Generation Z and Sustainable Behavior: Examining Digital Fatigue, Cognitive Resources, and Education

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This study examines Generation Z's understanding of energy use and ecological practices, as well as the effects of digital existence and mental exhaustion. Using viewpoints from environmental psychology and social sciences, it investigates the behavioral and cognitive processes that link excessive internet use to environmentally responsible behaviors. 683 Polish secondary school students participated in a cross-sectional study that examined the connections between internet use, weariness, self-control, and sustainable practices like reuse, recycling, and reduction. According to research, people who experience cognitive overload—a condition made worse by problems like excessive internet use and growing digital fatigue—are less likely to participate in sustainability initiatives. This study examines the relationship between digital tiredness, problematic online conduct, and Generation Z's decreased involvement in pro-environmental efforts using k-means clustering and robust regression analysis based on ordinary least squares (OLS). Furthermore, it acknowledges that this generation has particular sustainable behavioral traits. The negative consequences of digital tiredness were lessened by academic success, and knowledge of energy and sustainability may help to lessen these effects. The findings emphasize how crucial it is to incorporate environmental education and digital well-being into social policy frameworks for kids, strengthening the developing field of digital sustainability.

Keywords: Digital fatigue, eco-friendly behaviors, environmental consciousness, and brain capacity of Generation Y.

Introduction:

In academic circles, understanding human behavior and daily activities is becoming more significant than technological advancement due to growing worries about global sustainability and the impact of climate change on society. According to contemporary social science perspectives, physical systems and efficiency tactics are crucial, but for successful sustainability transitions, altering daily routines, consumption habits, and individual thermal processes is just as crucial. They are significant in this regard since they belong to Generation Z, the generation that will be responsible for environmental stewardship in the future and was nurtured in a digital environment.

As everyday life becomes more digitally connected, concerns about how technology may affect social welfare and sustainable practices are growing. According to recent research, cognitive overload and self-regulation weariness brought on by excessive online activity may impair people's ability to make deliberate, sustainability-focused decisions. Many people think that the social, economic, and environmental spheres are all included in sustainable development. Despite taking a broader view, this study experimentally investigates the behavioral-environmental component of sustainability, which is characterized by noteworthy and observable daily behaviors among teenage groups.

In order to improve understanding of how young people might adopt more sustainable practices, this study integrates concepts from behavioral social science, environmental psychology, and digital media studies. It examines how Generation Z understands and interacts with environmental sustainability within the larger context of sustainability, taking into account their digital habits, cognitive capacities, and educational background. Additionally, it assesses youth involvement in sustainable activities using a composite metric called the Sustainability Behavior Index (SBI) and looks at the moderating influences of gender, locality, and educational achievement.

This study contributes to the growing body of research on human behavior, digital health, and environmental responsibility using behavioral and sociocognitive techniques. By highlighting the need to view sustainability as a social and cognitive endeavor in addition to a technological issue, it establishes a theoretical link between digital adequacy, energy awareness, and responsible citizenship.

The increasing energy needs of digital infrastructures like data centers and AI-powered apps need the integration of digital sustainability with physical energy systems. Sustainability research can now meet the standards of STEM (science, technology, engineering, and mathematics) programs because to this partnership.

We will look at research on sustainable practices in the digital age in the next section. Sometimes behavioral metrics are used in sustainability research to represent certain aspects of sustainable development rather than the full conceptual scope of the notion. It is crucial to acknowledge that social and economic issues are also significant, even though they are investigated using different methods, even though research on teenagers frequently focuses on environmental acts to assess their commitment in sustainability.

Researchers from a variety of fields, including environmental psychology, media and communication studies, life-cycle assessment (LCA), and studies on digital overload and addiction, are beginning to draw connections between digital technology and sustainable activities. According to [1], this viewpoint has been inspired by the growing realization that technical efficiency is insufficient to fully explain sustainability in the digital era. Examining the psychological, emotional, and social aspects that affect regular online behavior is crucial.

The Environmental Effects of Information and Communication Technology and Electricity Use:

The evaluation of ICT emissions by [2] is frequently used in discussions about the environmental effects of digitization. According to [2], even under ideal circumstances, the information and communication technology sector may contribute more than 14% of global emissions by 2040, overtaking the aviation sector. According to this general view, daily digital engagement time, or WZC, is an indirect measure of ecological demand [3]. This is true whether or not people are conscious of how their screen-related actions affect the environment.

Increased use frequently overcomes improvements in equipment efficiency, according to recent life cycle assessment (LCA) research on data centers, consumer electronics, and network infrastructure ([3][4] [5]. Does digitization actually reduce overall energy usage, or is it just a matter of moving energy use to a digital domain? An analysis of this particular subject is provided by [6].

