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Pens, Plastics, and Planet: A Study of Student Groups' Plastic Pen Usage and Awareness of Its Impact on Environmental Sustainability

RISHAV RAY[1], PALLAVI BHATT[2], NEHA KASWAN[2], GARVITA SINGH[2], DEEKSHA DAVE[1] AND RENU SONI[2]*

[1]School of Inter-Disciplinary and Trans-Disciplinary Studies, Indira Gandhi National Open University, New Delhi, 110068, India

[2]Department of Botany, Gargi College, University of Delhi, New Delhi, 110049, India

E-mail: rishavrey@gmail.com, bhattpallavi349@gmail.com, nehakaswan094@gmail.com, garvita.singh@gargi.du.ac.in, deekshadave@ignou.ac.in, renu.soni@gargi.du.ac.in

ORCID: 0009-0004-9952-7423 (RR), 0000-0001-8119-0237 (GS), 0000-0001-5578-6280 (DD), 0000-0002-9351-5323 (RS)

***Corresponding author**

ABSTRACT

Plastic pens, popular for their affordability and convenience have revolutionized writing and communication but their unchecked use contributes to overall plastic waste. Pens and refills are non-biodegradable since they contain several plastic and metal components, making them non-recyclable and ending up in landfills. In the present study, a data-driven survey methodology was employed, analysing student attitudes and practices regarding the use of plastic pens in everyday life. The study investigates the practice of using plastic pens among student groups in Delhi-NCR, focusing on their eco-awareness and need for the responsible waste disposal and recycling. The study assesses the significant usage of plastic pens, pollution caused due to it, and long-term impact on ecosystems and human health. Student-focused surveys on plastic pens usage can provide valuable data on consumer behaviour, environmental consciousness, educational programs, product development, legislation, behavioural change research, and marketing tactics. Understanding students' preferences, habits, and perspectives on plastic pens can benefit companies and policymakers, as they are often seen as a representative sample of the general public. The findings of the present study will contribute to existing literature, promotion of sustainable alternatives, and policy formulation for sustainable plastic pens waste management practices.

Key words: Plastic pens, Environmental consciousness, Student groups, waste management, Microplastics

INTRODUCTION

Plastic pens are available in a wide range of patterns and styles. Their manufacturers frequently design pens with a variety of grips, barrel forms, and cap types to accommodate a range of personal preferences. The wide range of colours allows users to express their individuality and choose pens that match their personal taste or corporate branding. Generally, pens are classified into two categories: ball point pens and non-ball point pens such as gel pens. Over time, pen design and materials continued to evolve, with pens in various colours, shapes, and sizes. Plastic pens are ubiquitous writing instruments that have become an integral part of our daily lives. They are popular for their affordability, availability, and ease of use (Hansford 2022). Plastic pens have been produced since the 1950s, but their unregulated disposal has led to significant waste. Their invention has revolutionized writing and communication, but their unchecked use largely contributes to the overall plastic waste (Shrivastav 2022). The extensive use of plastic pen today has led to enormous environmental and management issues. The term "plastic pen pollution" describes the negative impact, involving improper disposal and accumulation of plastic pens in the environment. When carelessly disposed of these plastic pens which are composed of non-biodegradable materials significantly contributing towards plastic wastes (Fig. 1a,b), causing environmental issues (Kedzierski et al. 2020). In general, "single-use culture" refers to an environmental situation in which resources, goods, or services are made with the intention of being used just once before being destroyed and this idea is frequently linked to disposable things, which are

