Impact of plastic on environment as stated by the students

from external sources, such as factories, industries, and marketplaces, rather than from their own everyday activities and that of their families. Upon being asked about their own contribution to plastic pollution, a majority (62 per cent) blamed the external sources (factories and industries), 22 per cent stated their own daily habits contributed only little to nothing to the issue, while only 16 per cent accepted that they significantly contribute to the production of plastic waste.

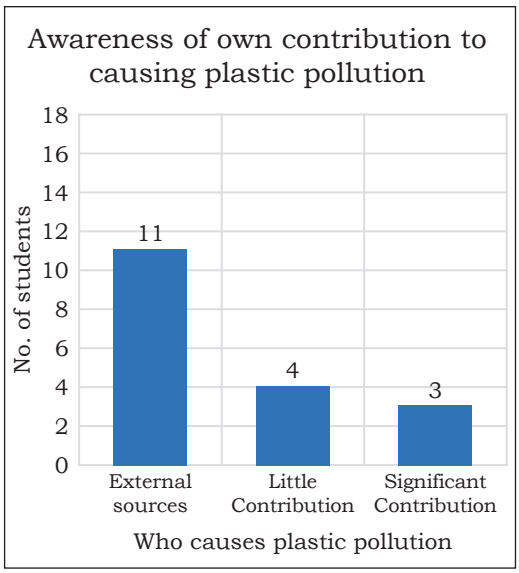


Figure 4: Student's perception of their personal contribution to plastic pollution

Thus, only 3 out of 18 students (16 per cent) acknowledged their own daily use, especially polythene bags, was a significant contributor to plastic pollution, and the remaining 84 per cent believed their families used minimal plastic or that their habits did not significantly contribute to the problem. This revealed a disconnection between the vast issue of plastic pollution and their everyday habits of consumption. They saw this issue as unrelated to their own lives. This highlighted a gap between their awareness of climate change due to plastic pollution and the impact of their own participation in it. This shows that the locus of control for owning the responsibility is external in students (Hawthorne and Alabaster, 1999).

When asked about the average amount of plastic they used, and thus reflect on their own use of plastic as well as that of their families, most students believed their families used very little plastic. Their responses focused only on highly visible and common items, such as polythene bags, water bottles, or food-safe plastic lunch containers and justified them as being reusable. This limited inventory demonstrated a lack of awareness regarding the many forms of plastic embedded in daily life from packaging and disposable items. For example, they were completely ignorant of the daily production of single-use plastic waste from their homes. Their inability to recognise the full extent of plastic usage suggested that they did not see their consumption patterns as part of a wider environmental issue.

These findings from the pre-task interview helped in designing the

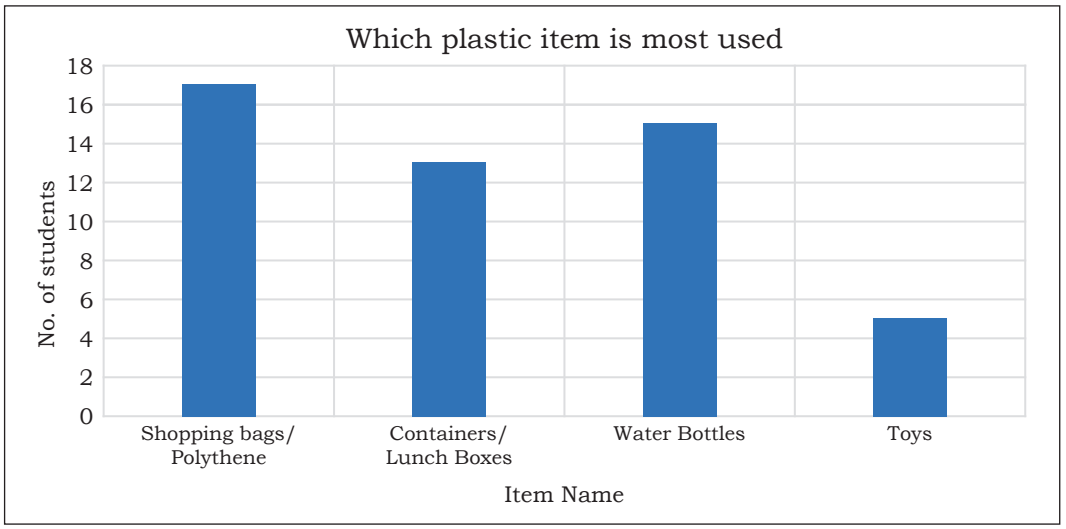


Figure 5: Major plastic items used in households of students

worksheets and tasks which could help students in understanding this issue better.