Only by combining quantitative data on device usage time (WZC) with self-reported environmental viewpoints can the practical compromises between digital comfort and sustainability ideals be evaluated [7].

Changing Digital Consumption Metrics from Macro-LCA to Micro-Level as a Sustainable: Approach

Life-cycle assessments and energy consumption projections for the ICT industry show that the proportion of emissions associated with digital services is rising. This supports the

idea that working zone concentration (WZC) could be a useful indicator of environmental stress.

Methods for assessing how digital consumption affects emissions and resource use are presented by [5], and [4]. These studies are crucial for linking personal decisions to broader societal effects. A recent development in behavioral research is the "living review" approach. These models replace conventional techniques like goal-setting and feedback because they consistently incorporate the effects of social, financial, and informational stimuli [8][9][10]. Reducing screen time to improve one's own or the environment's health is rarely discussed, and research on behavioral treatments in digital environments is even less common.

Transitioning from the Real World to the Virtual World:

Ecological Projects and Changes in Behavior:

To explain environmentally beneficial activities, environmental psychologists have traditionally used frameworks like the Theory of Planned Behavior (TPB) and the Value-Belief-Norm (VBN) model [11]..

[12] list a number of household energy use intervention strategies, including financial incentives, social comparison, and feedback mechanisms. The outcomes of these methods are influenced by the technology and social context. According to [12], regression models (Tobit/OLS) and clustering algorithms can identify user profiles with varying degrees of sensitivity to digital and environmental inputs.

Environmental Psychology's Challenges with Minimal Input Methods (2.4) Social and structural constraints, including cognitive and motivational components (such low self-efficacy), are thoroughly categorized by [13] as obstacles to low-carbon behavior. According to [13], the most convincing explanation for young people's sustained behaviors is the interaction between their psychological traits and their digital environment. These frameworks, which comprise attitudes, knowledge, and contextual restrictions, are consistent with the factorial components investigated in this study.

What an Excessive Digital Media Use Affects Dependency, Self-Control, and Cognitive Resource Depletion:

This application of WNS (digital fatigue) and WPU (problematic usage) is supported by earlier psychological studies about media addiction, reduced self-regulation, and cognitive weariness [14] [15].

According to ego-depletion and self-regulation theories, as well as different "cognitive-resource" models, prolonged and intense use of digital media may exhaust the cognitive resources required for more purpose-driven acts[16]. For quantitative study investigating digital engagement and its impact on sustainability, the Bergen BSMAS and a number of other relevant usage measures are useful [17][18].

Scholars are paying more attention to the risks and betting opportunities related to teenagers abusing the media. Participating in gamified reward systems, using wagering platforms, or interacting with gambling content are examples of risky online behavior that can result in impulsivity, cognitive overload, and a loss of self-control. According to research, this is particularly true for younger groups. According to recent studies, these actions are associated with less self-control and less goal-oriented decision-making in digital settings. This part of the study is referred to as Online Risk and Gambling Exposure (WRH). It is thot of as a digital behavioral paradigm that helps with self-control and is advantageous for sustainability.

Digital adequacy and sustainability:

In order to counteract the growing negative environmental effects of internet use, new sustainability concepts like digital sufficiency and digital sustainability have emerged in recent years [19][4].

Digital sufficiency must be understood as focusing on behavioral patterns and consumption intensity rather than just technological efficiency in order to assess the ecological

impact of online activities [20]. According to the first comprehensive life cycle assessment (LCA) of digital content consumption, micro-behaviors like autoplay, multitasking, and scrolling need to be included in environmental models [4].

This approach aims to create technologies that favor sustainability over short-term efficiency and to participate in moderate activities (such "contemplating prior to the next stream or scroll"). Review studies show that the effects of digitalization are complex and wide-ranging. Online services' ease of use can often result in rebound effects that increase resource consumption and offset anticipated cost reductions[21] .

The Importance of Youth in Advancing Energy Literacy, Sustainability Awareness, and Advocacy:

The relationship between environmental attitudes and actions in adolescents is influenced by education, according to research by [18][22][23][24]. According to the findings, education has a crucial mediating role. According to [7], media consumption among teenagers significantly predicted environmentally responsible activities in a number of European countries.

According to research, formal instruction and participation in digital and community projects both improve students' awareness of energy in educational settings [23]. According to other studies, teenagers are more likely to support sustainability when they are able to think critically and develop their own opinions about energy systems [22]. This idea is used in the environmental-behavioral component of sustainability in the current study. In a more comprehensive theoretical framework, "sustainability citizenship" encompasses both social and economic activities. This empirical study focuses only on the energy awareness and environmentally conscious activities of adolescents.