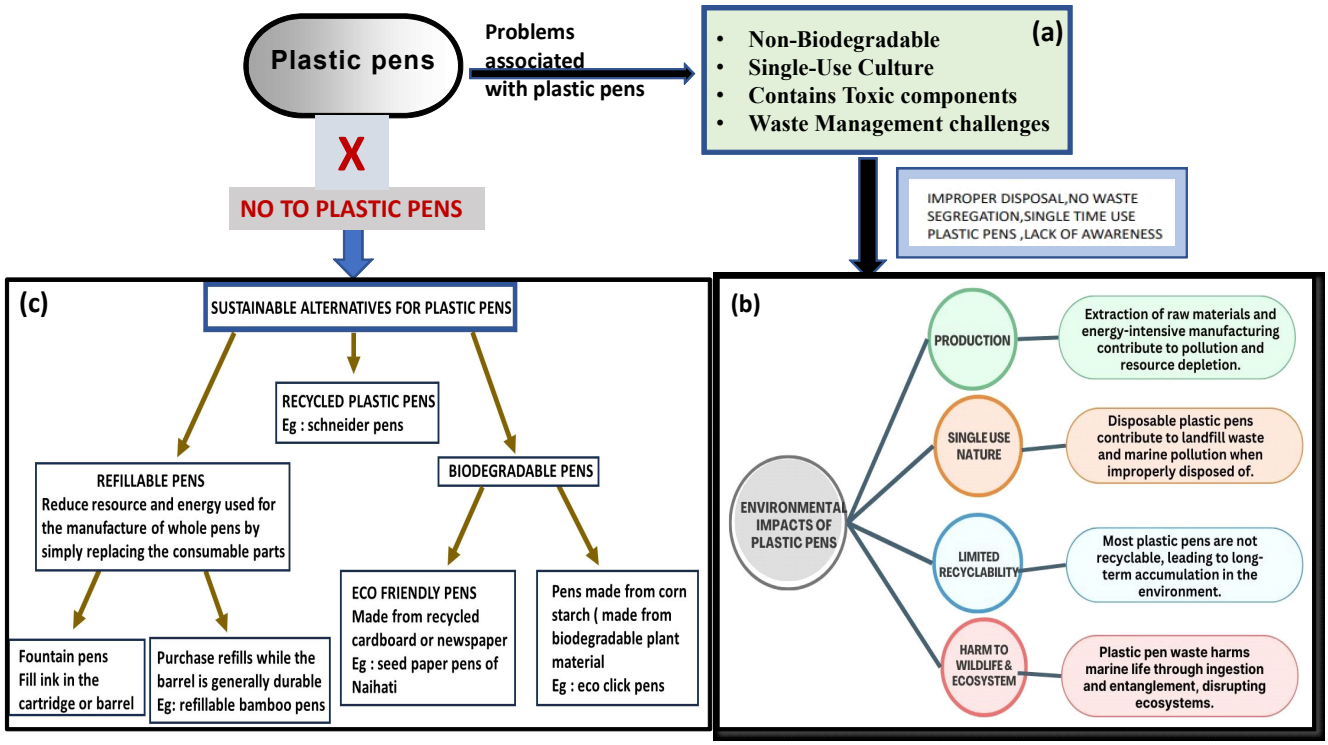

Figure 1. Problems associated with plastic pens production, its impacts on environment and sustainable alternatives for plastic pens

utilized just momentarily before being thrown away, adding to environmental issues including pollution, waste buildup, and resource depletion (Springle et al. 2022). Since plastic pens are frequently single-use items, there is a greater production of waste. They create long-term plastic pollution since they are made up of non-biodegradable substances like polypropylene or polystyrene. Additionally, their compact size and varied material composition make recycling challenging, leading to additional problems with waste management (Kibria et al. 2023). Each year, between 1.6 and 2.4 billion plastic pens enter the market nationwide, yet 91% of the plastic waste generated from these pens remains unrecycled. Despite the shift toward digital technology and paperless alternatives, the use of disposable pens remains remarkably high (Godani and Thomas 2023). Although there is increasing awareness of plastic pollution, plastic pens are still used by many students due to ease in use and affordability. Against this backdrop, the primary aim of this research is to create consumer awareness regarding the fact that the plastic we consume leads to toxins in landfills and water bodies. Plastic production and accumulation in the natural environment are happening at an unprecedented scale because of reckless use, poor recycling, and landfill deposits and present and presents serious challenges to waste management (Kumar et al. 2021). The main weakness of plastic lies in its post-consumption phase, as improper disposal in the environment can cause significant socio-environmental issues, hindering progress toward the Sustainable Development Goals (SDGs) (de Sousa 2021).

Important components of plastics include toxic compounds like Phthalates and Bisphenol A (BPA), which can disrupt hormones and cause reproductive issues. These compounds may eventually leak into the environment and threaten ecosystems and human health (Campanale et al. 2020). Additional research (Sachinthana 2021) emphasizes the negative effects of fully constructed ballpoint pen items on the environment, such as marine ecotoxicity and global warming. Plastics' sluggish rate of breakdown increases the long-term environmental risks (Chamas et al. 2020). The production process of plastic pens requires resources that are mostly obtained from fossil fuels, which contributes to an ongoing cycle

of environmental damage. This problem can be mitigated using sustainable solutions that use recycled or biodegradable materials. Due to this, the aquatic life and the food chain are under risk from microplastics, which degrade over time (Qaiser et al. 2023). The growing worry over plastic pollution has prompted a shift to more environmentally friendly alternatives to plastic pens, such as ink pens, metal pens and eco-friendly pens (Fig.1c). Plastic pollution, as described by Borja et al. (2020), is highly the focal point of concern in the area of the current public debate, research, and policy response. But it is less certain that this focus is fully warranted, relative to other current threats to the ocean and human health.

This research aims to assess the prevalence of plastic pen use among student groups in Delhi-NCR, their awareness of the environmental impact of plastic waste, and their willingness to adopt sustainable alternatives. It examines usage patterns, students' understanding of plastic pollution, and their attitudes toward eco-friendly choices. Focusing on young students in government schools, colleges, and universities, the study gathers data through online surveys and in-person interactions. It evaluates the widespread use of plastic pens, their contribution to pollution, and their long-term effects on ecosystems, wildlife, and human health. By surveying students across various academic disciplines and age groups, this research seeks to identify the connection between plastic pen consumption and environmental awareness while exploring students' readiness to transition to more sustainable alternatives.

MATERIAL AND METHODS

The research focuses on Delhi-NCR, aiming to understand the young generation's thoughts and responses to the increasing trend of plastic pens usage. Data collection involved online questionnaire distribution and physical interaction with young students at various government schools, colleges, and universities. The study assesses the significant usage of plastic pens, its pollution consequences, and long-term impact on ecosystems. Through the survey of students across different academic fields and age brackets, this study seeks to determine the relationship between plastic pen use and environmental sustainability awareness. It also investigates students' readiness to make a change to more sustainable options.