Two tasks were designed for students so that they can relate with the environmental issue.

- *Understanding the mathematical representation of data:* It was found that students were used to arithmetic exercises but had not worked meaningfully with real-world data. For example, when shown plastic waste statistics for various areas of Delhi, many students struggled to grasp the large-scale figures (for example, Delhi generates approximately 3,45,000 tons of plastic waste annually), large units of measurement, and pictorial representation of data in the form of chart and graph. Students were unfamiliar with the representation of data on environmental issues through images, charts, and graphs. This limited their ability to comprehend the seriousness of the issue.
- *Attitude towards environment:* After studying the annual plastic waste data for Delhi, though the students recognised that stopping plastic pollution is the need of the hour, there was still a perceived powerlessness among them as they believed that there is such a vast amount of plastic being generated by the factories and industries that their personal actions would not make a significant difference. Thus, they showed a lack of understanding of collective responsibility and impact, as found by Gifford (2011) that

individuals disengage from sustainability efforts when they feel their impact is too small. Thus, students saw this issue as an external large-scale problem and failed to link it to their personal habits, only believing that it is the government's duty to reduce plastic and pollution caused due to it.

Objective 2: To explore the impact of integrating environmental issues into the mathematics classroom on students' behaviour towards sustainability and environmental responsibility

It was through the analysis of post-task interviews that the impact of using environmental issues related to mathematical tasks was analysed. The thematic analysis of the interviews brought out the following findings:

- *Promotion of environmental awareness:* After completing the tasks, students gained a much deeper understanding of the consequences of plastic waste pollution. Through designed worksheets, students realised the scale of the issues. The real plastic waste data in the worksheet helped them in recognising plastic waste as a vast environmental issue affecting cities, countries, and ecosystems. The students realised the severity of the issue. Students were able to identify the most prevalent sources of plastic waste in their homes, such as polythene bags, food packaging and sachets (sauce, shampoo), wrappers (chips, biscuits, chocolates, etc.), plastic water bottles, Styrofoam plates, and disposable cutlery. The top two most consumed plastic items were polythene bags and food packaging.

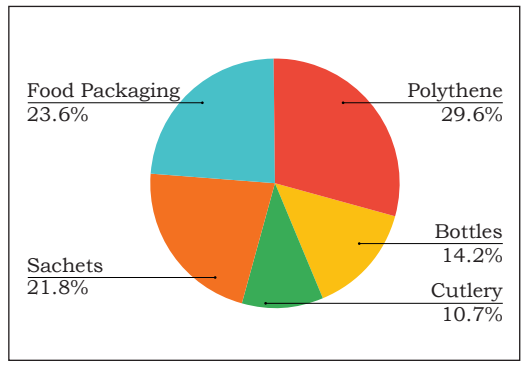


Figure 6: Combined plastic waste material distribution of all the 18 households

Many of the students said that they didn't even realise that food packaging was in fact plastic. Thus, after taking the one-week plastic consumption survey, students were able to link their daily habits to its broader environmental consequences.

- *Acknowledging environmental impact:* The post-task discussion opened a space where students spoke about the effects of plastic on animals, plants, ecosystems, and human health. Students were now articulating these concerns in their own words,

demonstrating critical thinking and a deeper understanding of sustainability. A student even explained how microplastics enter the food chain, impacting marine life and human health. This certainly reflects that a sense of social responsibility was duly acknowledged by the students.

- *Mathematical data interpretation:* Students developed and applied important mathematical skills by analysing real-world statistics. By engaging with graphs, charts, and large-scale measurement units like tons, they learned to read and compare plastic waste generation levels across regions. They also performed arithmetic operations, while tracking and recording their own consumption of single use plastic for a week.

Name	Polythene Bags	Plastic Bottles	Plastic Straws, Plates	Food Packaging	Plastic Sachets
Me	7 |	||	|	6 |	||
Mom	7 |	|	|	10 |	||
Papa	||	0	|	|||	0
Bhai	6 ||	||	|	5	||
Week Total	30	6	4	30	7

Figure 7: A student's one-week plastic waste tracking sheet

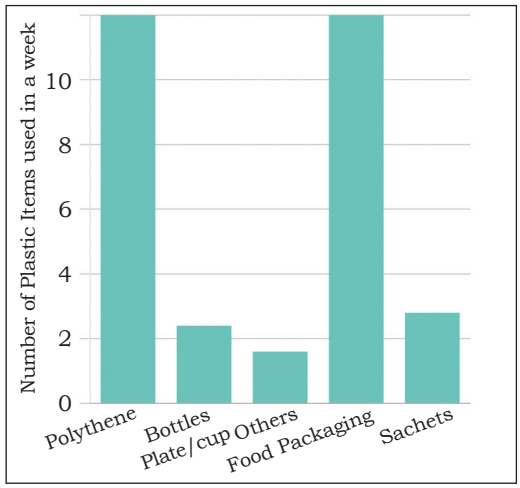


Figure 8: Graph plotted by a student based on their tracking sheet on the school computer

