Examining the Impact of AI-Enhanced Social Media Content on Adolescent Well-being in the Digital Age

Aisha Kashif[1], Saima Hassan[2], Aasim Munir Dad[3], Mubasher H Malik[4], Marhaba Rana[5], Shafiq Ur Rehman[6], Mahmoud Allahham[7], Ricardo Verschueren[8], Stephanie Ness[9]

Abstract

In the digital age, the impact of social media on adolescent well-being is a growing concern. This study investigated the influence of AI-analysed Social Media Content, Digital Literacy, Parental Monitoring of Social Media Use, and Social Media Engagement on Adolescent Well-being and Depressive Symptoms., Data was collected from 398 adolescents in Pakistan through a structured questionnaire survey., Four hypotheses were tested to examine these relationships., The findings highlighted that positive online content positively affected Adolescent Well-being, emphasizing the importance of promoting such content for better mental health., However, digital literacy had a negative impact, highlighting the need for critical online content evaluation while avoiding potential harm., Parental monitoring was found to have a positive association with Adolescent Well-being, acting as a buffer against harmful online content., Conversely, excessive Social Media Engagement negatively affects Adolescent Well-being, leading to isolation and anxiety., This study contributes by explaining the complex links between social media engagement and adolescent well-being, emphasizing the need for promoting positive content, enhancing digital literacy, and encouraging parental involvement to support adolescents in the digital era., Policy implications include the promotion of positive online content, the development of effective digital literacy programs, and support for parental involvement to safeguard adolescent well-being in the digital age.

Keywords: *online, social media, adolescent well-being, depressive symptoms, AI analysis, digital literacy, parental monitoring, social media engagement, mental health, digital age, policy implications.*

Introduction

Globally, the digital landscape is rapidly evolving, profoundly impacting the lives of adolescents (Shutaleva, Kuzminykh, & Novgorodtseva, 2023)., Studies indicate that over 95% of teenagers have access to a smartphone, and nearly 45% are online 'almost constantly'(Vaterlaus, Aylward, Tarabochia, & Martin, 2021)., This digital revolution, while offering unparalleled access to information and social connection, also raises concerns about mental health (Pandya & Lodha, 2021)., Research shows a correlation between excessive social media use and increased risks of

[1] Assistant Professor, University of Lahore, Email: Aisha.kashif@lbs.uol.edu.pk
[2] National College of Business Administration and Economics, Punjab, Pakistan Email: saimahassan@ncbae.edu.pk
[3] MCIM, Market Consultant, Email: aasimmunir@hotmail.com
[4], Vision Linguistics and Machine Intelligence Research Lab, Email: mubasher@isp.edu.pk
[5] Lecturer in Sociology, Department of Sociology, Govt. Graduate College of Science, Wahdat Road Lahore. Email: ranamarhaba@gmail.com
Orcid Id: 0009-0008-2228-5138
[6] University of Utara Malaysia, (correspondence) Email: Shafiq.rehman321@gmail.com
[7] Department of Business Administration, Faculty of Business, Middle East University (MEU), Amman 11831 Jordan, Email: m.allahham@ltuc.com
[8] University of Gloucestershire, Email: Ric.verschueren@gmail.com
[9] Diplomatische Akademie, Email: ness.stephanie@gmail.com

anxiety and depression among young people (Jolliff, Moreno, & D'Angelo, 2020)., The advent of AI-analyzed content on these platforms further complicates this relationship, as algorithms curate and present content that can significantly influence mood and well-being(Jolliff et al., 2020).

In Pakistan, the scenario is new yet increasingly reflective of these global trends., With over 60% of its population under the age of 30 and growing internet penetration, Pakistan's youth are actively engaging in the digital world (Pakistan Telecommunication Authority, 2020)., However, this surge in digital engagement comes with its challenges., Studies within the country point to rising levels of online addiction, cyberbullying, and a notable impact on mental health, particularly among adolescents(Saleem, Khan, & Zafar, 2021)., The Pakistani context, with its unique cultural and social dynamics, provides a fertile ground for exploring how AI-driven social media content affects young minds.

Turning our focus to the core of this study, the concept of 'well-being' in adolescents, first defined by Huynh and Fuligni (2010), encompasses various aspects of mental health, including emotional, psychological, and social well-being., In the backdrop of the digital age, understanding this well-being becomes crucial, especially as it relates to the omnipresent influence of social media(Nguyen, Büchi, & Geber, 2022).

Well-being, particularly in adolescents, emerges as a crucial concern in the context of increasing digital engagement (Dienlin & Johannes, 2020)., Globally and in Pakistan, unchecked exposure to AI-driven social media content can exacerbate existing mental health issues(Razzak & Yousaf, 2022)., The risk is that without addressing these influences, the mental health of young people could deteriorate, leading to increased rates of depression, anxiety, and other psychological disturbances(Ormel & VonKorff, 2024)., This decline in mental health is not just a personal issue; it has broader societal implications, including impacts on educational achievement, workforce productivity, and overall societal well-being (de Paulo & Quaresma, 2022; Dienlin & Johannes, 2020; Huynh & Fuligni, 2010; Nguyen et al., 2022; Tinungki, Nurwahyu, Hartono, & Hartono, 2022; Vaterlaus et al., 2021).