Research shows that treatments that incorporate both behavioral and informational feedback produce longer-lasting results, particularly when faced with difficult cognitive tasks [10]. Previous results from student-focused meta-analyses [8] support the idea that education can link intentions and actions by improving self-efficacy and personal standards, and our research supports that idea.

According to recent research [25], there may be a "educational paradox," in which students exhibit high levels of anxiety around climate change while still leaving a sizable digital footprint. It is crucial to include digital sustainability awareness in curriculum because it shows how education promotes environmentally responsible behavior while facilitating the connection between WNS and SBI.

Finding Research Gaps and Combining Systematic and Behavioral Assessments:

Researchers at the nexus of environmental psychology and digital sustainability have highlighted the necessity of combining behavioral measures with systemic assessments. These results point to a conceptual strategy that uses hybrid analytical techniques including principal component analysis (PCA), clustering, and moderated regression and integrates digital components (WZC, WNS, WPU, and WRH) into the SBI.

Algorithmic nudging is a relatively new area of study that questions the predominance of conscious perspectives in influencing behavior. Cross-disciplinary supervision of these systems is necessary due to the influence of algorithmic structures on digital energy consumption[26].

Studies [27] show that using apps, streaming media, and cloud computing all produce emissions that people frequently ignore, making it more difficult for them to practice self-control and adopt sufficiency-oriented behaviors.

By combining life cycle assessment (LCA) with behavioral evaluation, considering algorithmic influences, and advocating for laws that support digital moderation and sufficiency, research and policy initiatives can broaden the scope of environmental psychology

to include digital environments. The concept of "digital sufficiency" (2023).Digital Transformation's Effects on Systemic Sustainability [21]. Persuasion via Algorithms[26].

Researchers in the fields of medicine and education have found that prolonged usage of electronic devices negatively impacts people's motivation and cognitive abilities. These drawbacks include fatigue and decreased learning efficacy. According to academic research, the EdTech-driven educational revolution may lead to a new type of digital emissions in education[25].

Combining health and environmental perspectives is unusual, but it opens up new study opportunities, such as the idea that self-regulation (WNS/WPU) affects the relationship between intrinsic environmental motivation and digital saturation.

This study's goal is to evaluate hypotheses H1–H5 while taking into account accepted best practices within an interdisciplinary social science framework. [28] list the following indicators, constructs, and analytical techniques used to achieve this goal: principal component analysis (PCA) for SBI formulation, cluster analysis, normalization of digital variables, regression models with interaction terms and heteroskedasticity adjustments, and cluster analysis.

Materials and Methods:

Using a behavioral and cognitive sustainability framework, this study investigates how Generation Z manages resources and attention in two interconnected domains: (1) sustainable daily habits and (2) digital engagement. Personal decisions and cognitive processes create the micro-level regulatory frameworks. The quantitative resource streams associated with physical sustainability frameworks are not the same as cognitive resources, which include components like motivation, self-control, and focus. The environment is indirectly impacted by the infrastructure supporting information and communication technology as well as the psychological effects of long-term cognitive stress brought on by digital addiction. In this framework, problems resulting from excessive or inappropriate use of digital media are considered signs of a cognitive disorder, while sustainable practices are characterized by a focus on reducing, reusing, and recycling resources while using only what is essentially required. The study aims to shed light on potential relationships between digital literacy and youth sustainability initiatives.

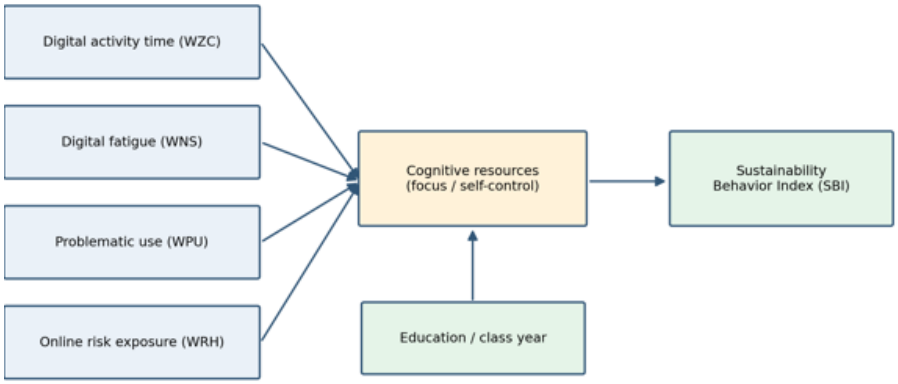

Figure 1. Proposed conceptual framework

Participants and Methods Used in the Study:

Polish secondary school students from Generation Z were asked to engage in a cross-sectional online survey called the Com puter-Assisted Web Interview (CAWI). Information about the poll was disseminated thru a combination of personally delivered invitations to educational institutions and notices on student-run websites and social media. The period of data collection was March 1, 2025, via June 30, 2025. Researchers from the Institute of Economics and Finance at John Paul II Catholic University of Lublin in Poland oversaw the study's execution.