Survey-based research was conducted among 506 respondents from various schools, colleges, and universities in Delhi-NCR. The authors emphasized equal attention to all students, from school-going to Ph.D. scholars, belonging to age groups between 10-28 years, to fully comprehend the attitudes and reactions of the younger generation over the growing use of plastic pens. To conduct this study, data-driven survey methodology was employed for the analysis of student's attitudes and practices regarding usage of plastic pens in everyday life, starting from their buying preferences, the methods they usually employ for disposal and associated environmental awareness that surrounds around them (Fig. 2). The survey was conducted from 15th October, 2023, to 31st January, 2024. To establish intelligible research a user-friendly self-explanatory questionnaire based on Google forms were used as survey-based research tool. The questionnaire had 4 sections, where the first section focused upon personal/demographic details. Section two had a total of five questions based on preferences and purchasing frequency. Section three had four questions based on methods of disposal they usually

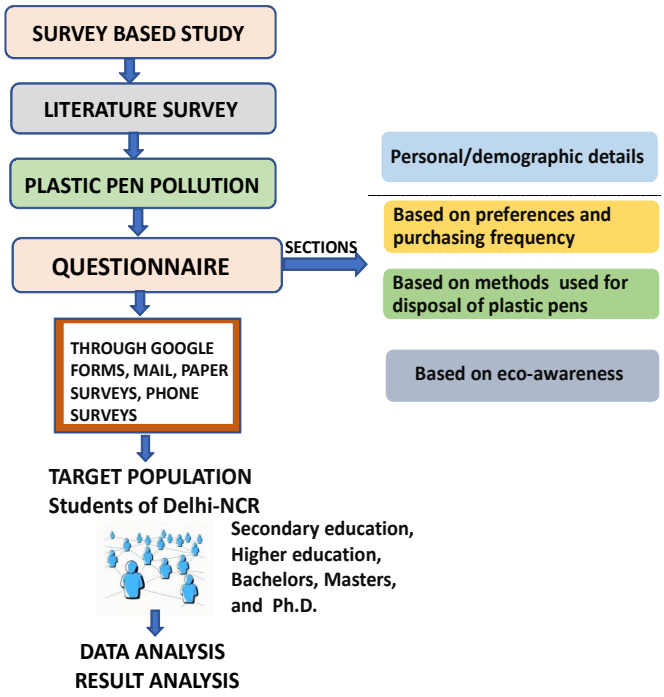

Figure 2. Methodology employed for the proposed survey on the usage of plastic pens and associated eco-awareness

employ to dispose of plastic pens. The last section had a total of eight questions, focusing upon plastic pens and their associated eco-awareness.

The objective questions comprise diverse set of questions ranging from multiple-choice type, multiple select type and statement-based questions to gather insights from student groups. Students enrolled in various schools, colleges, and universities in Delhi-NCR were sent the Google form through WhatsApp, LinkedIn, and other social networking platforms. The questionnaires were distributed among students, ranging from secondary education to higher education. Further an awareness session was conducted in one of the schools run by Govt. of NCT-Delhi, through Vidyanjali initiative under Ministry of the Education, Government of India to spread awareness regarding plastic pens pollution. Microsoft excel and other statistical packages were used as a tool for creating data tables, computing, and analyzing the results.

RESULTS AND DISCUSSION

Analysis was done on the basis of data collected through a survey questionnaire based on Students' attitudes and behaviours about the use of plastic pens in daily life, including their purchasing habits, typical disposal techniques, and related environmental awareness of their surroundings. The sample size was 506 covering students from various parts around Delhi-NCR. Most of the respondents (51.6%) belonged to the age group 16-20 years. The percentage of remaining respondents belonging to different age groups is summarized in Table 1. The majority of respondents are from Government-funded institutions (78.2%). Regarding the educational qualifications, most of the respondents (54.2%) were pursuing graduation, followed by students pursuing post-graduation and Ph.D. (18.8%), Senior Secondary school students (15.4%) and secondary school students (11.7%). Most of the respondents were from Delhi (75.9%), followed by Faridabad (6.1%), Gurugram (5.5%), Noida (4%), Greater Noida (4%) and Ghaziabad (3.8%).

The majority of those surveyed respondents (42%) prefer using plastic pens over other kinds of pens (Fig. 3a). Speaking about the category of pens, respondents generally prefer to use single use plastic

Table 1. Demographic details of the respondents

Parameter	Percentage
Age (in years)	
10-15	13.20
16-20	51.60
21-25	21.50
>25	13.40
Educational qualification	
Secondary school	11.70
Senior secondary school	15.40
Graduation	54.20
Post-graduation & above	18.80
Type of institution	
Government funded	78.20
Private funded	21.80
Area	
Delhi	75.90
Noida	4.00
Greater Noida	4.00
Ghaziabad	3.80
Faridabad	6.10
Gurugram	5.50

pens (53%), followed by refillable plastic pens (35.2%), metallic pens/ink pens (7.1%), eco-friendly and other types (4 and 0.8%) (Fig. 3b), where as in a another survey study conducted showed that 22%of the participants use ecofriendly pen, where participants include school students, college students and working class (Godani and Thomas, 2023). Increase in response may be because of working class participants. Also, most of the respondents (51.4%) buy less than 5 pens on an average per month (Table 2. Q 1). Data analysis showed, 96% of the respondents prefer to buy these pens from conventional stationery stores, (15.80%) from supermarkets and (15.60%) from online retailers (Table 2. Q 2) reason being their cheap and easy availability (77.1%), followed by lack of other alternatives (46%), their easier use (37%) and fancier design and attractiveness (18.4%) (Fig 3c).