With the help of family survey-based task, students were enabled to view their plastic usage as a numerical quantity. They practised data collection by tracking each family member's plastic consumption, performed calculations and estimated their annual household plastic consumption. Students represented their findings on pie-charts and bar graphs, showcasing data handling skills. They found in their surveys that their use of polythene bags while shopping for vegetables, or disposable cutlery while eating out accumulated over time. Thus, the students were able to identify the major sources of plastic waste in their households by visualising the problem, and take necessary actions to reduce, reuse, or recycle. These tasks reinforce their ability to analyse data and take action in the real world.

- *Understanding gendered patterns of plastic usage:* An interesting insight that emerged from this task was students' observation of gender-specific roles in household plastic consumption. Eighty-three per cent of students identified their mother as the highest contributor to plastic waste within the household. This was primarily attributed to mothers being responsible for daily grocery shopping, cooking, and household management activities that often involved frequent use of polythene bags, packaged goods, and disposable items. Eleven per cent recognised their fathers as key contributors, while the remaining students cited siblings or grandparents. While this observation reflected household dynamics, it also prompted a critical conversation around shared responsibility rather than placing blame. Students began to discuss how every family member plays a role and that everyone must participate in reducing plastic consumption.

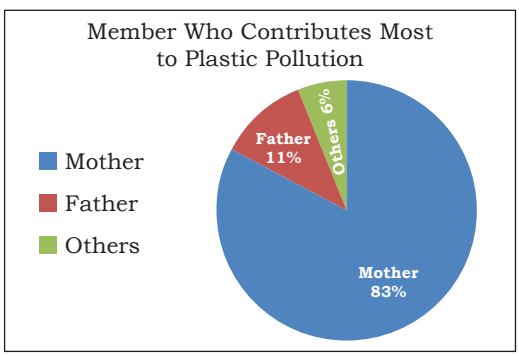


Figure 9: Top contributor from student's households towards plastic pollution

- *Behavioural change—Sensitivity towards environment:* By tracking and recording their family's plastic waste generation over a week, students recognised their personal contribution to pollution and became more mindful of their daily consumption habits. Many students reflected that they were unaware of this usage pattern. They suggested alternative approaches like educating and making their family and parents aware about the extent of their daily plastic consumption and its ultimate effect on the environment, using cloth or jute bags for daily grocery shopping instead of polythene bags, opting for steel or glass bottles or *mitti ghadas* (traditional mud pots) like those in villages instead of plastic, buying cutlery made out of leaves instead of the plastic disposable ones, and encouraging parents to purchase products with minimal plastic packaging (for example, buying loose flour or grains) in order to reduce the waste. Thus, the students became more critical about their habits of daily plastic consumption. They recognised the threat posed by food packaging wrappers and proposed that they could instead try to reuse or recycle such plastic waste.

Conclusion and Implications

The CME has a large discourse of studying the power structure or social issues through mathematics (Skovsmose, 2014) but certainly it is

required that it should be used in studying environmental issues so as to enable students to critically engage with real-world issues concerning sustainability and climate change. By tracking and analysing their own family's plastic use and through national and global statistical data, they not only expanded their mathematical skills but also developed a strong understanding of the impact of human actions on the environment. Indian education policies have also prioritised fostering responsible citizens equipped with practical knowledge to tackle such challenges. Furthermore, the importance of traditional sustainable practices that enrich the curriculum (Varish and Sharma, 2021), with locally relevant solutions for sustainability should also be acknowledged and incorporated. The study demonstrates the potential of a Critical Mathematics Education approach in transforming students from passive recipients of theoretical learning to active participants in climate action, thus inculcating sustainable attitudes that lead to a more eco-conscious and responsible society. It highlights that mathematics can promote ethical responsibility (Atweh and Brady, 2009) in students. These constructive initiatives where teachers also consider climate change-related social issues as their ethical and moral responsibility (Abtahi et al., 2017) will surely make students a responsible environmental citizen (Shimray, 2016).