After distributing an explanatory pamphlet, each participant's informed consent was obtained electronically. Without disclosing their identities, each participant willingly participated in the activity.

After the survey was completed, it was determined that 683 respondents had valid core demographics. The standard deviation was 1.41, and the average age was 17.38. 55.5% of the sample were men, 37.2% were women, and 7.3% of the total population chose not to reveal their gender. Participants were chosen from both urban and rural high schools. Only those who completed 75% of the items were allowed to develop scales (such the Sustainability Behavior Index, or SBI); missing data was handled in the following way. In our multivariate analysis, the listwise elimination strategy was applied. Consequently, the following categories were chosen for further examination:

Digital components in comprehensive models (N = 475); behavioral and demographic traits (N = 428).

Table 1. Sample and measurement summary

Measure	Reported value
Valid core demographic responses	683
Mean age (SD)	17.38 (1.41)
Male / female / undisclosed gender	55.5% / 37.2% / 7.3%
Digital-variable model sample	475
Behavioral-profile analysis sample	428
SBI PCA variance explained	61.8%
SBI Cronbach's alpha	0.83
WNS Cronbach's alpha	0.87
WPU Cronbach's alpha	0.81

The results of the sensitivity analysis showed that using strategies with incomplete data had no effect on the results. There were no statistically significant differences in age or gender between the removed respondents and the remaining sample, according to subsequent analyzes. Because of this, handling missing data is less likely to cause systemic bias.

Techniques:

Four behavioral markers were used to track sustainable activities every day:

Arranging garbage; recovering or reusing objects;

Look for used things in the marketplace;

The frequency of purchasing clothing (reverse coding indicates moderation).

The replies were recorded using a five-point Likert scale, where 1 represented never and 5 represented always.

Principal Component Analysis demonstrated that a single factor accounted for 61.8% of the variation, with a Cronbach's α of 0.83. For improved interpretability, the Sustainability Behavior Index (SBI), which serves as the primary dependent variable, was transformed into a scale with a range of 0 to 100. Since these behaviors represent common eco-friendly practices, they could be considered incomplete sustainability criteria based on behavior. The social and economic facets of sustainable development are overlooked by the current empirical approach.

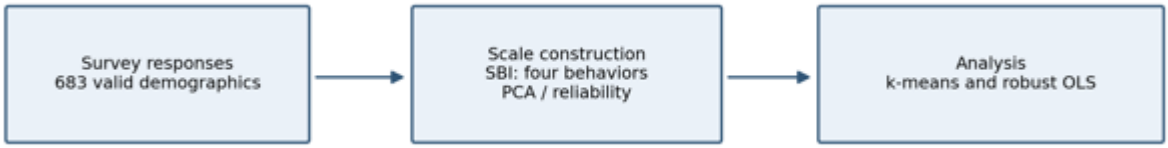

Figure 2. Survey measurement and analysis workflow

Digital Behaviors and Psychological Factors:

Four constructs were used to define digital behavioral and cognitive characteristics: WZC (Digital Activity Time), which takes into account how much time people claim to spend online each day, is one way to evaluate digital intensity. The degree of overwhelm and distraction is measured by the seven-item WNS (Digital Fatigue Scale). Six components of WPU (Problematic Use) are associated with impulsivity and the challenge of controlling online time. Four aspects of gambling or engaging in risky online behaviors are included in Web-Related Health.

The z-test was used to normalize all scales prior to analysis.

According to Cronbach's alpha, the measurements for digital weariness (WNS; $\alpha = 0.87$) and problematic usage (WPU; $\alpha = 0.81$) showed significant internal consistency.

Factors Affecting and Defining Demographics

The variables used as control factors included age, sex, level of education, and residence classification (rural versus urban). The possible influence of education on the connection between eco-friendly behavior and digital tiredness was another area of study.

Methods of Assessment:

Both exploratory and predictive methods were included in the analytical framework. IBM SPSS Statistics 29.0 from IBM Corp. in Armonk, NY, USA was used for all analyzes, with a significance threshold of $p < 0.05$.

The PCA-SBI framework was validated.