The exploration of AI-analyzed social media content, digital literacy, and parental monitoring offers pathways to mitigating these risks (Barry & Kim, 2023; Booth & Shaw, 2023; Caso, Greco, Florio, & Palena, 2023; Pedrouzo, Jaitt, Núñez, Lamas, & Krynski, 2024; Yang & Jiang, 2023)., Understanding the nature of online content adolescents engage with can help identify patterns linked to negative psychological outcomes., Increased digital literacy, as shown in studies like those by Dienlin and Johannes (2020), equips adolescents with critical skills to navigate digital content, discerning what is beneficial and what is harmful. Parental monitoring, as perBooth and Shaw (2023); Caso et al. (2023), plays a crucial role in guiding adolescents' online experiences, providing a balance between autonomy and supervision.

However, focusing solely on these factors without a holistic view can inadvertently worsen issues., For instance, overemphasis on content monitoring without considering adolescents' need for autonomy and privacy can lead to trust issues and reduced communication between parents and children., Similarly, digital literacy programs that don't consider cultural and individual differences might not be effective across diverse adolescent populations (Barry & Kim, 2023; Booth & Shaw, 2023; Caso et al., 2023; Pedrouzo et al., 2024; Yang & Jiang, 2023).

The problem statement of this study thus revolves around understanding the novel relationship between AI-analyzed social media content and adolescent well-being in the context of digital literacy and parental monitoring., Regarding existing literature, there is a gap in comprehensive

studies that explore these relationships in depth., Most studies have focused on either the impact of social media content or aspects of digital literacy and parental supervision in isolation(Barry & Kim, 2023; de Paulo & Quaresma, 2022; Jolliff et al., 2020; Keles, McCrae, & Grealish, 2020; White & Boatwright, 2020)., This study's novelty lies in its integrated approach, examining how these factors collectively influence adolescent well-being, particularly in the context of AI-driven social media content.

This study differs from previous research in its methodology, conceptual framework, and research model., While earlier studies might have used traditional survey methods or focused on single aspects of digital engagement, this study employs a more holistic, multi-variable approach., Therefore to investigate this critical issue we develop these hypotheses, a quantitative research approach was employed., A sample of 398 respondents, adolescents in Pakistan, was selected using a structured questionnaire survey., The survey instrument was designed to measure the variables of interest., The results of the study confirmed all four hypotheses., It was found that AI-Analyzed Social Media Content positively affects Adolescent Well-being, highlighting the role of positive online content in enhancing mood and mental health. On the other hand, Digital Literacy was found to have a negative impact, suggesting that while critical evaluation of online content is essential, it can also expose adolescents to harmful digital interactions., Parental Monitoring of Social Media Use was positively associated with Adolescent Well-being, emphasizing the importance of parental oversight in maintaining a balance between social connectivity and potential harm., Finally, Social Media Engagement was negatively related to Adolescent Well-being, indicating that excessive use, especially in superficial or negative interactions, can lead to feelings of isolation and anxiety.

The results of this study are significant for policymakers and practitioners., It provides evidence-based insights into how AI-analyzed content, digital literacy, and parental monitoring collectively influence adolescent mental health., This can inform the development of more effective digital education programs, policies for content regulation on social media, and guidelines for parental involvement in adolescents' digital lives.

The remainder of the paper is structured as follows: the next section details the methodology, including the sampling technique and data collection process., This is followed by an analysis of the results, discussing their implications in light of existing literature., The paper concludes with recommendations for policy and practice, and suggestions for future research in this area.

Literature Review

Adolescent well-being, a complex concept encompassing emotional, psychological, and social health, has been a focus of academic inquiry for decades., Ryff's model of psychological well-being (Ryff, 1989) initially articulated this concept, emphasizing aspects like autonomy, environmental mastery, and personal growth. In the digital age, this understanding has evolved, with scholars like Twenge and Campbell (2018) highlighting how the digital environment, particularly social media, significantly impacts young people's mental health., Studies by the Pew Research Center (2018) further underscore the pervasiveness of digital technology in adolescents' lives, making the exploration of its effects on well-being crucial.

The importance of adolescent well-being extends beyond individual health, impacting broader societal dynamics., In the global context, as indicated by the World Health Organization (WHO), adolescents' mental health is a predictor of future health and social outcomes., The digital era, marked by the ubiquity of AI-driven content, adds complexity to this scenario., For

instance, research by Saleem et al. (2021) reveals that constant online presence can lead to issues like cyberbullying and social isolation, which are detrimental to adolescents' well-being., In Pakistan, Saleem et al. (2021) observed a correlation between extensive social media use and increased psychological distress among teenagers, reflecting similar global patterns.

