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MODELING USER ENGAGEMENT AMONG YOUTH IN DIGITAL PLATFORMS: A MACHINE LEARNING APPROACH

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Abstract: As digital media becomes an integral part of daily life, young people are increasingly exposed to both opportunities and risks in online spaces. This study explores the factors that shape youth experiences with digital media, focusing on negative online behaviors such as exposure to fake information, cyberbullying, and digital peer pressure. Using a decision tree regression approach, we analyzed responses from 301 adolescents aged 11 to 17, identifying key predictors of negative online experiences. Results indicate that daily media consumption in leisure time, personal leisure and social activity importance, and parental media habits are among the strongest influencers of youth digital interactions. Findings highlight the need for targeted digital literacy initiatives and parental guidance strategies to foster safer online environments. This study contributes to understanding digital media's impact on youth and offers practical recommendations for educators, policymakers, and parents to support responsible media engagement and digital well-being among adolescents.

Keywords: Youth digital media, online experiences, decision tree regression, media literacy, cyber risks, parental media influence, youth online behavior, predictive modeling, digital well-being

1. INTRODUCTION

The rapid evolution of digital media has fundamentally transformed how young people engage with information, social interactions, and personal identity development [1]. While digital spaces provide opportunities for learning, creativity, and socialization, they also introduce significant risks, including exposure to misinformation, cyberbullying, and digital peer pressure [2], [3]. As adolescents become increasingly immersed in online environments, understanding the predictors of negative digital experiences becomes critical for educators, policymakers, and parents seeking to foster safe and responsible media usage among youth [4], [5].

Existing research highlights that digital literacy and parental influence play a crucial role in shaping young users' online behaviors. Studies have found that social media can impact psychological well-being in both positive and negative ways, depending on the intensity and nature of engagement [6]. Some scholars argue

that increased social media use enhances digital competency and awareness of online risks, while others suggest that excessive exposure heightens vulnerability to harmful experiences, such as cyberbullying and compulsive usage patterns [7], [8]. Additionally, problematic social media use has been linked to emotional dysregulation and psychological distress, further complicating the relationship between online behavior and mental health [9].

Predictive modeling techniques, such as decision tree regression, offer valuable insights into the factors that contribute to youth experiences in digital spaces. By analyzing patterns in online behavior, researchers can identify key predictors of negative digital interactions, ranging from personal media consumption habits to parental media engagement [10]. This study employs a decision tree regression approach to examine how various digital habits and contextual factors influence adolescents' encounters with negative online experiences.

Thus, this research seeks to answer the following question: *Which factors most accurately predict negative online experiences among adolescents, and how do digital media consumption habits shape these interactions?*

2. METHODS

2.1 Participants

The study included a sample of 301 adolescents aged between 11 and 17 years old. Participants were recruited from various educational institutions to ensure a diverse representation of youth experiences in digital spaces. The sample was nearly evenly distributed across age groups, with the largest proportion of participants being 13 years old (15.0%) and 14 years old (15.3%). The majority of participants resided in urban areas (82.3%), while a smaller percentage (12.7%) were from rural areas, and 5.0% did not specify their residence. In terms of gender distribution, 48.3% of the respondents identified as male, 49.7% as female, and 2.0% chose not to disclose their gender. The participants were enrolled in various educational levels, with the highest representation from seventh-grade students (36.0%), followed by sixth (24.0%) and eighth-grade students (20.0%), as seen in Table 1.