References

Abtahi, Y., P. Gotze, L. Steffensen, K. Hiis, and R. Barwell. 2017. 'Teaching Climate Change in Mathematics Classrooms: An Ethical Responsibility'. *Philosophy of Mathematics Education Journal*. Vol. 32. Retrieved from https://hdl.handle.net/11250/2993623

Atweh, B. and K. Brady. 2009. 'Socially Responsible Mathematics Education: Implications of an Ethical Approach'. *Eurasia Journal of Mathematics, Science and Technology Education*. Vol. 5, No. 3. pp. 267–276. Retrieved from https://doi.org/10.12973/ejmste/75278

Barwell, R. 2013. 'The Mathematical Formatting of Climate Change: Critical Mathematics Education and Post-normal Science'. *Research in Mathematics Education*. Vol. 15, No. 1. pp. 1-16. Retrieved from https://doi.org/10.1080/14794802.2012.756633

Central Pollution Control Board, Ministry of Environment, Forest and Climate Change, Government of India. *Annual Report 2020-21 on Implementation of Plastic Waste Management Rules, 2016 Annexure I*. 2022. Retrieved from https://cpcb.nic.in/uploads/plasticwaste/Annual_Report_2020-21_PWM.pdf

Creswell, J.W. 2007. 'Qualitative Inquiry and Research Design'. *Choosing Among Five Traditions (2nd edition)*. Sage, Thousand Oaks.

Gifford, R. 2011. 'The Dragons of Inaction: Psychological Barriers that Limit Climate Change, Mitigation and Adaptation'. *American Psychologist*. Vol. 66, No. 4. p. 290. American Psychologist Association.

Hamilton, J. and T.J. Pfaff. 2013. 'Sustainability Education: The What and How for Mathematics'. *Primus*. Vol. 24, No. 1. pp. 61–80. Retrieved from https://doi.org/10.1080/10511970.2013.834526

Hawthorne, M. and T. Alabaster. 1999. 'Citizen 2000: Development of a Model of Environmental Citizenship'. *Global Environment Change*. Vol. 9, No. 1. pp. 25–43. Retrieved from doi:10.1016/s0959 3780(98)00022-3

Li, H. and T. Tsai. 2021. 'Education for Sustainable Development in Mathematics Education: What Could It Look Like?' *International Journal of Mathematical Education in Science and Technology*. Vol. 53, No. 9. pp. 2532–2542. Retrieved from https://doi.org/10.1080/0020739x.2021.1941361

Ministry of Education, Government of India. 2020. *National Education Policy (NEP) 2020*.

———. 2023. *National Curriculum Framework for School Education (NCFSE) 2023*. National Council of Educational Research and Training.

Renert, M. 2011. 'Mathematics for Life: Sustainable Mathematics Education'. *For the Learning of Mathematics*. Vol. 31, No. 1. pp. 20–26.

Sharma, D., S. Sharma, and Varish. 2022. 'Environmental Sensitivity: A Road to Achieve SDGs 2030'. In A. Biswal, R.C. Patel and S. Chaturvedi (Eds.). *Contemporary Social Science Researches on School Education in Indian Universities*. pp. 222-228. Global Academic Publishers, Daryaganj, New Delhi, India.

Shimray, C. 2016. *Teaching Environmental Education: Trends and Practices in India*. Sage, Thousand Oaks Publications, New Delhi, India.

Skovsmose, O. 2014. *Critical Mathematics Education*. In Springer eBooks, pp. 116–120. Retrieved from https://doi.org/10.1007/978-94-007-4978-8_34

Swedberg, R. 2020. 'Exploratory Research' In C. Elman, J. Gerring and J. Mahoney (Eds.), *The Production of Knowledge: Enhancing Progress in Social Science.* pp. 17–41. Cambridge University Press, Cambridge.

Varish and D. Sharma. 2021. 'Education for Sustainable Development: An Intrinsic Case Study'. S. Chauhan (Ed.). *Emerging Trends in Interdisciplinary Research in Higher Education.* pp 88- 95. Bloomsbury India, Delhi.

———. 2023. 'Green School for Sustainable Future'. *Universe Journal of Education & Humanities*. Vol. 10, No. 2. pp. 13–17. Retrieved from http://www.omvsesss.org/ArticleImages/38702%20Mr.%20Varish%20&%20Mr.%20Deepak.pdf

Wolfmeyer, M. and J. Lupinacci. 2017. 'A Mathematics Education for the Environment: Possibilities for Interrupting All Forms of Domination'. *Philosophy of Mathematics Education Journal.* Vol. 32. Retrieved from http://socialsciences.exeter.ac.uk/education/research/centres/stem/publications/pome32/index.html