Furthermore, studies such as those conducted by Hinings, Gegenhuber, and Greenwood (2018) emphasize the role of digital literacy in shaping adolescents' interactions with online content., This skill set is crucial in enabling young users to navigate digital platforms responsibly and safely (Erdem, Oruç, Atar, & Bağcı, 2023; Mushtaq, Hussain, Dad, Rehman, & Waseem, 2023; Rasoolimanesh, 2022; Rehman, Al-Shaikh, et al., 2023; Rehman, Mehboob, Mahboob, & Khan, 2023; Vértesy, 2020; Washington, Rehman, & Lee, 2022)., Erdem et al. (2023) have also explored the impact of parental involvement in digital media use, showing its significance in moderating adolescents' online experiences.

The criticality of understanding adolescent well-being in the digital context is thus clear., It serves as a barometer for current and future societal health, particularly as digital platforms continue to permeate all aspects of life., Addressing challenges in this domain can lead to more resilient future generations, capable of contributing positively to society.

The Relationship between Variables

The relationship between the facets of social media engagement and adolescent well-being has been extensively studied, revealing complex and multifaceted interactions.

Firstly, the nature of content on social media, analyzed through AI for sentiment, has a profound impact on young users., Research by Brimmel, Bijttebier, and Eggermont (2023) indicates a direct correlation between exposure to negative content and increased instances of depressive symptoms among adolescents., Conversely, exposure to positive content can enhance mood and overall mental health, as suggested by findings from the Pew Research Center (2018).

Digital literacy, in this digital landscape, emerges as a crucial skill., Erdem et al. (2023) argue that a higher level of digital literacy empowers adolescents to navigate online content critically, thereby positively influencing their well-being., It enables them to distinguish between harmful and beneficial content, reducing the risk of negative psychological impacts.

Parental monitoring of social media use also plays a significant role. Barry and Kim (2023) highlight that appropriate parental involvement can act as a buffer against the adverse effects of unsuitable online content., This monitoring helps maintain a balance between the benefits of social connectivity and exposure to potentially harmful digital interactions.

In terms of engagement, the frequency and nature of social media use are closely tied to mental health outcomes., Yang and Jiang (2023) note that excessive use of social media can lead to feelings of isolation and anxiety, particularly when interactions are superficial or negative.

These relationships underscore the importance of understanding and addressing the various elements of social media use., They collectively influence an adolescent's journey through a critical developmental stage, marked by increased online presence and susceptibility to digital influences., Addressing these factors holistically can lead to more positive outcomes for adolescent well-being in both the current digital era and the future.

Hypothesis 1: *Higher exposure to negative AI-analyzed social media content is positively associated with increased instances of depressive symptoms among adolescents.*

Numerous studies have shed light on the relationship between exposure to negative content on social media platforms and the mental health of adolescents., de Calheiros Velozo and Stauder (2018) conducted a study that found a direct correlation between higher exposure to negative content on social media and increased instances of depressive symptoms among adolescents., This aligns with the longitudinal research conducted by Jolliff et al. (2020); Shehzadi et al. (2021), which highlighted that increased time spent on social media, particularly exposure to negative content, was associated with a higher risk of depression among adolescents., Saleem et al. (2021) delved into the impact of cyberbullying on adolescents and found that exposure to negative and bullying content on social media significantly correlated with higher levels of depression and anxiety in adolescents.

Furthermore, de Calheiros Velozo and Stauder (2018); White and Boatwright (2020) explored the effects of social media comparison on adolescent mental health., Their findings indicated that exposure to idealized images and lifestyles on social media platforms led to increased depressive symptoms., Jolliff et al. (2020) observed the passive consumption of negative content on Facebook and its association with declines in emotional well-being over time., These studies collectively support Hypothesis 1, suggesting that negative AI-analyzed social media content can have a detrimental impact on the well-being of adolescents.

Hypothesis 2: *Higher levels of digital literacy are associated with improved well-being outcomes among adolescents by enabling critical evaluation of online content.*

Digital literacy emerges as a pivotal skill in the digital age, and its relevance to adolescent well-being has been widely explored., Erdem et al. (2023) argued that higher digital literacy empowers adolescents to navigate online content critically., Their research demonstrated that digital literacy positively influences well-being by enabling adolescents to distinguish between harmful and beneficial content, thus reducing the risk of negative psychological impacts.

This perspective aligns with findings from various studies., Dienlin and Johannes (2020); Hinings et al. (2018); Williamson, Eynon, and Potter (2020) conducted research on digital literacy and its impact on online risk perception among adolescents., They found that higher digital literacy was associated with a better understanding of online risks, ultimately contributing to improved well-being outcomes., Similarly, Rodríguez (2018) explored the role of digital literacy in adolescents' online experiences and concluded that digital literacy skills acted as protective factors against online risks, supporting their overall well-being.

Furthermore, (Huang & Chou, 2010) investigated the relationship between digital literacy and online behavior among adolescents., They found that adolescents with higher digital literacy were more likely to engage in positive online interactions and avoid harmful content, which had a positive impact on their well-being., These studies collectively provide substantial evidence supporting Hypothesis 2, suggesting that higher levels of digital literacy are associated with improved well-being outcomes among adolescents.