Table 1

Participants characteristics				
Category	Frequency	Percent	Valid Percent	Cumulative Percent
Age				
11 years	44	14.6	14.6	14.6
12 years	43	14.3	14.3	28.9
13 years	45	15	15	43.9
14 years	46	15.3	15.3	59.2
15 years	40	13.3	13.3	72.5
16 years	42	14	14	86.5
17 years	41	13.6	13.6	100
Residence				
Rural	38	12.6	12.7	12.7
Urban	246	81.7	82.3	95
I don't know	15	5	5	100
Gender				
Male	145	48.2	48.3	48.3
Female	149	49.5	49.7	98

Not disclosing	6	2	2	100
Class				
5th	47	15.6	15.7	15.7
6th	72	23.9	24	39.7
7th	108	35.9	36	75.7
8th	60	19.9	20	95.7
9th	11	3.7	3.7	99.3
10th	1	0.3	0.3	99.7
11th	1	0.3	0.3	100

Participation in the study was voluntary. Informed consent was obtained from both the participants and their parents or legal guardians before data collection, ensuring that all ethical guidelines for research involving minors were met. Participants were assured of anonymity, and they were informed that they could withdraw from the study at any time without consequences.

2.2 Instruments

Data collection was conducted using a structured questionnaire that included validated scales to assess digital behaviors, media consumption habits, and experiences with online risks. The questionnaire comprised several measures. Daily media consumption in spare time was assessed using a 9-item scale rated on a 6-point Likert scale ($\alpha = .701$), which measured the frequency of media usage across different platforms such as gaming consoles and social networks. Parental media consumption in spare time was measured with a similar 9-item, 6-point Likert scale ($\alpha = .741$) evaluating parents' digital habits, including smartphone use. Perceptions of parental media consumption were assessed through a single-item 5-point scale measuring how participants viewed their parents' media engagement, while another single-item scale examined their emotional response to their parents' media habits. Experiences with negative online behaviors were measured using a 7-item, 5-point Likert scale ($\alpha = .729$), capturing instances of exposure to cyberbullying, misinformation, and other online risks. Additionally, a single-item measure assessed participants' emotional responses after engaging with social media. Personal leisure and social activities importance was measured using

a 9-item, 10-point scale ($\alpha = .706$), capturing the significance of activities such as social networking and recreational screen time. Finally, media literacy and digital competency were assessed using a 9-item, 5-point scale ($\alpha = .856$) measuring self-reported digital knowledge and media literacy skills.

2.3 Procedure

This study employed a decision tree regression analysis using JASP to identify key predictors of negative online experiences among adolescents. The dependent variable was experiences with negative online behaviors, while independent variables included daily media consumption, personal leisure and social activity importance, parental media habits, media literacy, and demographic characteristics such as residence, gender, and class. To enhance model accuracy and reliability, a train-test split approach was implemented, with 227 cases allocated for training and 56 cases reserved for testing. The decision tree algorithm identified the most influential predictors of negative online experiences by iteratively splitting the dataset based on variable importance, optimizing predictive accuracy.

The performance of the model was evaluated using statistical measures, including mean squared error (MSE), root mean squared error (RMSE), mean absolute error (MAE), mean absolute percentage error (MAPE), and R^2 values. Additionally, a feature importance analysis was conducted to determine the most significant contributors to negative online experiences, offering insights into the interplay between media consumption habits, digital literacy, and exposure to online risks.

3. RESULTS AND DISCUSSION

3.1. Results

The analysis examined the descriptive statistics of key variables related to adolescents' digital behaviors, media consumption patterns, and experiences with negative online interactions. The results provide insights into the frequency and importance of media use, perceptions of parental influence, and levels of

media literacy among participants, depicted in Table 2.

Table 2

Scales and single items descriptive statistics

	Valid	Missing	Mean	Std. Dev.	Min.	Max.
Daily media consumption in spare time	301	0	2	0.729	0	6
Parent media consumption in their spare time	301	0	1.713	0.689	0	5.444
Perception about parent media consumption	295	6	3.976	0.863	1	5
Feelings about parent media consumption	288	13	3.969	0.802	1	5
Experiences with negative online behaviors	301	0	1.869	0.63	0.143	4.429
Post social network experience	276	25	4.163	0.844	1	5
Personal leisure and social activities importance	301	0	7.047	1.469	0.667	10
Media literacy and digital competency	301	0	3.504	1.056	0	5

On average, participants reported a daily media consumption in spare time of 2.00 (SD = 0.73) on a 6-point scale, indicating moderate engagement with digital media. Similarly, parental media consumption in spare time had a mean score of 1.71 (SD = 0.69), suggesting slightly lower digital engagement among parents compared to their children. Adolescents' perception of parental media consumption was generally neutral to positive, with a mean score of 3.98 (SD = 0.86) on a 5-point scale, and their

feelings about parental media consumption were similar, averaging 3.97 (SD = 0.80).

