

Evaluating Consumer Responses TO Augmented Reality Based Environmental Education Tools FOR Promoting Sustainable Lifestyle Choices

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Abstract

The growing urgency of climate change necessitates innovative approaches to environmental education, particularly in rapidly urbanizing countries like India. This study explores the effectiveness of Augmented Reality (AR)-based environmental education tools in promoting sustainable lifestyle choices among consumers. The research is grounded in the idea that immersive technologies like AR can enhance environmental awareness by creating engaging, interactive, and visually compelling learning experiences. The study addresses three core research questions: (1) the impact of AR-based environmental education on sustainable consumption, (2) the influence of environmental awareness on lifestyle choices, and (3) the role of demographic and psychographic factors in predicting sustainable behavioral intentions.

Conducted in two phases, the study first interacted with the participants to apprise them about environmental awareness, followed by hands-on interaction with selected AR apps such as Google Arts & Culture, Earth Hero, Eco Lens, and Go Jauntly. Data from 213 respondents was collected through a survey and analyzed using SPSS version 24.. The results revealed that AR-based tools positively affect environmental knowledge, emotional engagement, and intentions to adopt sustainable lifestyle choices. Younger, tech-savvy individuals showed higher engagement, while demographic and psychographic differences significantly influenced technology acceptance and behavioral outcomes.

The study contributes to the limited but emerging body of literature on AR in environmental education, especially within the Indian context. It highlights the need for customized, accessible AR experiences to foster sustainability at the individual level. The findings offer practical implications for educators, policymakers, and app developers aiming to drive climate-conscious behavior through immersive technology.

Key words: *Augmented reality, Sustainability, consumer behavior, low carbon footprint.*

1. INTRODUCTION

A deteriorating climate change can be attributed to human activities, which have led to increase in green house gases impacting global warming, water issues, food insecurity etc.[1]. In a country like India that is urbanizing steadily, it has become imperative to promote environment awareness and low carbon lifestyles. Awareness is the key to influencing behavior and immersive technologies like augmented reality (AR), virtual reality(VR) can be used to provide environmental education [2]. These technologies are well equipped with providing 3-D images, interactive environment and spatial position of the objects in real world foster better immersive learning environments. They also help in promoting active learning, collaboration, and critical thinking through simulations and interactive experiences [3]. AR can help in overlaying the virtual content onto the real world, thereby allowing individuals to visualize the impact of their daily choices on carbon footprint.

Extant literature underscores the critical role of early education in delivering accurate information about climate change, as this helps prevent the formation of misconceptions. If left unaddressed, these misconceptions may obstruct individuals' capacity to make informed decisions and engage in effective climate change mitigation efforts[4]. Taking this as a foundation, the study undertaken aims to evaluate how Indian consumers respond to AR-based environmental education tools and whether such tools influence their intention to adopt low-carbon lifestyle behaviors. Based on this following research questions have been formulated

RQ1: Does AR-Based Environmental Education impacts Sustainable consumption?

RQ2: Do levels of environmental awareness impacts sustainable Lifestyle choices?

RQ3: Which demographic and psychographic factors are predictors of sustainable lifestyle choices

2. LITERATURE REVIEW AND OBJECTIVES OF THE STUDY

2.1 Impact of AR-Based Environmental Education on Sustainable consumption

UNESCO define environment education as a process that allows individuals to explore environmental issues, engage in problem-solving, and take action to improve the environment, thereby developing a deeper understanding of environmental issues and acquiring the skills to make informed and responsible decisions [5]. Environmental education is based on five core pillars i.e. awareness & sensitivity, knowledge & understanding, attitude, skill and participation[6]. Awareness and sensitivity helps in ensuring that individuals have sensitivity towards their environment, Knowledge and understanding deals with developing understanding about the environmental functions and their impact on humans. Attitude deals with fostering concerns towards environmental issues and preservation. Skill deals with the building of necessary capabilities to protect environment. Participation deals with the encouragement & motivation to get involved in the activities related to the environment. Consumer response refers to the measurable reactions or actions taken by individuals in reaction to a stimulus(product, service, or informational intervention). It encompasses a range of outcomes including cognitive (awareness or understanding), affective (emotions or attitudes), and behavioral (intentions or actions) response. In this study the consumer response include getting aware of the environmental issues, forming behavioral intention and making carbon positive lifestyle choices. Environmental education has the capability to reshape the consumer response by providing sufficient knowledge and skill of the ecological impacts. By promoting sustainability values and responsible decision-making, environmental education influences consumers to choose eco-friendly products and adopt low-carbon lifestyles, aligning individual actions with broader environmental goals and contributing to sustainable consumption patterns[8,9]. Sustainable consumption can happen at individual, community and organizational level[10]. While organizational levels are monitored by the governments, individual levels can only be manoeuvred by imparting environmental education. Carbon footprint and sustainable consumption are closely linked concepts that underpin efforts to promote low-carbon lifestyles[11]. A carbon footprint is defined as a measure of total carbon dioxide emission caused either directly or indirectly by an activity [12]. While sustainable consumption has been defined as use of goods and services for improving quality of life with minimum use of natural resources so as to maintain needs of the future generation[10]. More awareness a consumer has about sustainability, higher are the chances of his to evaluate his daily consumption. Some of the AR based educational tools available in the market can help in understanding the relationship between two concepts. By engaging consumers interactively, AR-based education can foster more informed, eco-conscious decisions, ultimately contributing to reduced carbon footprints and more sustainable consumption patterns. Based on this following objective has been formulated