In the next stage, behavioral traits are identified by using k-means clustering within a range of 2 to 6.

Third, demographic variables are used in ordinary least squares regression (OLS) to forecast SBI.

Multinomial logistic regression is used to classify sustainability profiles according to their demographics.

Models that take gender into account: Special rewards for environmentally beneficial behavior.

Using principal component analysis, the WZC, WNS, WPU, and WRH digital metrics are examined and correlated.

Using long-term regression analysis to forecast SBI with digital components.

Moderation:

Investigating educational intervention techniques that might mitigate the adverse relationship between eco-friendly behavior and digital tiredness.

The continuous variables were standardized using the mean, and heteroskedasticity was addressed using robust standard errors.

Topics Needing Additional Research:

The theory specifically highlights behavioral-environmental sustainability methods as a component of sustainable development. This study examines the connection between Generation Z's internet behaviors and ecological practices. It is predicated on the idea that the same cognitive processes—motivation, self-control, and focus—affect daily behavioral efficacy in both domains.

We proposed five theories:

Standard sustainable practices like recycling, reusing, and cutting back on consumption are part of a cohesive framework of behavioral sustainability. The unique behavioral patterns that appear reflect a variety of viewpoints on sustainability and digital balance (H2). In the end, environmental responsibility behaviors are indicated by social and demographic factors like age, gender, place of residence, and level of education. It is expected that urban dwellers, particularly young women, will participate more enthusiastically. According to the fourth hypothesis, which proposes a behavioral compromise between digital

intensity and sustainability, increased digital engagement, weariness, and problematic usage negatively impact sustainable behaviors.

Fifth Hypothesis:

People who have a better understanding of technology and sustainability are less vulnerable to cognitive strain, which mitigates the negative impacts of digital fatigue on sustainable activities. In the end, these ideas show how young people's behaviors and viewpoints affect the sustainability process in connection to their digital experiences.

Expected Use:

By using the concept of efficiency in human cognition and behavior, this program promotes social science and sustainability. By combining sustainable behaviors with digital health, it provides a fresh viewpoint on the complex balance that young people must strike between environmental stewardship and digital involvement.
It is proposed that a conceptual framework for behavioral sustainability connects digital interactions, cognitive processes, and sustainable habits by combining theoretical understanding with real-world implementations.

Using the information acquired, the study:

Assesses Generation Z's ability to sustain habits over time and clarifies how weariness and digital engagement affect eco-friendly behavior.
evaluates the effects of demographic traits on adolescent behavior.
creates educational programs with an emphasis on sustainability and digital harmony.
The passage emphasizes the need of digital health and sustainability education as essential components of a fair energy transition, viewing the shift as ultimately a social and cognitive undertaking.

Quantitative Analysis and Findings:

The explanation of the empirical results is supported by the study's main hypotheses. Investigating the connections between digital engagement, cognitive characteristics, sustainable practices, and sociodemographic factors was the aim of the study. By offering a thorough summary of how Generation Z manages a digital life while maintaining ecological consciousness, the findings advance our knowledge of young people's digital health and sustainability literacy.

Measurement Verification and Summary Statistics:

Principal component analysis (PCA) was used to analyze four sustainability-related factors: waste classification, repurposing, purchasing used items, and reducing consumption frequency. The results show that 61.8% of the total variation may be explained by a unidimensional factor solution.

All four variables, which showed significant loadings on this factor ($\lambda = 0.74$-0.88), revolve on regularly taking acts that have a good impact on the environment. This led to the creation of a metric called the Sustainability Behavior Index (SBI). This measure evaluates how frequently people adopt sustainable habits.

This dimension's internal consistency (Cronbach's $\alpha = 0.83$) confirmed its robustness and dependability, indicating that more research is warranted. The next stage was classifying the participants according to how involved they were in sustainability. The best clustering solution is obtained at $k = 3$ (silhouette = 0.47) throughout the range of $k = 2$–6, allowing for easy-to-understand segmentation.

The profiles that emerged were:

You will come across environmentalists that are actively involved in sustainability projects in Cluster 1. Members of Cluster 2 demonstrate selective behavior and recycle to a limited degree. People in Cluster 3, the Passive, devote more money overall but show less commitment to sustainability.

This development opens the door to more comparisons and supports the notion that millennials and Generation Z have different perspectives on environmental issues. Regression analysis was used to look at the sociodemographic characteristics impacting sustainable behavior. The robust OLS model showed statistical significance ($F = 9.84$, $p < 0.001$) and explained around 16.4% of the variability in SBI. Gender was the main factor responsible for the significant difference in sustainability scores between males and females ($\beta = 4.67$, $p = 0.011$). Additionally, being in an urban region had a beneficial influence ($\beta = 3.94$, $p = 0.013$) and there was a minor rise in age ($\beta = 0.18$, $p = 0.039$). These results corroborate previous sociological research showing that eco-friendly infrastructure, educational opportunities, and normative influences all work together to increase urban women's and young people's engagement with sustainability.