Participants' experiences with negative online behaviors, such as cyberbullying or misinformation, were reported at a relatively low level, with a mean score of 1.87 (SD = 0.63) on a 5-point scale. However, despite exposure to negative online behaviors, participants' post social network experience was predominantly positive, with a mean of 4.16 (SD = 0.84), indicating that most adolescents felt good after engaging with social media platforms.

Regarding the importance of online and offline activities, personal leisure and social activities importance received a relatively high mean score of 7.05 (SD = 1.47) on a 10-point scale, indicating that participants valued social interactions and leisure activities. Finally, media literacy and digital competency, which assessed participants' self-reported digital knowledge, had a mean score of 3.50 (SD = 1.05) on a 5-point scale, suggesting moderate confidence in digital literacy skills among adolescents.

These findings highlight the complexity of digital engagement among youth, where moderate to high media consumption coexists with relatively positive perceptions of social media use and parental influence. However, the presence of negative online experiences suggests the need for further examination of the factors influencing digital well-being and the role of parental guidance and media literacy in shaping adolescents' online experiences.

To examine the key predictors of adolescents' negative online experiences, a decision tree regression model was applied. This machine learning technique was used to analyze relationships between various predictor variables (e.g., media consumption, parental influence, media literacy) and the dependent variable (experiences with negative online behaviors). The decision tree model was trained and tested using a train-test split approach, ensuring that the model's predictive accuracy could be evaluated on unseen data.

The splitting strategy in the decision tree regression process determines how the dataset is divided into branches based on variable importance. In this case, the model was trained on 227 cases and tested on 56 cases, meaning approximately 80% of the dataset was allocated

for training and 20% for testing. This approach prevents overfitting by ensuring that the model is not learning patterns from the training data alone but is also tested for generalizability on new, unseen data.

To assess the performance of the decision tree regression model, several evaluation metrics were computed, including Mean Squared Error (MSE), Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), and R^2 (coefficient of determination). These metrics provide insight into the accuracy and predictive strength of the model and are depicted in Table 3.

Table 3

Evaluation Metrics	
	Value
MSE	0.811
RMSE	0.901
MAE / MAD	0.731
MAPE	220.46%
R^2	0.144

The evaluation metrics indicate that the decision tree regression model captures meaningful relationships but has limitations in predictive accuracy. The MSE (0.811) and RMSE (0.901) suggest moderate prediction accuracy, though some variance remains unaccounted for. The MAE (0.731) confirms the presence of errors, albeit within a reasonable range. However, the MAPE (220.46%) highlights challenges in absolute precision, likely due to variability in individual experiences with negative online behaviors. The R^2 value (0.144) indicates that only 14.4% of the variance in negative online experiences is explained by the model, suggesting that additional behavioral or psychological variables could enhance its explanatory power. While the model successfully identifies key predictors, its accuracy could be improved through further optimization and feature selection.

The decision tree regression model identified the most significant predictors of adolescents' experiences with negative online behaviors by assessing the relative importance of each independent variable. Feature importance

represents the contribution of each variable to the model's predictive accuracy, with higher values indicating stronger predictive power, as presented in Table 4.