Based on this following objective is proposed

Obj1: To evaluate the impact of AR-Based Environmental Education on Sustainable consumption

2.2 Influence of Environmental Awareness on Sustainable Lifestyle Intentions

Augmented Reality (AR) provides immersive experiences that enhances environmental engagement by adding visual and spatial aspect to the environmental issues [13]. AR can be employed as an innovative educational medium to influence consumer awareness and behavioral intention. By overlaying digital content onto physical surroundings, AR enabled users to better understand the environmental impact of their daily choices, fostering motivation for low-carbon and sustainable living[14]. Thus bridging the gap between abstract environmental concepts and personal action, making sustainability education more impactful and accessible to a wider audience. Based on this following objective has been formulated.

Obj2: To examine the influence of Environmental Awareness on sustainable Lifestyle choices

2.3 Demographic and Psychographic Predictors of Sustainable Behavioral Intentions

Consumer responses to AR-based education tools, technology acceptance varies significantly across their profiles. Factors such as age, education level, environmental concern, and digital literacy influenced receptiveness to AR content[15]. Younger, tech-savvy consumers were more likely to engage with AR tools and report increased awareness of low-carbon practices[16]. Conversely, older individuals or those with limited exposure to digital technologies showed lower acceptance. Understanding these demographic and psychographic differences was

essential to assess how effectively AR tools could drive behavioral intention. Tailoring AR experiences to specific consumer segments enhanced their educational and motivational impact. The output can be seen in the form of changes behavioural intentions like changes in consumption habits, travel plans and energy usage[17,18,19]. This further helps in reducing individual carbon footprint and fostering sustainability. Based on this following objective has been formulated

Obj3: To identify demographic and psychographic predictors of sustainable behavioral Intentions

3. RESEARCH GAP

Despite the growing urgency of environmental issues and the increasing use of AR in education, there is limited empirical research examining the effectiveness of Augmented Reality (AR) tools in shaping consumer awareness and behavior related to sustainability [20]. While AR is seeing its utilization in different digital platforms and mobile apps, very less mobile apps related to sustainability have integrated it. As the results limited studies have focused on immersive AR experience and their impact on consumer toward adopting sustainable lifestyles[21,22]. Moreover, existing literature often addresses either technological acceptance or environmental behavior change in isolation, without integrating these perspectives to understand how AR-based education can act as a behavioral catalyst. Additionally, demographic and psychographic predictors influencing consumer responses to AR tools remain underexplored, particularly in developing country contexts like India, where both digital literacy and environmental awareness are unevenly distributed. This study addresses these gap by combining digital engagement tools with behavior-focused survey design and statistical modeling.

4. METHODOLOGY

The study was carried out in two phases. In phase I, interaction with the respondents was done to apprise them about environment concerns and sustainability. In phase II respondents were allowed to interact with selected AR-based environmental educational apps and then were administered a survey regarding AR apps to reduce carbon footprint. The AR apps used to gain education about environment; carbon footprint and sustainability were Google Arts & Culture, Earth Hero, Eco lens and Go Jauntly. The survey (ANNEXTURE-I) administered was divided into two parts. Part I consisted of demographic factors and part II consisted of questions related to environmental concern, AR experience & perception, environmental awareness and behavioral intention. The survey questions related to environmental concern, AR experience & perception, and behavioral intention were adapted from Dunlap et al, 2000 & Kaiser et al.[23,24], 1999; Huh,et al., 2020 & Raymond (2023) [25, 26]; Wei et al., 2016 & Ma & Chen (2025). [27, 28] respectively. The data was collected from 213 respondents and was further analyzed using SPSS version 24.