According to the survey, nearly half of the survey participants (47%) choose to reuse their plastic pens, indicating that a significant number of respondents are practicing sustainability by prolonging the lifespan of these writing tools. On the other hand, it

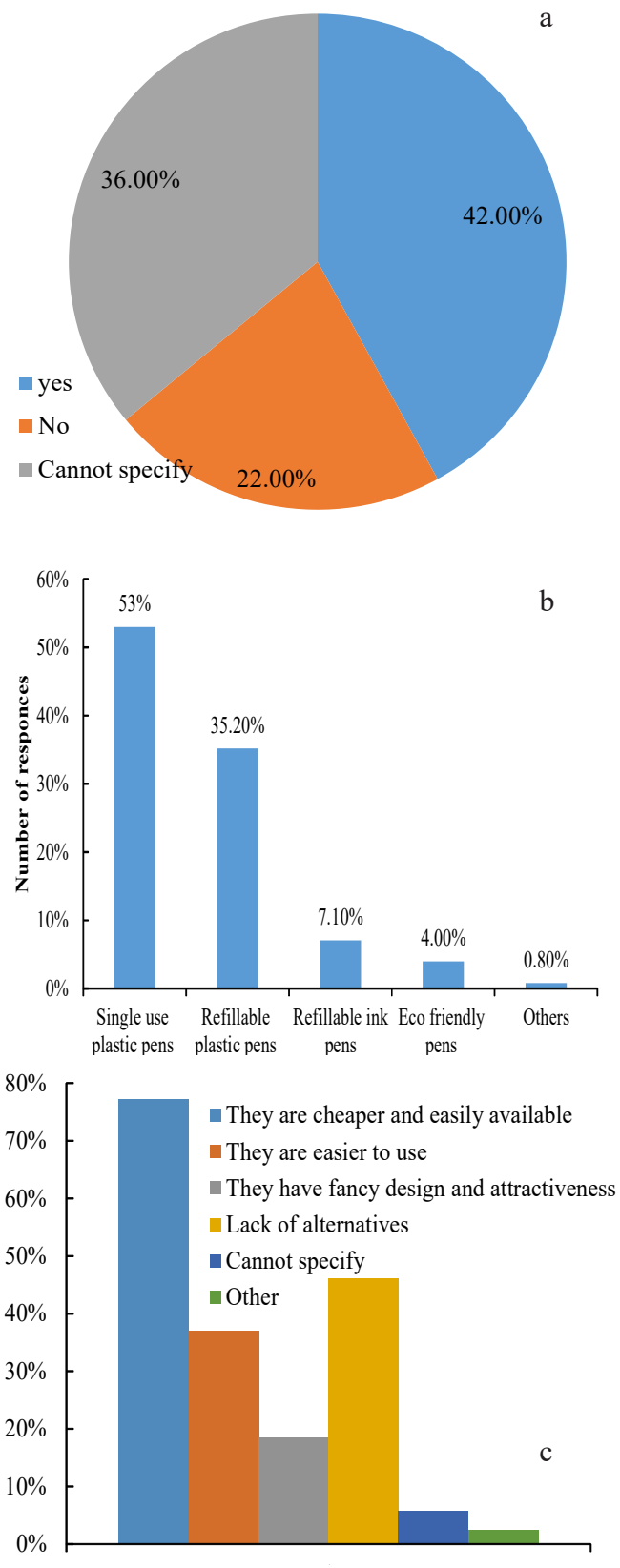

Figure 3. Purchasing frequency of plastic pens. a) Plastic pens preferences, b) Preferences for types of pens, c) Reasons for plastic pens preference over other kinds of pens

was revealed that 45.3% of participants do not reuse their pens, indicating a considerable portion that may contribute to the issue of single-use plastic waste (Fig. 4a). The majority of the respondents (70.4%) dispose of plastic pens in the trash, highlighting a potential environmental concern, similarly in another survey study majority of the participants (73%), throw used pens and purchase new ones (Godani and Thomas, 2023). However, 27.3% engage in responsible disposal by either repurposing the pens for parts, while 28.7% respondents practice of keeping pens for parts for making crafts. Another positive trend is that 27.1% of participants hand their pens over to waste collectors (Fig. 4b). Regarding re using plastic pens, (50.4%) of the respondents rarely reuse their pens, once their ink gets used up. However, (16.8%), reused only once, (26.7%) re use between 2-5 times and 5.9% of the respondents, re use it more than 5 times (Table 2. Q 3). The survey findings demonstrate a strong preference for raising awareness about proper plastic pen disposal through educational institutions (68.2%), underscoring the importance of integrating campaigns about the environmental impact of plastics into schools and higher education institutes. Product packaging (53.2%) and social media (43.7%) are also seen as valuable channels for disseminating information, emphasizing the need for accessible information (Table 2. Q4).