Table 4

Feature Importance	
	Relative Importance
Daily media consumption in spare time	33.756
Personal leisure and social activities importance	14.83
Parent media consumption in their spare time	10.426
Media literacy and digital competency	9.885
Residence	9.732
Feelings about parent media consumption	7.823
Perception about parent media consumption	7.78
Class	3.794
Gender	1.974

The next most important factors were picture and video media importance in the family (12.640), script-based media importance in family (10.506), and voice and audio media importance in family (9.820), suggesting that different forms of media engagement within the household play a crucial role in shaping children's digital behaviors. Time limits rule (9.161) also showed notable importance, indicating that parental restrictions on screen time contribute to differences in media consumption.

Other moderately important predictors included child daily media consumption (7.657) and feeling about own media consumption at work (6.471), which suggest a potential link between parents' own digital habits and their children's engagement with media. In contrast, variables such as mutual agreements (2.237) and parental media control type (1.842) had lower relative importance, suggesting that while parental regulation strategies matter, they may not be as decisive as perceptions and media exposure at home. Lower-ranked features, including analog home media use (0.711), software control (0.684), and media-free family

activity (0.264), suggest that explicit parental restrictions and structured media-free time play a lesser role in predicting child media consumption compared to parental perceptions and overall household media exposure. These findings underscore the complexity of digital parenting and suggest that a combination of parental attitudes, household media culture, and specific regulatory strategies contribute to children's media behaviors. The predictive performance plot (Figure 1) provides a visual representation of the model's accuracy in estimating child media consumption based on parental factors. This plot illustrates the alignment between observed and predicted values, highlighting the model's ability to capture underlying patterns while also indicating the presence of some variance that remains unexplained.

The most influential predictor was daily media consumption in spare time, with a relative importance of 33.756. This suggests that the amount of time adolescents spend on digital media plays a crucial role in shaping their exposure to negative online experiences. Higher media engagement may increase the likelihood of encountering harmful content, misinformation, or cyberbullying.

The second most important predictor was personal leisure and social activities importance (14.830). This finding highlights the role of adolescents' attitudes toward social activities, indicating that those who place a higher value on leisure and social interactions—both online and offline—may have different exposure levels or coping mechanisms related to negative online experiences. Parental media consumption in spare time (10.426) also emerged as a significant factor, reinforcing the idea that parents' digital habits influence their children's online experiences. Adolescents whose parents engage frequently with media may either adopt similar behaviors or be affected by the degree of parental supervision and digital guidance.

Media literacy and digital competency (9.885) ranked fourth in importance, suggesting that a higher level of media literacy might mitigate the risks associated with online exposure. This aligns with prior research indicating that digital competence can serve as a

protective factor against online threats such as misinformation and cyberbullying.

Residence (9.732) was another relevant predictor, indicating that an adolescent's living environment—urban or rural—may influence their digital engagement and subsequent online experiences. Differences in internet access, digital education, and parental supervision across urban and rural areas could contribute to variations in exposure to online risks.

Feelings about parental media consumption (7.823) and perception about parental media consumption (7.780) were also notable predictors, underscoring the psychological dimension of adolescents' views on their parents' media use. Adolescents who perceive their parents' media habits negatively may either mirror these behaviors or experience greater digital risks due to limited guidance or emotional detachment.

Class level (3.794) and gender (1.974) were the least influential factors. While educational level might play a minor role in shaping online experiences, gender differences in negative digital experiences appeared to be less pronounced in this study. This could suggest that both male and female adolescents encounter similar online risks, or that gender-specific patterns of digital engagement require more nuanced analysis.

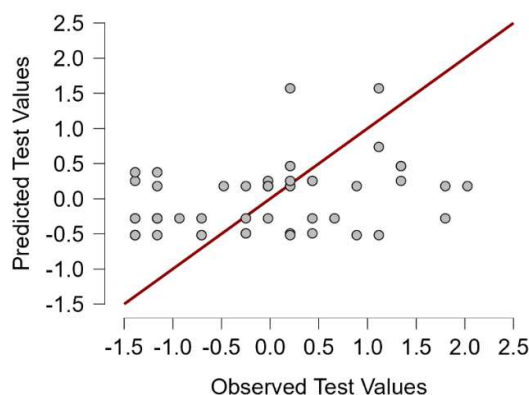


Fig. 1. Predictive Performance Plot

To further illustrate the effectiveness of the decision tree regression model, Figure 1 presents the predictive performance plot, which visualizes the relationship between actual and predicted values of negative online experiences. The plot provides insight into how well the