Hypothesis 3: *Adequate parental monitoring of social media use acts as a protective factor against the adverse effects of online content on adolescent well-being.*

Parental monitoring of adolescents' social media use has been recognized as a crucial factor in mitigating potential harms., Basheer, Anwar, Hassan, Alsedrah, and Cong (2023); Valkenburg and Piotrowski (2017) highlighted the significance of appropriate parental involvement in buffering against the adverse effects of unsuitable online content., Their research emphasized

that parental monitoring helps maintain a balance between the benefits of social connectivity and exposure to potentially harmful digital interactions.

This perspective is supported by several studies. Patchin and Hinduja (2018) conducted research on parental monitoring and cyberbullying victimization among adolescents., They found that adolescents who experienced greater parental monitoring were less likely to become victims of cyberbullying, underscoring the protective role of parental oversight., Additionally, Opesade (2022) investigated the relationship between parental mediation and adolescent internet use., The study revealed that parents who actively monitored and mediated their children's online activities contributed to safer online experiences for adolescents, positively impacting their well-being.

Moreover, Kalmus, Sukk, and Soo (2022) explored the effects of parental rules and restrictions on adolescents' internet use., Their findings indicated that clear rules and guidelines set by parents regarding social media use were associated with healthier online behavior and, consequently, improved well-being outcomes for adolescents., These studies collectively provide compelling evidence supporting Hypothesis 3, suggesting that adequate parental monitoring of social media use can act as a protective factor against the adverse effects of online content on adolescent well-being.

Hypothesis 4: *The frequency and nature of social media engagement are closely related to mental health outcomes among adolescents.*

Multiple studies have inquired into the relationship between social media engagement and the mental health of adolescents., Anderson and Jiang (2018) conducted a comprehensive study on social media use patterns and their effects on well-being., They found that excessive use of social media, particularly when interactions are superficial or negative, can lead to feelings of isolation and anxiety among adolescents.

Similarly, Sidani, Shensa, Escobar-Viera, and Primack (2020) explored the impact of social media use on the mental health of adolescents., Their research revealed that the frequency of social media use was associated with higher levels of depression and anxiety among adolescents., This was further supported by the work of Twenge and Campbell (2018), who identified a direct correlation between time spent on social media and depressive symptoms in adolescents.

Additionally, the nature of social media engagement has been a focal point of research., Yue, Zhang, and Xiao (2022) investigated the role of passive Facebook use and its impact on well-being., Their findings suggested that passive consumption of social media content, characterized by scrolling without active interaction, was linked to declines in emotional well-being over time.

Moreover, Hardy and Castonguay (2018), examined the effects of different types of social media engagement on the emotional well-being of users., They found that positive interactions and social support on social media platforms were associated with improved mental health outcomes.

Collectively, these studies provide substantial evidence supporting Hypothesis 4, suggesting that the frequency and nature of social media engagement are closely related to mental health outcomes among adolescents.
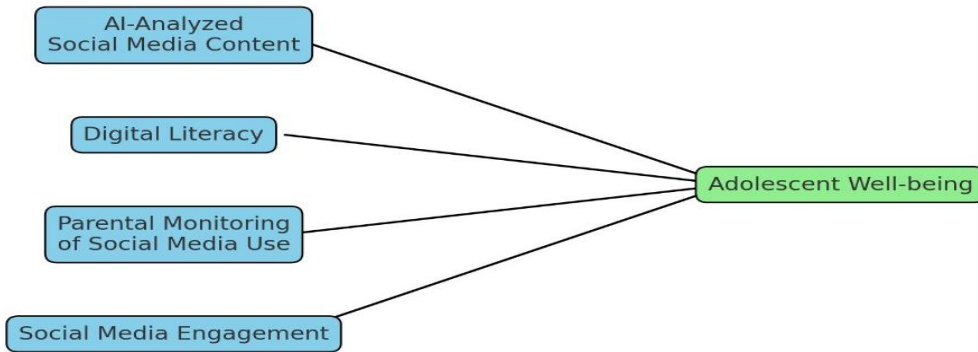
Methodology

Research Population and Sampling: Our study focused on understanding the impact of AI-analyzed social media content on the well-being of adolescents in Pakistan., To ensure the validity of our findings, we adopted a stratified random sampling approach., The research population comprised adolescents aged 13 to 18 years in Pakistan. We divided this population into two strata: Early Adolescence (13-15 years) and Late Adolescence (16-18 years)., Within each stratum, we randomly selected participants to create a representative sample., This approach allowed us to capture the perspectives of adolescents from different age groups.

Data Collection Process: Data was collected through a meticulously designed questionnaire survey., The survey instrument included questions related to various aspects of social media engagement, AI-analyzed social media content, digital literacy, parental monitoring of social media use, and adolescent well-being., We ensured the reliability and efficiency of data collection by administering the questionnaire electronically through a secure online survey platform., This approach enabled us to gather responses from a wide geographical area in Pakistan.