The survey reveals a strong preference for disseminating information on safe plastic pen disposal through educational institutions (68.2%), emphasizing the importance of integrating campaigns on plastic impacts into schools and higher educational institutes. Product packaging (53.2%) and social media (43.7%) are deemed valuable, emphasizing the importance of accessible information (Fig. 4c). During this survey, we also found that students who are pursuing graduation (54.2%) (Table 1) tends to seem more environmentally conscious towards reusing and safe disposal of plastic pens.

As we know that discarded plastic wastes hamper normal functioning of the ecosystem and discarded plastic pens constitutes an important proportion. While assessing Students' knowledge regarding eco-awareness about the increased usage of plastic pens, it was discovered that most of the respondents agreed

Table 2. Purchase frequency, methods of disposal of plastic pens, and students' knowledge regarding eco-awareness

Questions		Options	Percentage
Purchasing frequency of plastic pens			
Q1	On an average how many plastic pens do you buy in a month?	1. Less than 5	51.40
		2. 5-10	40.30
		3. 10-15	5.90
		4. More than 15	2.20
Q2	From where you normally prefer to get pens?	1. Stationary stores	96.00
		2. Online retailers [eg. Amazon, eBay]	15.60
		3. Supermarkets	15.80
		4. Other	0.10
Methods of disposal employed			
Q3	How often you reuse plastic pens?	1. Rarely	50.40
		2. Reuse it only once	16.80
		3. Reuse it 2-5 times	26.70
		4. Reuse it more than 5 times	5.90
Q4	How would you want to receive information on safe ways to dispose of plastic pens?	1. Information on product packaging	53.20
		2. In-store signage or displays	24.10
		3. Online resources	23.90
		4. Social media campaigns	43.70
		5. Information should be given in Schools/Higher educational institutes	68.20
		6. Parents should inculcate the habit of using ink pens over plastic pens	29.40
Assessing students' knowledge regarding eco-awareness			
Q5	For environmental safety, do you believe in replacing plastic pens with Ink pens and other sustainable alternatives?	1. Yes	79.40
		2. No	10.70
		3. Cannot specify	9.90
Q6	What are the factors, do you believe, are responsible for an increased trend in eco-friendly pens?	1. More marketing of plastic pens as compared to ink pens/plastic pens	71.30
		2. Lack of awareness	52.50
		3. Cheap prices and easy availability	79.40
		4. They look more attractive	28.50
		5. Others	0.79
Q7	There are pens manufactured from recycled craft paper, wheat straws, biodegradable bamboo wood, and reprocessed plastics that are sold on various E-commerce websites. Have you ever used such pens or are you aware about the same?	1. Yes	39.72
		2. No	13.20
		3. Cannot specify	9.50
Q8	Which type of pen would you choose if you had the options to pick up just one to receive as a gift from the list?	1. Plastic pens	2.00
		2. Latest refillable pens (Fountain pens)	50.80
		3. Eco-friendly pens with simple design	67.60
		4. Metallic pens	16.40