model captures the variability in the data, with closer alignment between actual and predicted values indicating better predictive accuracy. Given the moderate performance metrics reported earlier (e.g., $MSE = 0.811$, $R^2 = 0.144$), the plot likely reveals some degree of deviation between predicted and actual outcomes, suggesting that while the model identifies meaningful patterns, additional refinement may be necessary for greater predictive precision.

Figure 2 displays the decision tree plot, illustrating the hierarchical structure of the model's decision-making process. The tree diagram highlights how the dataset was split at different levels based on the most significant predictors, beginning with the most influential variable—daily media consumption in spare time—at the root node. Subsequent branches represent additional splits determined by other important predictors, such as personal leisure and social activities importance, parental media consumption, and media literacy. Each terminal node (leaf) in the tree represents a predicted outcome for a specific combination of predictor values, offering a clear visual representation of how different digital behaviors and contextual factors contribute to negative online experiences.

The decision tree regression model visualized in Figure 2 provides a structured breakdown of the key predictors influencing adolescents' experiences with negative online behaviors. The tree is constructed using a hierarchical approach, with daily media consumption in spare time serving as the most significant predictor at the root node ($n = 227$). This confirms that the amount of time adolescents spend on digital media is the most critical factor influencing their exposure to negative online experiences.

The first major split occurs at a threshold of 0.977 for daily media consumption in spare time. Adolescents who consume less media than this threshold are further classified based on media literacy and digital competency ($n = 198$), suggesting that digital literacy moderates the relationship between media consumption and online risks. Those with low media literacy (below 0.11) are further split based on their personal leisure and social activities importance ($n = 93$), indicating that adolescents who engage