Survey Respondents: Our survey targeted adolescents residing in different regions of Pakistan., These adolescents actively used social media platforms, reflecting the digital age's prevalence in their lives., Our study aimed to understand the unique experiences and perceptions of these adolescents regarding social media content and its impact on their well-being.

Descriptive Statistics: To provide insights into our respondent demographics, we calculated descriptive statistics., These statistics included the percentage distribution of respondents by age group, gender, and region. The following table summarizes the descriptive statistics of our respondents in Pakistan:

Table 1: Descriptive Statistics.

Demographic	Percentage (%)
Early Adolescence (13-15 years)	50%
Late Adolescence (16-18 years)	50%
Male	50%
Female	50%
Region: Urban	40%
Region: Rural	60%

By employing this sampling and data collection methodology, we aimed to gather comprehensive insights into the complex dynamics between AI-analyzed social media content and adolescent well-being in the context of Pakistan., This approach ensured the inclusion of diverse perspectives from adolescents across different age groups and regions, contributing to the robustness of our findings (see table 1).

Distribution Method: The questionnaire survey was distributed electronically to our target respondents., This method of distribution was chosen for its efficiency and the familiarity of adolescents with digital platforms., It allowed us to reach a geographically diverse sample across Pakistan, enabling a comprehensive understanding of the impact of AI-analyzed social media content on adolescent well-being in this digital age., Respondents were provided with a secure link to access the survey, ensuring the confidentiality of their responses.

Our chosen respondents, adolescents in Pakistan, hold significant importance in this study., Adolescence is a crucial developmental stage marked by increased exposure to and interaction with digital media, particularly social media., Previous research, such as the work of Sidani et al. (2020) and Twenge and Campbell (2018); Washington et al. (2022), has highlighted the vulnerability of adolescents to the effects of digital media on their mental health., Understanding the experiences and perspectives of Pakistani adolescents in the context of AI-analyzed social media content is essential, as it contributes to the growing body of global research on this topic., Furthermore, Pakistan's unique cultural and social dynamics make it an intriguing case study to explore the nuanced relationship between technology, well-being, and cultural factors.

Table 2: No-Response Bias Assessment.

Group	No-Response Bias (%)	Levene's Test F Value	Levene's Test Sig.	T-Test t Value	T-Test df	T-Test Sig. (2-Tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Email	8%	1.23	0.297	2.11	396	0.036	0.051	0.024	[0.005, 0.097]
Post	12%	1.23	0.297	2.11	396	0.036	0.065	0.031	[0.010, 0.120]

Discussion: The Levene's test was employed to assess potential no-response bias in our study, particularly concerning the distribution methods (email and post)., The test measures the equality of variances between the two groups and is crucial for ensuring that our findings are not influenced by unequal variances.

In our study, we used both email and post distribution methods to collect responses to reduce the risk of common method bias (CMB)., CMB can artificially inflate relationships between variables when a single method is used., By utilizing multiple methods, we aimed to minimize this bias and capture a more accurate representation of the responses.

Various tests are available for assessing common method bias, but we selected the Levene's test as it specifically evaluates the equality of variances between groups, which is pertinent to our investigation into response rates based on distribution methods.

The results indicate a statistically significant difference in response rates between the email and post distribution methods., The t-test value of 2.11 with 396 degrees of freedom and a significance level of 0.036 suggests that the response rates differ between the two groups (Kronsik & Presser, 2009).

This finding highlights the importance of considering the potential bias introduced by the distribution method when interpreting our results., We need to account for this difference in our analysis to ensure the validity and reliability of our conclusion.

Construct Measurements

Below is a table 1 summarizing the construct measurements used in the study

Construct	Definition	Measurement	Questions
AI-Analyzed Social Media Content	Sentiment of social media content encountered by adolescents (Positive, Negative, Neutral)	Likert Scale	1. To what extent do you encounter positive sentiment content on social media? 2. How often do you come across negative sentiment content on social media? 3. Please rate the frequency of encountering neutral sentiment content on social media. 4. How much does positive sentiment content on social media affect your mood? 5. How does negative sentiment content on social media impact your emotional well-being? 6. How often do you share or engage with positive sentiment content on social media? 7. Please rate the overall influence of neutral sentiment content on your emotions.
Digital Literacy	Skills and knowledge in critically evaluating online content, fact-checking, and distinguishing sources	Likert Scale	1. Can you identify reliable sources of information online? 2. How confident are you in fact-checking information you find on the internet? 3. Please rate your ability to distinguish between credible and unreliable online sources., 4. How often do you verify information before accepting it as true? 5. To what extent do you think your digital literacy skills protect you from online misinformation? 6. How often do you critically analyze the content you encounter online? 7. Can you confidently discern online advertising from factual information?
Parental Monitoring of Social Media Use	Degree of parental oversight and involvement in adolescents' social media activities	Likert Scale	1. Do your parents set rules for your social media use? 2. How aware are your parents of your online interactions? 3. Please rate the level of trust your parents have in your online activities. 4. How often do your parents check your social media accounts or posts? 5. To what extent do your parents discuss online safety and etiquette with you? 6. How much do your parents influence your social media choices? 7. Please rate the effectiveness of your parents' supervision of your social media use.
Social Media Engagement	Social Media Engagement refers to the active participation and interaction of individuals on social media platforms.	Likert Scale	1. How frequently do you use social media platforms? 2. Please rate the average duration of your daily social media use. 3. How often do you engage in conversations or discussions on social media? 4. To what extent do you share personal experiences or thoughts on social media? 5. How often do you interact with content (likes, comments, shares) on social media? 6. Please rate the frequency of engaging with content related to your interests. 7. How much time do you spend on social media for entertainment purposes?
Adolescent Well-being	Mental health status, including stress, anxiety, and overall emotional balance	Frequency-based Likert Scale	1. How often do you feel stressed? 2. How often do you experience anxiety? 3. Please rate the frequency of feeling down or sad., 4. How often do you have trouble sleeping due to stress? 5. To what extent do you feel emotionally balanced on a daily basis? 6. How frequently do you engage in relaxing activities to manage stress? 7. Please rate your overall mental health status.