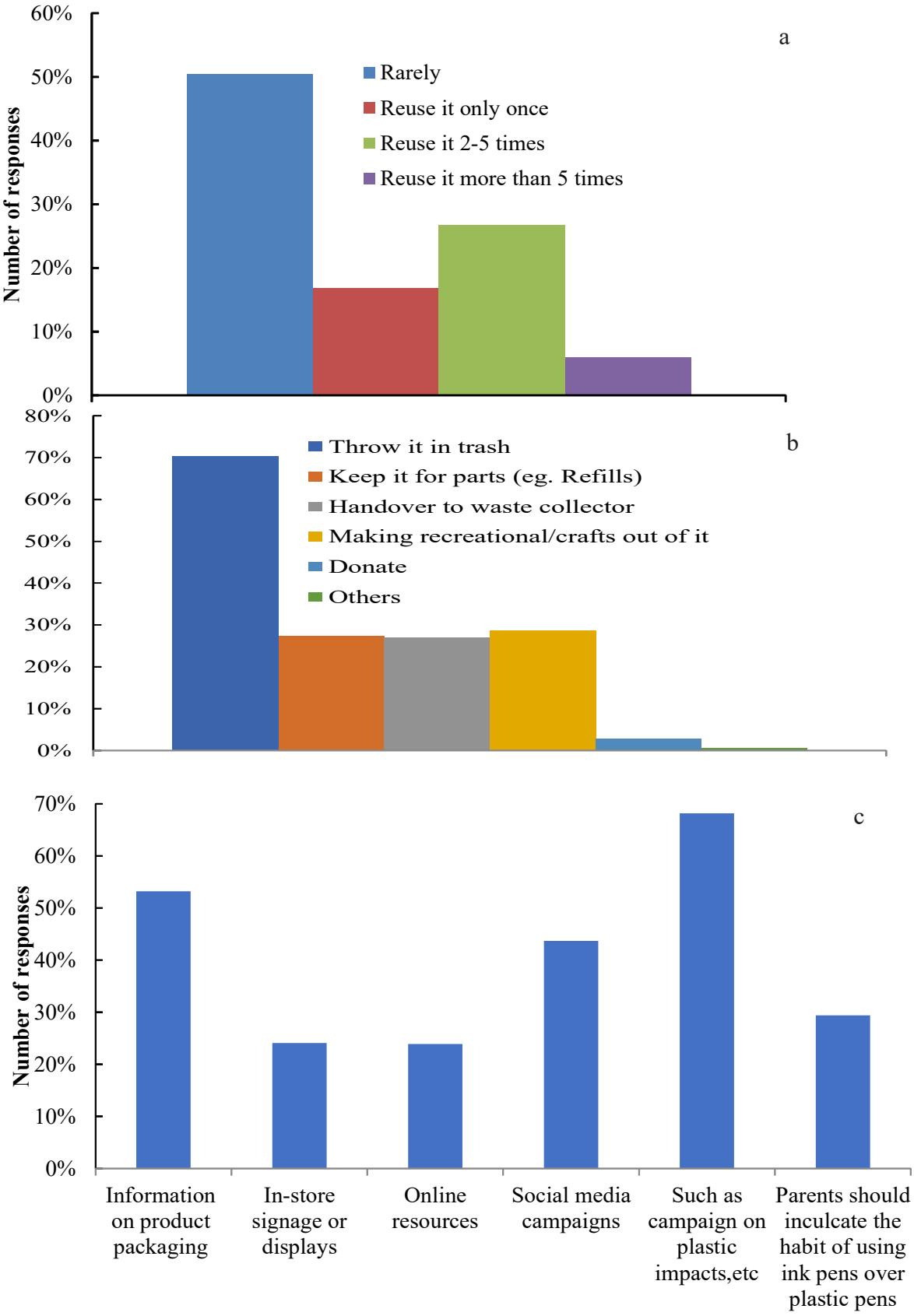

Figure 4. Various disposal techniques employed by respondents with respect to plastic pens. a) Habits of reusability of plastic pens; b) Various processes employed for safe disposal of used plastic pens; c) Different ways of getting information on safe ways to dispose of plastic pens