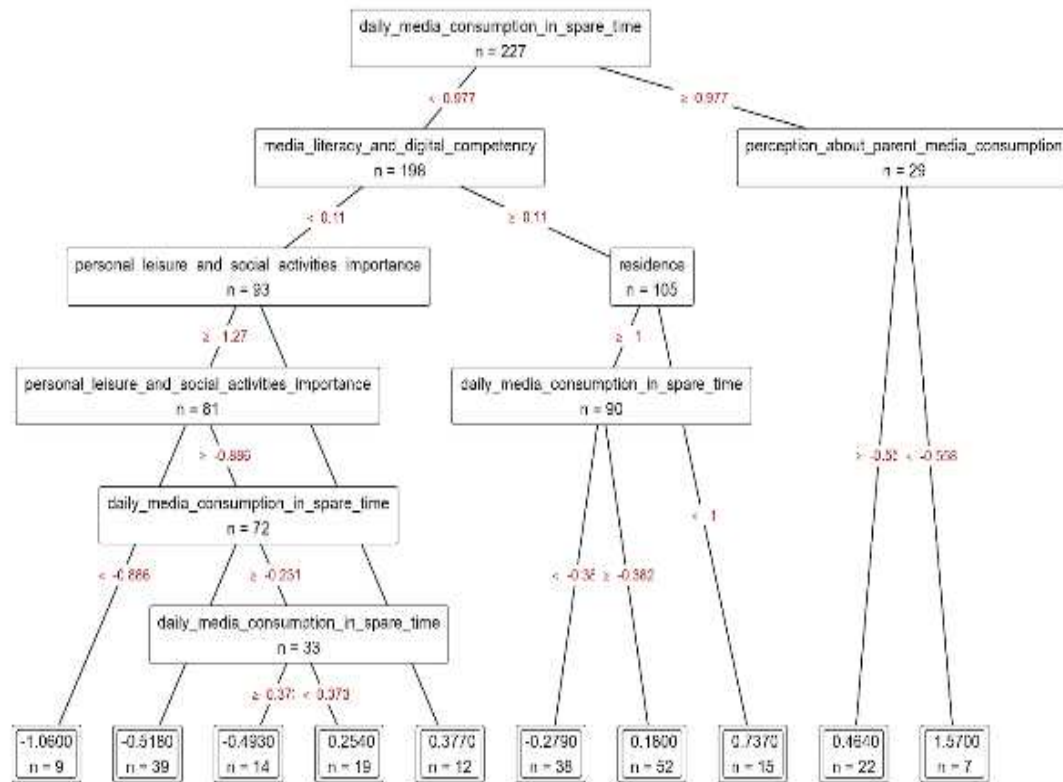


Fig. 2. Decision Tree Plot

less in offline social activities may be more vulnerable to negative digital interactions.

Among this group, individuals who rate personal leisure and social activities importance below -1.27 are further classified into another sub-group based on the same variable ($n = 81$). This subgroup is split again by daily media consumption in spare time, which indicates that both high and low engagement in leisure activities, combined with excessive digital media use, can influence online risk exposure. The final leaf nodes show the predicted values of negative online experiences, with values ranging from -1.0600 ($n = 9$) to 0.3770 ($n = 12$). Negative values represent lower exposure to online risks, while positive values indicate higher exposure.

For adolescents with daily media consumption in spare time above 0.977, the next significant predictor is their perception about parent media consumption ($n = 29$). This split suggests that how adolescents perceive their parents' digital habits influences their own

digital behaviors. A further division occurs between those with perception scores below -0.55 and those above -0.558, leading to leaf nodes with predicted negative online experience values ranging from 0.4640 ($n = 22$) to 1.5700 ($n = 7$). The highest predicted risk of negative online experiences (1.5700) appears in adolescents who consume high amounts of digital media and have a negative perception of their parents' media consumption.

For those with daily media consumption below 0.977 but with higher media literacy and digital competency (≥ 0.11), the next key predictor is residence ($n = 105$). Adolescents from rural and urban areas are classified differently, suggesting that living environment plays a role in shaping digital behaviors and risk exposure. Within this branch, another split based on daily media consumption in spare time ($n = 90$) occurs at a threshold of -1, with further branches dividing individuals based on smaller consumption thresholds (-0.38 and -0.382).

The final predicted values range from -0.2790 ($n = 38$) to 0.7370 ($n = 15$), indicating variations in risk exposure depending on both location and digital consumption habits.

3.2. Discussion

The findings of this study provide important insights into the factors influencing adolescents' negative online experiences, particularly in relation to media consumption habits, parental influence, and digital literacy. The decision tree regression model identified daily media consumption in spare time as the most significant predictor, highlighting the role of digital engagement in shaping online interactions. This aligns with previous research indicating that prolonged exposure to digital platforms increases the likelihood of encountering cyber risks such as cyberbullying, misinformation, and digital peer pressure [11]. Adolescents who spend excessive time online may be more vulnerable to these risks due to increased exposure to unregulated content, interactions with unknown individuals, and reduced parental supervision.

Additionally, media literacy and digital competency emerged as critical moderators of negative online experiences. Adolescents with higher levels of digital literacy demonstrated lower exposure to harmful online behaviors, suggesting that enhancing digital education can serve as a protective factor [12]. This finding aligns with broader discussions on digital citizenship, emphasizing the need for formal educational interventions that teach critical thinking, online ethics, and responsible media engagement. Programs that integrate digital literacy into school curricula may help mitigate the risks associated with online engagement by equipping students with the necessary skills to navigate digital spaces safely.

Another key finding was the influence of parental media consumption habits and adolescents' perceptions of them on online experiences. Adolescents who held negative perceptions of their parents' media use were more likely to experience cyber risks, reinforcing the social-ecological model of cyberbullying, which suggests that family dynamics significantly impact digital behavior patterns [13]. This underscores the importance

of parental mediation and co-use strategies, where parents actively engage in discussions about online safety, model responsible media behaviors, and set appropriate digital boundaries. Without such interventions, adolescents may develop distrust toward parental guidance, leading to riskier online behaviors and diminished self-regulation in digital spaces.