5 RESULTS AND DISCUSSIONS

Table 1 shows the demographic profile of the respondents. Of the sample of 213, 32.4% were belonging to low age group (18-34 years) while 67.6% belonged to high age group (34 years and above). 44.1% of the respondents were male while 55.9% were female.47.4% of the respondents had low education (high school and graduation) while 52.6% had high education level (post graduation and others). Monthly income wise 44.6 % of the respondents had monthly income up to Rs. 50 thousand and 55.4% had income more than Rs.50 thousand.

Table 1: Descriptive Statistics of Respondents

Variable	Category	Frequency	Percentage(%)
Age Group	Low	69	32.4
	High	144	67.6
Gender	Male	94	44.1
	Female	119	55.9
Education	Low	101	47.4
	High	112	52.6
Monthly family income (Rs)	Low	95	44.6
	High	118	55.4

Source: Output from SPSS

Table 2 depicts the AR tool usage and behavioral change. From Table 2, 87.8% of respondents reported having used AR-based environmental education tools, and 88.3% indicated that these tools increased their awareness of sustainability issues. Moreover, only 71.4 % of users reported making actual changes in behavior, such as reducing plastic usage, changing energy consumption. Table 4 shows that AR tool usage had a positive and statistically significant effect on sustainable lifestyle intentions ($B = 3.815$, $p = 0.000$, $OR = 1.22$). This suggests that those who used AR tools were 1.22 times more likely to express an intention to adopt sustainable practices compared to those who didn't use AR tools. Hence it can be concluded that AR-based educational tools significantly enhance consumer motivation toward sustainable consumption. These tools have potential to transform awareness into actionable behavior. Thus meeting objective 1 of the study.

Table 2: AR Tool Usage and Behavior Change

Variable	Yes (%)	No (%)
Used AR tool	87.8	12.2
AR tool improves engagement	71.4	28.6
Awareness increased post-AR	88.3	11.7
Behavior will change due to AR usage	90.6	9.4
Recommendation of AR tools	89.2	10.0

Source: Output from SPSS

Table 3 reflects the environmental awareness level of the consumers. The mean environmental awareness score was 3.751 out of 5, indicating a moderately high level of awareness across the sample. Table 4 demonstrates a statistically significant influence of environmental awareness on sustainable lifestyle choices ($B = 1.052$, $p = 0.002$, $OR = 0.349$). This indicates that for each unit increase in awareness score, the odds of intending to adopt sustainable behaviors increases by 0.349 times. Hence it can be concluded that higher awareness significantly increases sustainable lifestyle choices ($OR = 0.349$, $p < 0.05$). Thus meeting objective 2 of the study.

Table 3: Environmental Awareness Levels

Variable	Mean	SD	Min	Max
Awareness Score	3.751	0.626	2	5

Source: Output from SPSS

Table 4 shows the logistic regression table with demographic and psychographic predictors of sustainable lifestyle choices. The value of Nagelkerke $R^2 = 0.426$, suggesting the logistic regression model explains around 42% of the variance in sustainable lifestyle choices. The classification accuracy of 82.2% and non-significant Hosmer-Lemeshow test ($p = 0.634$) indicate a good fit and robust predictive power of the model. Table 4 shows that unlike demographic factors like income & education, age & gender do not play any important role in changing to sustainable lifestyle choices. This can also be attributed to introduction of environment education in higher education. Furthermore, consumers with higher income levels tend to have greater financial flexibility and access to green alternatives—such as eco-friendly products, renewable energy options, and sustainable mobility—enabling

them to incorporate low-carbon choices more readily into their lifestyles [29, 30]. These findings suggest that structural enablers like education and economic capacity are more influential than immutable demographic traits in shaping sustainable lifestyle choices.

Psychological variables like carbon concerns is strong predictor of the sustainable lifestyle choice with $B = 0.562$, $p = 0.029$, $OR = 1.570$, suggesting consumers who care more about environmental impact are 1.570 likely to make take make sustainable lifestyle choices. This finding aligns with previous research emphasizing the role of environmental attitudes and perceived severity of climate change in influencing pro-environmental intentions[31]. The significant odds ratio further underscores the motivational salience of ecological consciousness, indicating that internalized concern for carbon emissions may serve as a catalyst for behavioral change. Such insights reinforce the relevance of affective and cognitive components—particularly personal relevance and risk perception—in shaping voluntary low-carbon practices.