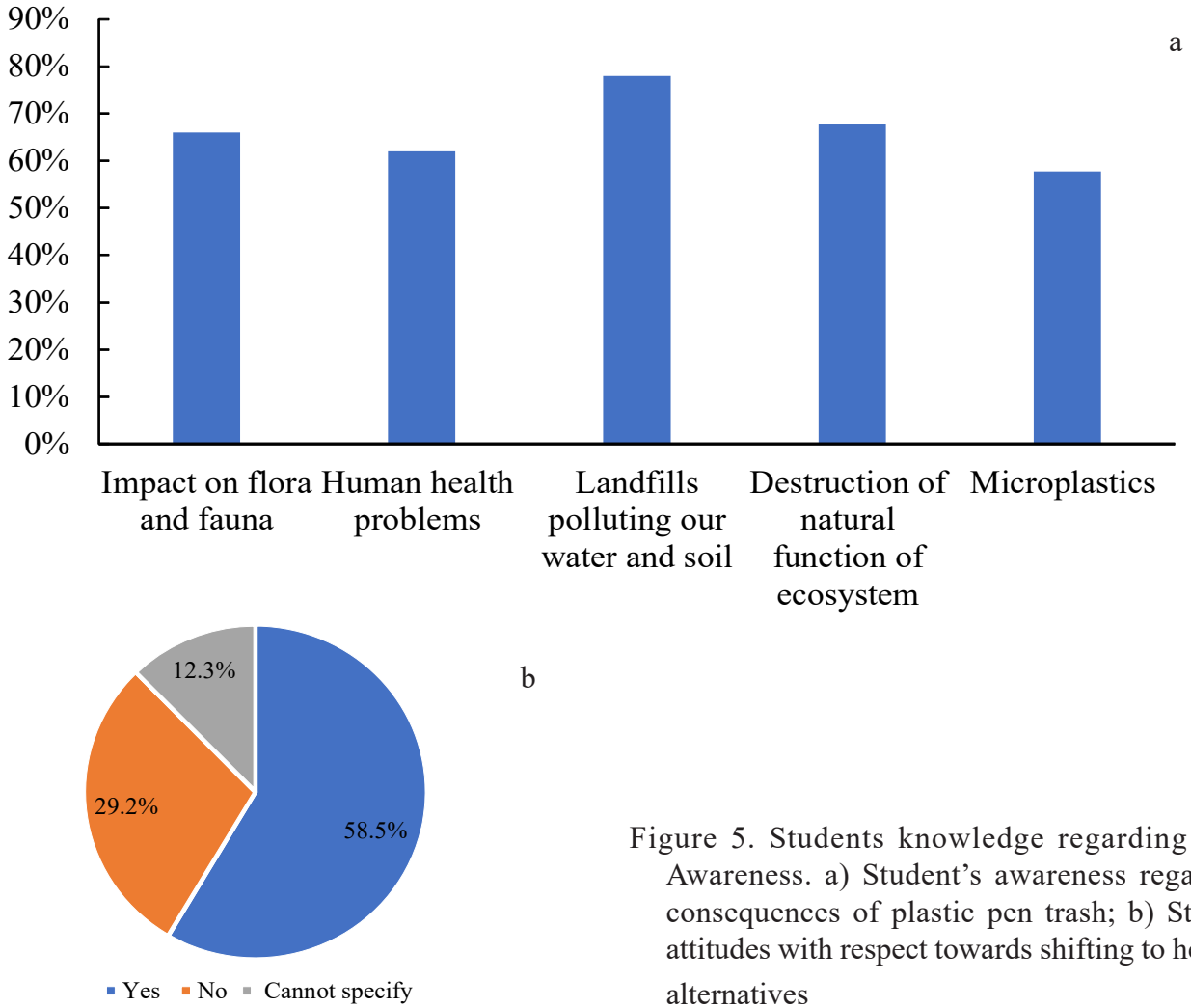

Figure 5. Students knowledge regarding Eco-Awareness. a) Student's awareness regarding consequences of plastic pen trash; b) Student attitudes with respect towards shifting to healthy alternatives

on effects of unchecked plastic pens trash. Nearly 66% of the respondents agreed that plastic pen trash have negative impact on local flora and fauna, 62% agreed on human health impacts, 78% agreed on the landfill contribution by plastic pens, disturbs water and soil environment (57.8% of the respondents) were aware about the release of microplastics due to improper pen disposal (Fig 5a). Also, when asked about their intent to shift towards healthy alternatives to plastic pens, 58.5% agreed (Fig.5b), underscores the growing awareness and preference for sustainable options (Fig. 5 b). This trend reflects a broader societal shift towards environmentally responsible consumer behaviour and recognition of the environmental impact of everyday choices; same results were obtained by another survey study on plastic pens, majority of the respondents agreed to use ecofriendly pens, as these are environment friendly (Godani and Thomas 2023).

79.4% respondents believe that plastic pens should be slowly replaced with ink pens, metallic pens and other sustainable alternatives (Table 2, Q. 5). When asked about the causative factors for increased trends in plastic pen usage, most of the respondents (79.4%) believe that cheap price and easy availability of these pens is one of the major factors, followed by extensive marketing (71.3%) and their attractiveness (28.5%) (Table 2, Q 6). Also, when they were asked about their knowledge regarding eco-friendly pens made from bamboo, recycled papers, only 39.7 % of the students were actually aware of these categories of pens (Table 2, Q7).

Regarding scenario analysis, when the respondents were asked about the category of pen, they will take for free with option of opting only

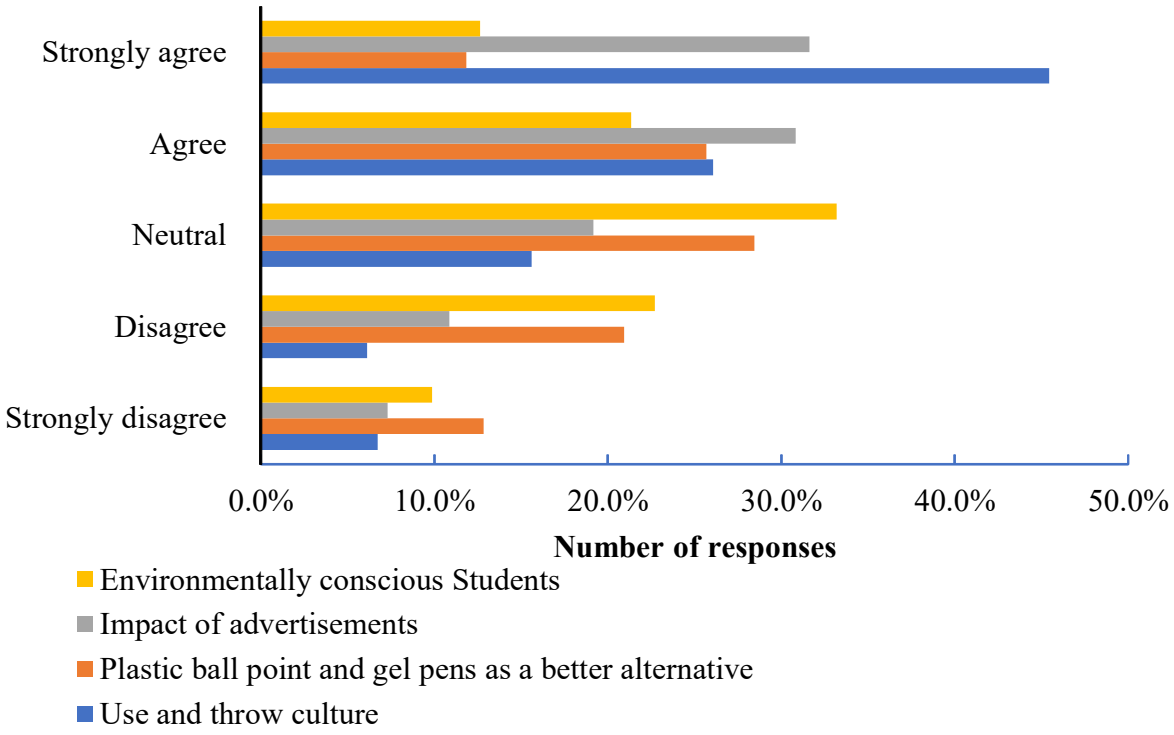

Figure 6. Graphical representation of statement-based responses regarding eco-awareness related statements

one, 67.6% of the respondents opted for eco-friendly alternatives followed by metallic pens (16.4%), fountain pens (13.2%) and conventional plastic pens (2%), which gives a strong sense that the young generation is cautious and wants to move towards the path of environmental sustainability (Table 2, Q8). Refillable pens offer convenience without the environmental drawbacks of single-use plastics, making them an attractive option for individuals seeking a balance between practicality and sustainability.