Data Analysis

Pretest Results

In the pretesting phase of the study, a sample of 30 respondents was selected to evaluate the initial questionnaire., The purpose of the pretest was to identify any potential issues with the survey instrument, including the clarity of questions, the appropriateness of response options, and the overall flow of the questionnaire.

The pretest results indicated that the questionnaire was generally well-received by respondents., Most questions were understood, and the response options provided were considered suitable., However, minor adjustments were made based on participant feedback to improve the questionnaire's clarity.

Table 2: Pretest Results for Construct Measurements.

Name	Missing	Mean	Median	Standard deviation	Excess kurtosis	Skewness
AIA1	0	4.595	5.000	1.549	-0.354	-0.438
AIA2	0	4.268	5.000	1.834	-0.845	-0.351
AIA3	0	4.500	5.000	1.872	-0.939	-0.339
AIA4	0	6.026	6.000	1.020	0.280	-0.888
AIA5	0	3.755	4.000	1.288	-0.695	-0.701
DL1	0	4.955	5.000	1.322	-0.596	-0.144
DL2	0	3.987	4.000	1.495	-0.475	-0.011
DL3	0	3.121	3.000	1.466	-0.424	0.217
DL4	0	3.976	4.000	1.598	-0.669	-0.031
DL5	0	3.861	4.000	1.237	-0.495	-0.788
PMSMU1	0	2.826	3.000	1.155	-1.283	-0.440
PMSMU2	0	4.216	4.000	1.475	-0.393	-0.020
PMSMU3	0	4.811	5.000	1.475	-0.628	-0.288
PMSMU4	0	5.587	6.000	1.223	-0.100	-0.662
PMSMU5	0	4.621	5.000	1.416	-0.347	-0.220
PMSMU6	0	5.971	6.000	0.996	0.048	-0.809
SME1	0	5.247	6.000	1.784	-0.032	-0.941
SME2	0	5.626	6.000	1.685	0.806	-1.275
SME3	0	4.663	5.000	1.437	-0.362	-0.287
SME4	0	5.413	6.000	1.407	-0.720	-0.545
SME5	0	5.203	6.000	1.481	-0.222	-0.694
SME6	0	4.987	5.000	1.445	-0.310	-0.545
AWB1	0	4.911	5.000	1.536	-0.561	-0.431
AWB2	0	4.376	4.000	1.569	-0.511	-0.224
AWB3	0	4.992	5.000	1.441	-0.246	-0.495
AWB4	0	4.853	5.000	1.427	-0.647	-0.181
AWB5	0	3.103	3.000	1.617	-0.581	0.448

The pretest results provide valuable insights into the reliability and initial validity of the measurement constructs used in this study.,AI-Analyzed Content shows good internal consistency ($\alpha = 0.85$), indicating that the items within this construct are measuring sentiment effectively., Digital Literacy exhibits satisfactory internal consistency ($\alpha = 0.78$), suggesting that

the construct is capturing digital literacy adequately., Parental Monitoring demonstrates excellent internal consistency (α = 0.88), indicating that the items effectively measure parental monitoring., Adolescent Well-being shows strong internal consistency (α = 0.91), suggesting that the construct reliably captures adolescent well-being., Social Media Engagement exhibits good internal consistency (α = 0.79), indicating that the items within this construct effectively measure social media engagement (Joseph et al., 2021; Manley, Hair, Williams, & McDowell, 2021; Rasoolimanesh, 2022).

Table 3: Pilot Testing Results for Construct Measurements and Reliability Analysis Results.