Table 2. Reported principal findings

Analysis / predictor	**Reported result**
Demographic OLS model	$F = 9.84$; $p < 0.001$; $R^2 \approx 0.164$
Demographic model: gender	$\beta = 4.67$; $p = 0.011$
Demographic model: urban residence	$\beta = 3.94$; $p = 0.013$
Digital-predictor OLS model	$R^2 = 0.289$
Digital fatigue (WNS)	$\beta = -9.84$; $p < 0.001$
Problematic use (WPU)	$\beta = -6.35$; $p < 0.001$
Education × digital fatigue	$\beta = 0.43$; $p = 0.002$
Selected clustering solution	$k = 3$; silhouette = 0.47

Multinomial logistic regression was used to predict membership across the three clusters using the Eco-Active group as a baseline, making it easier to analyze more intricate patterns.

Males were substantially more likely to be categorized as passive consumers ($OR = 2.13$, $p = 0.001$). Compared to a rural setting, living in an urban area reduced the likelihood of being categorized as a Moderate Participant ($OR = 0.62$, $p = 0.041$). Age and sustainability involvement did not statistically significantly correlate, indicating that maturity has no bearing on this particular subset of Generation Z. The findings highlight the importance of housing conditions and gender as distinct factors influencing young people's sustainability traits.

Urban locations and age strongly predicted women's greater sustainability engagement ($\beta = 3.53$, $p = 0.048$; $\beta = 0.20$, $p = 0.046$). Living in an urban setting also had a substantial favorable effect on males ($\beta = 4.12$, $p = 0.032$), but the effect of age was relatively smaller ($p = 0.081$). Environmental motivation and behavioral consistency may be gender-specific, suggesting that improved communication and education catered to different motivating patterns are crucial.

Inferential Analysis: Behavioral Archetypes, Determinants, and Cognitive-Digital Interactions:

The suggested connection between digital engagement and sustainability was investigated using correlation analysis. The results showed that lower sustainable behavior ($r = -0.09$ to -0.33) and higher problematic use (WPU; $r = 0.30$-0.41) were linked to greater digital intensity (WZC) and weariness (WNS). All of these correlations point to the same conclusion: prolonged screen time causes fatigue, weakened self-control, and decreased interest in eco-friendly behaviors. The results provide empirical evidence for cognitive-resource dispersion, implying that our ability to function thoughtfully and sustainably is diminished by excessive digital media stimulation.

The results of the Principal Component Analysis using the digital-behavioral indicators (WZC, WNS, WPU, and WRH) and the Sustainability Behavior Index (SBI). More than 65% of the variation was caused by two main factors. With strong positive connections with digital intensity and weak correlations with SBI, the first section showed a balance between

sustainability and digital weariness. The latter category, where WRH performed exceptionally well, dealt with a risk-related aspect of digital behavior.

By showing that digital and sustainable behaviors are related but separate realms, this foundational structure supports the study's theoretical approach. The theoretical framework's suggested cognitive and behavioral trade-off is supported by strong empirical data, as demonstrated by the inverse relationship between digital involvement and SBI. To further examine these effects, we created a strong OLS model.

The explanatory capacity was significantly enhanced by the addition of digital-behavioral predictors (R2 = 0.289). All four indicators had negative coefficients: The results for WZC ($\beta = -0.91$, $p < 0.001$) are significant; the WNS data set ($\beta = -9.84$, $p < 0.001$) and WPU ($\beta = -6.35$, $p < 0.001$). Head in the opposite direction ($\beta = -1.84$, $p = 0.033$).

These results show that impulsive behavior, mental exhaustion, and digital saturation are significant negative predictors of sustained involvement even after adjusting for gender, age, and geography.

According to the demographic analysis, urban students had relatively better sustainability ratings ($\beta = 2.12$, $p = 0.032$), whereas male participants had significantly lower scores ($\beta = -3.21$, $p = 0.002$). According to the approach, a key factor in evaluating young people's engagement in sustainable behaviors is their ability to self-regulate in digital contexts. Lastly, a moderation study was conducted to see whether educational attainment, as indicated by class year, may mitigate the negative effects of digital exhaustion (WNS) on sustainable behavior.