For capturing psychometric data, few statements were provided to the respondents. To which 45.45% of the respondents strongly agreed on the fact that the use and throw culture have been significantly increased, since the introduction of plastic pens. Approximately 25.69% of respondents agreed that plastic ballpoint and gel pens are a better alternative to fountain pens, while 28.45% remained neutral. In contrast, 20.94% strongly disagreed, and 12.84% disagreed, reflecting their awareness of the environmental impact of plastic pens. When asked about their environmental consciousness and willingness to choose greener alternatives, 21.34% of respondents agreed, Further study conducted showed approximately 31.62% of the respondents, strongly agreed, 30.83% believed that advertisements shown by various pen manufacturing companies, especially in which new age social media influencers are present are attracting young minds to buy these fancy looking pens in large numbers, irrespective of them thinking about their negative impacts on the environment (Fig. 6).

Plastic pens, despite their seemingly harmless appearance, significantly contribute to the global plastic pollution problem. They are made from non-biodegradable polymers like polypropylene and polystyrene, which accumulate in landfills and natural areas over time. Discarding plastic pens also leads to marine pollution, as improper disposal can lead to microplastics that can bioaccumulate and end up in human body. Plastic pens also contribute to the total amount of plastic waste produced worldwide, with millions of pens thrown away annually. Despite recycling initiatives, the intricate design of pens, including metal springs and ink cartridges, poses challenges to effective recycling processes, leading to a significant portion of pens

being incinerated in landfills.

The use of plastic pens by students has increased noticeably in recent years. The transition from conventional writing utensils to plastic pens is influenced by a number of variables, such as marketing impact, cost, and convenience. These pens are useful, but there are concerns about how much of them students are using, how it affects their learning environment, and the wider ecological implications. For students who are usually on a limited budget, plastic pens are generally more affordable. Students can readily get them because they are widely available at convenience stores and school supply stores. Because they are easy to use and don't need to be constantly refilled like some other pens, plastic pens are a useful option for taking notes during lectures and tests. With plastic production expected to double by 2040 (Anonymous 2024), addressing the environmental impact of plastic pens are crucial. According to a report, published by the Central Pollution Control Board (CPCB), Ministry of Environment, Forests, and Climate Change, between 1600 and 2400 million plastic pens are sold each year, with 91% of them not being recycled (Anonymous 2020). This unrestrained use of plastic pens has a detrimental effect on the environment. Disposable plastic pens are a practical and affordable solution for students, often used as promotional gifts by educational institutions and businesses (Santhapuram 2021). Their widespread appeal is due to their branding and marketing techniques. These pens are easy to use and reliable, making note-taking and test writing more efficient. However, students may not be fully aware of the environmental impact of plastic pens due to their focus on immediate convenience.

To combat the growing threat of plastic waste, it is essential to raise awareness among students and employees about its environmental impact through workshops, seminars, and informational materials like posters. Partnering with suppliers to offer affordable, eco-friendly pen alternatives can significantly reduce plastic waste. Institutions can further promote sustainable choices by implementing a reward and incentive system to encourage students to switch to environmentally friendly pens. These pens, made from sustainable, biodegradable, or recycled materials, help minimize environmental harm. By adopting these strategies, institutions can effectively reduce plastic consumption and foster a culture of environmental responsibility among students and staff.

CONCLUSIONS

Plastic pollution is a significant issue that requires a combination of consumer behaviour, legislation, and technological innovation. Manufacturers should use recyclable materials, promote sustainable design principles, and explore refillable and biodegradable pen options. Disposable pens contribute to global plastic crises by producing significant plastic waste. To combat this, it is crucial to replace plastic pens with sustainable alternatives. Refillable pens can reduce energy and resource inputs required for entire pens production, such as fountain pens or purchasing refills and reusing the barrel. Sustainable inks like soy-based inks can also be used for refilling, but they require more time to dry than other inks and should only be used with a drier. Many organizations from all over the world are promoting the use of recycled plastic pens, while biodegradable pens are being introduced as a sustainable alternative. These eco-friendly pens, made from recycled paper, bamboo, and corn starch, are aesthetically pleasing and have a lower environmental impact (Mall 2023, Jeenath 2024). Educational institutes should include sessions explaining the harmful effects of plastic pens, knowledge campaigns, and practical actions like collection and recycling of plastic pens.

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to the conception or design of the work. RR, PB, NK, GS, DD and RS worked together for literature survey, data analysis, manuscript writing and interpretation of data for the work. Final editing and critical revision of the manuscript were done by GS, DD and RS. All authors approved the manuscript final version.

Conflict of interest: The authors declare no competing interests.

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