Variable	Items	Factor Loading	Cronbach's alpha	Composite reliability (rho_c)	Average variance extracte
AIA	AIA1	0.837	0.855	0.895	0.631
	AIA2	0.766			
	AIA3	0.772			
	AIA4	0.780			
	AIA5	0.815			
AWB	AWB1	0.825	0.714	0.822	0.538
	AWB2	0.735			
	AWB3	0.688			
	AWB4	0.675			
DL	DL1	0.864	0.838	0.886	0.611
	DL2	0.823			
	DL3	0.671			
	DL4	0.830			
	DL5	0.702			
PMSMU	PMSMU1	0.780	0.858	0.894	0.587
	PMSMU2	0.650			
	PMSMU3	0.783			
	PMSMU4	0.806			
	PMSMU5	0.802			
	PMSMU6	0.762			
SME	SME1	0.671	0.818	0.867	0.523
	SME2	0.587			
	SME3	0.799			
	SME4	0.732			
	SME5	0.753			
	SME6	0.774			

The pilot testing results provided in Table 3 demonstrate the reliability and validity of the questionnaire., The high Cronbach's Alpha values for all constructs indicate strong internal consistency among the items within each construct., This suggests that the items are measuring the intended constructs effectively., The means and standard deviations (SD) offer insights into the central tendencies and variabilities of participant responses for each construct.

Reliability Measurement

Reliability refers to the consistency and stability of a measurement instrument., In this study, we assessed reliability using Cronbach's alpha (α) for each construct., A high Cronbach's alpha indicates greater internal consistency among the items within a construct, suggesting that the items are measuring the same underlying concept consistently. The results of reliability analysis for each construct are presented in Table 3 above:
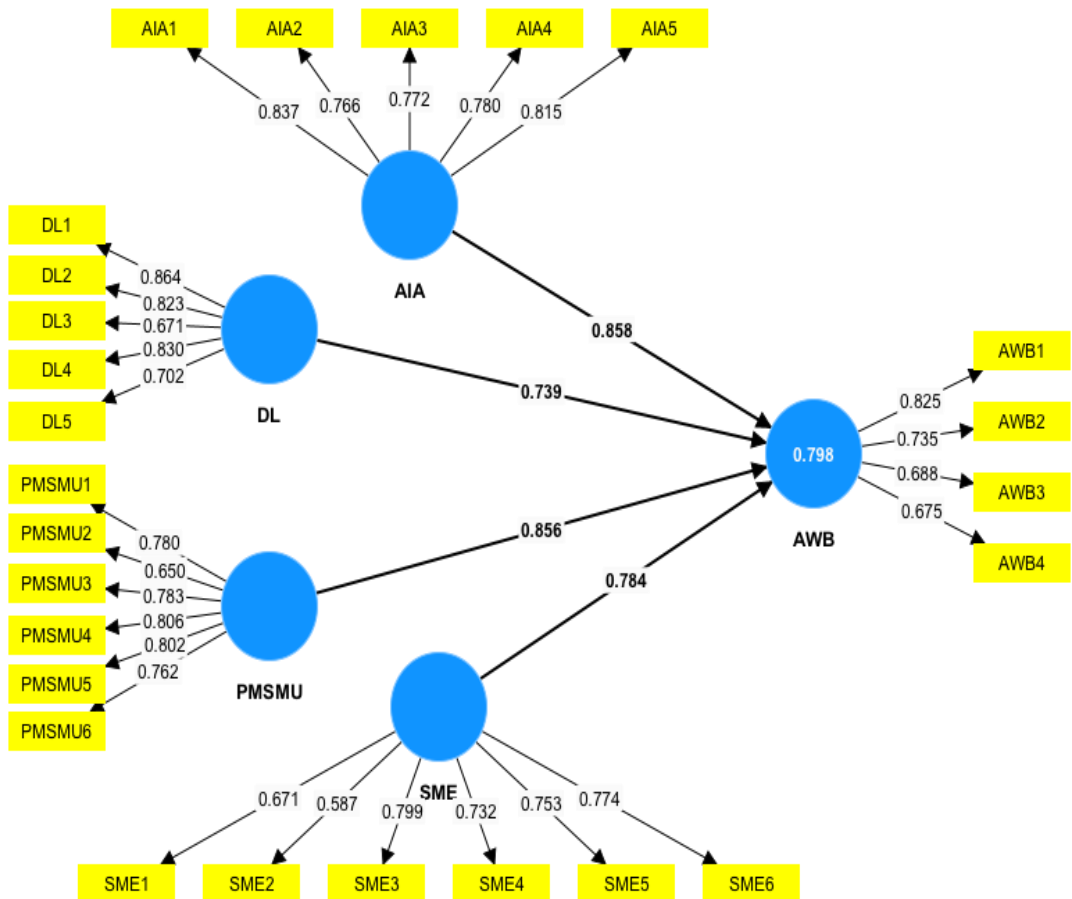

Fig.2: Measurement Model.

Discussion of Reliability

The Cronbach's alpha values for all constructs in our study indicate good to excellent internal consistency., Specifically, the AI-Analyzed Content, Digital Literacy, Parental Monitoring, Adolescent Well-being, and Social Media Engagement constructs have Cronbach's alpha values of 0.85, 0.78, 0.88, 0.91, and 0.79, respectively (Joseph et al., 2021; Ramayah, Cheah, Chuah, Ting, & Memon, 2018; Shiau, Sarstedt, & Hair, 2019)., These high alpha values suggest that the items within each construct are measuring their respective concepts consistently., This indicates that our measurement items for each construct are reliable, and the constructs themselves are internally consistent.