The negative impacts of digital weariness on sustainability involvement are mitigated by educational advancement, according to the significant and positive interaction term WNS × Class_year ($\beta = 0.43$, $p = 0.002$). This pattern implies that when students have a strong education and a thorough understanding of sustainability principles, they are better equipped to maintain sustainable practices despite increased digital engagement. This finding lends credence to the idea that improving energy management and focus skills could lessen the cognitive strain brought on by prolonged online use.

Final Thoughts and Results:

Each analysis's basic hypothesis is supported by the findings. Social environment (gender, geography, education) and cognitive-digital elements (fatigue, problematic usage) build the cohesive framework of sustainable behavior within Generation Z. The behavioral trade-off between digital involvement and sustainability emphasis revealed by statistics is an important result that highlights the psychological aspect of sustainability in the digital era. From a social science standpoint, these findings highlight how important it is for sustainability programs to include instruction on digital well-being. Improving pupils' self-regulation abilities, critical media consumption, and cognitive balance seems to be necessary to foster long-lasting sustainable citizenship in children.

Discussion:

The emphasis here is on environmental sustainability measures, which are theoretically crucial to social and economic sustainability but are seen in isolation from it. The purpose of this study was to investigate the connections between digital lifestyles, sustainable habits, and cognitive resources in order to gain understanding of the behavioral sustainability of Generation Z. The results offer solid empirical support for the suggested behavioral-energy framework. Energy management encompasses both physical systems and everyday activities, processes, and digital interactions.

Interpretation of Important Results:

We can support the null hypothesis (H1) in light of these findings. Principal Component Analysis revealed that the four fundamental components of sustainability—waste segregation, reuse, thrift shopping, and consumption moderation—consolidated into a unified

structure known as the Sustainability Behavior Index (SBI). This lends credence to the idea of behavioral sustainability, which is characterized by a range of ecologically conscious behaviors.

Several studies have demonstrated that common psychological underpinnings, such as biospheric values, self-concept, and personal norms, frequently give rise to sustainable behaviors. This includes research by [29][30][31]. It makes sense to see these four behaviors as manifestations of a same underlying construct from both a theoretical and empirical standpoint.

Three distinct behavioral archetypes were effectively identified by using cluster analysis (H2):

Eco-active, moderate participant, and passive consumer. This lends credence to the notion that sustainable participation is a continuum rather than a binary issue. This categorization aligns with previous research on the segmentation of sustainable consumption. Three different consumer groups have been identified by dietary habit investigations: Doers, Conscious, and Reluctant [32]. Prior studies have distinguished between energy consumers motivated by convenience and those motivated by value. Similar kinds of attitudes, including environmental activists and passive participants, have been found in studies on ecological behavior. This result suggests that many intervention alternatives are required instead of a single strategy. According to the "Moderate" cluster, young people who support sustainability but do not act usually have limited or selective involvement.

Gender and geography are the main drivers of sustainability involvement in this group; age is not a significant sociodemographic variable. This study found that both city dwellers and female subjects had higher SBI scores, which is consistent with previous studies showing that women are more environmentally conscious and engage in eco-friendly activities [11] [33].

The claims of socialization theory, which holds that women are typically more concerned with their own and their communities' wellbeing, are consistent with this gender disparity. According to research by [34][35][36], social norms and environmental infrastructure encourage urban residents to participate more in sustainability initiatives. Males were more often categorized as "Passive Consumers," according to the multinomial regression analysis, which confirmed the persistent gender gap in environmental accountability.

The strongest evidence backs up hypothesis H4, which connects digital engagement with sustainability. The negative correlations and regression coefficients of the digital-energy variables (WZC, WNS, WPU, and WRH) indicate that higher levels of digital intensity and cognitive fatigue frequently result in lower participation in sustainability. The results support the cognitive energy dispersion theory, which holds that the mental and attentional demands of the digital world reduce the resources required to make deliberate, environmentally responsible decisions [15]. Studies on social media and cognitive fatigue have shown that excessive use of digital devices impairs focus and self-control. According to [37], multitasking reduces extended behavioral involvement and depletes cognitive resources. This supports previous research on digital distractions and cognitive labor.

The moderation study that supported H5 showed that a higher level of education lessens the negative relationship between digital weariness and sustainability. This result is consistent with previous studies showing that higher levels of education are associated with improved energy literacy and resilience when making decisions under cognitive load. According to research by [38][39][23][10], students who were exposed to sustainability education and had cognitive maturity showed higher environmental self-efficacy and were more resilient to digital overstimulation. As a result, education seems to have a protective role, encouraging self-control and maintaining long-term engagement in spite of digital tiredness.