Thus meeting objective 3 of the study.

Table 4: Logistic Regression: Key Predictors of Sustainable Lifestyle choices

Predictor	B	SE	p-value	Exp(B)	95% CI
Age	0.650	0.408	0.111	NS	NS
Gender	0.299	0.390	0.444	NS	NS
Education	1.018	0.408	0.013	2.767	[1.244,6.153]
Income	0.585	0.392	0.136	0.557	[0.258,1.202]
AR Usage	3.815	0.808	0.000	1.22	[0.205,0.107]
Environmental Awareness	1.052	0.542	0.002	0.349	[0.121,1.011]
Carbon Concern	0.562	0.542	0.029	1.570	[0.197,1.649]

Source: Output from SPSS

6. RESULTS AND RECOMMENDATIONS OF THE STUDY

The study concludes that Augmented Reality (AR)-based environmental education tools significantly influence consumer awareness, and intention to adopt sustainable lifestyle practices. The results indicate a positive consumer response, particularly in terms of increased environmental knowledge, emotional involvement, and behavioral intent towards low-carbon choices. Factors such as family income, education level and carbon concerns emerged as a useful predictors of sustainable lifestyle choices. Based on these findings several recommendations can be made. First governments and communities should intergate AR into sustainability education programs to make learning more immersive and impactful. Concepts of sustianabilty should be introduced from the school level to ensure better civic sense among young citizens. Secondly mobile apps/digital platforms suppoting sustainability should be linked with some reward systems like free coupons, discounted certificates on environment education etc. These platforms should targeted to younger age group as they are more techsavy ensuring better popularity. Third, developers should focus on simplifying the interfaces of the AR, adding gamefied features to the platforms to make them more engaing. Lastly, future implementations should include monitoring mechanisms to assess long-term behavioral impact and integrate community feedback to iteratively impgrove AR experiences.

7. LIMITATIONS AND FUTURE SCOPE

The study was limited to the AR mobile apps linked with sustainability in in India. The sample size was small and confined to people who gave their concent for the study. To ensure more generality of the results, future studies can focus on comparative analysis of different types of apps(educational vs rewarding). To dwell into better understanding, comparative analysis of consumers of different area can also be done. Researchers can also compare AR with other digital tools like virtual reality(VR). Finally, creating AR content in local languages and based on local issues can make it more effective and relevant.

8.CONCLUSION

The study demonstrates that Augmented Reality (AR)-based environmental education tools have a positive impact on consumer awareness and intention to adopt sustainable lifestyle choices. By making environmental information more interactive and visually appealing, AR helps bridge the gap between knowledge and action. The findings highlight that consumers are more likely to respond positively to sustainability messages when delivered through immersive technologies. This suggests that AR can be a powerful tool for educators, policymakers, and developers aiming to promote low-carbon behaviors. Overall, the study supports the integration of AR into environmental education strategies as a means to inspire meaningful and lasting behavioral change.

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ANNEXTURE I

Section	Question No.	Item	Response Options
A. Demographics	A1	Age Group	Under 18, 18-24, 25-34, 35-44, 45-54, 55 and above
	A2	Gender	Male, Female, Other/Prefer not to say
	A3	Education Level	No formal, High school, UG, PG, Doctorate
	A4	Occupation	Student, Professional, Homemaker, Retired, Unemployed
	A5	Income (INR)	<₹25k, ₹25k-₹50k, ₹50k-₹1L, >₹1L
B. Psychographics	B1	Frequency of sustainable practices	Never to Always (5-point scale)
	B2	Importance of carbon footprint	Not important to Extremely (5-point scale)
	B3	Environmentally conscious	Yes, No
	B4	Seek environmental info	Yes, No
C. AR Tool Use	C1	Used AR for environment education	Yes, No
	C2	Engagement level	1-5 scale
	C3	Awareness increased via AR?	Yes, No
	C4	Behavior change due to AR?	Yes, No
	C5	Recommend AR tools	Yes, No
D. Environmental Awareness	D1	"Climate change caused by humans"	Strongly Disagree to Strongly Agree (5-point)
	D2	Awareness of impact	1-5 scale

	D3	Environmental education received	Yes, No
E. Intentions	E1-E5	Intend sustainable behaviors	Yes, No