The study also found that personal leisure and social activities importance played a significant role in predicting negative online behaviors. Adolescents who placed greater emphasis on offline social activities appeared to be less affected by digital risks, supporting previous findings that higher engagement in offline physical and social activities reduces the impact of cyber risks [14]. Encouraging adolescents to participate in extracurricular activities, sports, and in-person socialization may provide alternative coping mechanisms and reduce excessive dependency on digital interactions, ultimately fostering a healthier balance between online and offline experiences.

Finally, residence was also identified as a relevant predictor, indicating potential differences in digital exposure based on urban versus rural settings. Adolescents in urban areas may experience greater digital connectivity and access, but also higher exposure to cyber risks due to increased online engagement and peer influence. Conversely, rural adolescents might have limited exposure to digital risks due to restricted internet access, but they may also face barriers in accessing digital literacy education, further emphasizing the need for context-specific interventions tailored to different geographic settings.

4. CONCLUSION

This study contributes to the growing body of research on youth digital experiences and cyber risks by identifying key predictors of negative online behaviors through a decision tree regression model. The results highlight the complex interplay between media consumption, digital literacy, parental influence, and offline social engagement in shaping adolescents' vulnerability to cyber risks. While digital media is an integral part of modern youth culture, its

unregulated and excessive use can heighten exposure to online threats, necessitating targeted interventions to promote safer digital behaviors.

The findings suggest that enhancing digital literacy education, fostering parental engagement, and promoting balanced online-offline activities are essential strategies for mitigating negative online experiences. Schools should integrate structured digital literacy programs, equipping students with critical thinking skills to navigate online environments responsibly. Parents should adopt active mediation strategies, including open discussions about online safety, role modeling responsible media use, and establishing clear digital boundaries. Additionally, promoting offline socialization through extracurricular activities can provide adolescents with alternative forms of engagement, reducing the overreliance on digital interactions. Future research should explore additional variables, such as psychological factors (e.g., self-esteem, anxiety, peer influence) and technological behaviors (e.g., algorithm-driven content exposure, engagement patterns on different platforms), to refine predictive models of cyber risks. Longitudinal studies could also track changes in digital behaviors over time, offering deeper insights into how adolescents' online experiences evolve. Ultimately, this study underscores the importance of a multi-faceted approach—combining education, parental support, and social interventions—to foster safer and healthier digital environments for youth.

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Modelarea implicării utilizatorilor tineri în platformele digitale: o abordare de învățare automată

Pe măsură ce mediile digitale devin o parte integrantă a vieții cotidiene, tinerii sunt din ce în ce mai expuși atât oportunităților, cât și riscurilor din spațiile online. Acest studiu explorează factorii care modelează experiențele tinerilor cu mediile digitale, concentrându-se asupra comportamentelor online negative, cum ar fi expunerea la informații false, cyberbullying și presiunea digitală a colegilor. Folosind o abordare de regresie a arborelui decizional, am analizat răspunsurile de la 301 adolescenți cu vârste cuprinse între 11 și 17 ani, identificând predictorii cheie ai experiențelor online negative. Rezultatele indică faptul că consumul zilnic de media în timpul liber, timpul liber personal și importanța activității sociale și obiceiurile media ale părinților sunt printre cei mai puternici influențatori ai interacțiunilor digitale ale tinerilor. Constatările evidențiază necesitatea unor inițiative specifice de alfabetizare digitală și a unor strategii de orientare parentală pentru a promova medii online mai sigure. Acest studiu contribuie la înțelegerea impactului media digitale asupra tinerilor și oferă recomandări practice pentru educatori, factorii de decizie politică și părinți pentru a sprijini implicarea responsabilă în media și bunăstarea digitală în rândul adolescenților.

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