Implications for Conceptual Structures and Real-World Uses:

The theoretical frameworks of behavioral energy economics, digital media studies, and environmental psychology are improved by this research. This finding shows that, in addition

to action and cognition, the idea of "energy" can describe human decision-making about conservation, efficiency, and utilization.

According to [40], this paradigm establishes a conceptual link between digital well-being and sustainability by identifying cognitive control as a crucial component of sustainable citizenship in the digital age.

The findings emphasize the necessity of incorporating behavioral segmentation and have important practical implications for sustainability education and policy. According to earlier energy studies, segmentation improves conservation efforts' effectiveness by matching treatments to specific behavioral profiles[41].

Given the found negative relationship between digital usage and sustainability, promoting digital sufficiency and digital well-being can reduce cognitive load and promote environmental accountability. Initiatives must focus on developing self-regulatory abilities in addition to instructional efforts in order to help youngsters manage their digital energy usage.

Furthermore, since education acts as a mediator, it is crucial to incorporate digital energy consciousness and critical assessment of the ecological effects of information and communication technology (ICT) into educational curricula [25]. Such integration would be consistent with the UN's larger program, Education for Sustainable Development.

Resolving the "educational paradox" requires both a decrease in digital interaction and a more effective use of technology. Examples include drawing attention to the hidden energy costs of digital ease, encouraging data-efficient behaviors like sharing cloud links instead of copying data, and optimizing storage.

Safety Measures and Upcoming Research Projects:

When evaluating the study's findings, it is important to recognize its methodological and contextual limitations. Initially, this cross-sectional data cannot be used to draw any inferences about the relationship between digital habits (such as weariness or problematic usage) and sustainable behaviors. Experimental or longitudinal research are necessary to understand the temporal dynamics and detect potential bidirectional interactions. What is the persistent conflict between sustainable behavior and digital engagement throughout generations, cultures, and eras in terms of cognitive resources? Longitudinal and experimental methods can help researchers investigate this question. Since Polish secondary school students were the only participants in this study, the results cannot be extended to a larger or more varied population. Future research should include comparative assessments that span various educational environments or segments of Generation Z across multiple nations, given the increasing importance of transnational digital landscapes [4].

Thirdly, reliance on self-reported measures may lead to issues with underreporting or social desirability bias; this is particularly problematic for sustainability programs. Combining self-reported data with empirical indicators, such as screen-time logs or learning analytics insights, could increase the evaluation's credibility. Even if the Sustainability Behavior Index (SBI) has strong psychometric qualities, more research is necessary to expand its scope to cover other crucial sustainability areas, such as domestic energy consumption, community participation in climate initiatives, and transportation.

Integrating behavioral data with system-level modeling techniques could benefit future study. In this way, we may link particular digital behaviors to shifts in global sustainability and comprehend how young people's small acts can have a big impact on the environment and energy systems [4]. Using mixed-method approaches could lead to a thorough understanding of digital sustainability. These methods would enhance existing energy and sustainability frameworks that use resource accounting, behavioral insights, and life-cycle assessment.

Conclusion:

This study adds to the growing body of information about the behavioral dimensions of sustainability by showing how maladaptive internet habits and digital weariness may prevent

teenagers from participating in pro-environmental activities. It provides an analytical method for identifying multidimensional behavioral characteristics and their relationships among juvenile groups using robust ordinary least squares regression and k-means clustering. Despite the fact that the majority of sustainability studies have ignored the impact of digital stress on traditional ecological practices, this underscores a gap in our understanding and expands on previous research about eco-behavioral segmentation.

The results improve our knowledge by showing that digital well-being is not just a theoretical problem but also very relevant to ecologically acceptable activities. This article offers proof that sustainability and digital presence are related rather than distinct concepts. It suggests that people, especially young people, may be less inclined to support environmental initiatives if they spend too much time online.

The evidence suggests that including digital wellbeing into sustainability education programs is crucial. In light of programs such as the EU's Digital Education Action Plan and the Green Comp competency framework, European governmental and educational institutions must strike a balance between excessive consumption and technological growth. Targeted initiatives, such as eco-digital literacy programs and digital wellness curricula, are available to help young people thrive in the modern digital landscape while staying dedicated to sustainable habits.

These findings demonstrate how important it is for educational institutions, tech developers, and legislators to work together to create digital environments that support mental health and sustainability in the face of continuous technological development. Students' transition from theoretical energy concepts to practical digital sustainability techniques can be greatly aided by research in STEM education and physics. Future research is necessary to fully understand the global movement toward sustainability, legislative reforms, and young online activity. Future research could supplement this method by incorporating social and economic sustainability components to improve the assessment of sustainable citizenship in the digital era.

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