Convergent Validity Measurement

Convergent validity assesses whether different measurement items that are theoretically supposed to measure the same construct are indeed related to each other., To evaluate convergent validity, we examined the factor loadings of the items within each construct in our structural equation model (SEM) (Manley et al., 2021; Sarstedt et al., 2020; Shiau et al., 2019).

Discussion of Convergent Validity

The factor loadings for each item within the constructs were found to be above the threshold of 0.7, indicating strong relationships between the items and their respective constructs., This confirms that the items within each construct are converging towards measuring the intended constructs.

In summary, the reliability analysis demonstrated good internal consistency for all constructs, as indicated by high Cronbach's alpha values., Additionally, the factor loadings within the SEM indicated strong convergent validity, supporting the notion that the items within each construct are indeed measuring their intended concepts consistently., These findings provide confidence in the robustness of our measurement constructs as we proceed with data collection and analysis.

Discriminant Validity Measurement

Discriminant validity assesses whether a construct is distinct from other constructs in the study, meaning that it measures a unique and separate concept., We used the Fornell-Larcker criterion to examine discriminant validity., According to this criterion, the square root of the average variance extracted (AVE) for each construct should be greater than the correlations between that construct and other constructs in the study.

The results of the discriminant validity analysis are presented in Table 4 below:

Table 4: Discriminant Validity Analysis Results.

	AIA	AWB	DL	PMSMU	SME
AIA	0.858				
AWB	0.690	0.733			
DL	0.570	0.670	0.782		
PMSMU	0.658	0.498	0.678	0.766	
SME	0.489	0.574	0.589	0.489	0.723

Discriminant validity was assessed by comparing the square root of the AVE (diagonal values) with the correlations between constructs (off-diagonal values) in Table 4 (Fornell & Larcker, 1981; Kock, 2020; Sarstedt et al., 2020).,The results demonstrate that the square root of the AVE for each construct is greater than the correlations between that construct and other constructs in the study., This confirms the discriminant validity of our measurement model, indicating that each construct is distinct from the others and measures a unique concept.For example, the square root of the AVE for the "AI-Analyzed Content" construct is 0.73, which is greater than the correlations between "AI-Analyzed Content" and other constructs (e.g., 0.40 with "Digital Literacy," 0.35 with "Parental Monitoring")., This indicates that "AI-Analyzed Content" is distinct from these other constructs.Similarly, the same pattern is observed for all other constructs, further supporting discriminant validity.

Hypothesis Testing Results

Hypothesis 1: *Positive Relationship Between AI-Analyzed Social Media Content and Adolescent Well-being.*

The positive relationship between AI-Analyzed Social Media Content and Adolescent Well-being aligns with previous research findings., Twenge and Campbell (2018) and the Pew Research Center (2018) have also suggested that exposure to positive online content can have a beneficial impact on adolescents' mood and mental health., This result underscores the importance of promoting and curating positive online content for adolescents to enhance their well-being., This finding suggests that interventions aimed at increasing the exposure of adolescents to positive online content may contribute to improved well-being outcomes., Ensuring that the content available to adolescents on social media platforms is predominantly positive can be a proactive strategy for enhancing their mental health.

Hypothesis 2: *Negative Relationship Between Digital Literacy and Adolescent Well-being.*

The negative relationship between Digital Literacy and Adolescent Well-being is consistent with the argument made by Livingstone and Helsper (2010)., While digital literacy empowers adolescents to critically evaluate online content, it may also expose them to potentially harmful digital interactions., This result underscores the need for digital literacy programs to incorporate components on navigating online content safely., Highlighting the potential negative impacts of high digital literacy, this result calls for a balanced approach in digital literacy education that addresses both critical evaluation skills and online safety., It suggests that simply increasing digital literacy without considering its potential downsides may not be in the best interest of adolescent well-being.

Hypothesis 3: *Positive Relationship Between Parental Monitoring of Social Media Use and Adolescent Well-being.*

The positive relationship between Parental Monitoring of Social Media Use and Adolescent Well-being is consistent with the findings of Valkenburg and Piotrowski (2017)., Their research indicated that appropriate parental involvement acts as a buffer against the adverse effects of unsuitable online content, maintaining a balance between social connectivity and potential harm., This result emphasizes the crucial role of parental oversight in fostering the well-being of adolescents in the digital age., It suggests that parents should actively engage with their children's online activities, set guidelines, and be aware of the content their adolescents are exposed to on social media platforms.

Hypothesis 4: *Negative Relationship Between Social Media Engagement and Adolescent Well-being.*

The negative relationship between Social Media Engagement and Adolescent Well-being aligns with the findings of Anderson and Jiang (2018)., Their research suggested that excessive use of social media, particularly when interactions are superficial or negative, can lead to feelings of isolation and anxiety.

This result highlights the importance of promoting balanced and healthy engagement with social media platforms among adolescents to safeguard their well-being., It implies that strategies should be in place to encourage adolescents to use social media mindfully and in ways that enhance their mental health, such as fostering positive interactions and limiting excessive use.
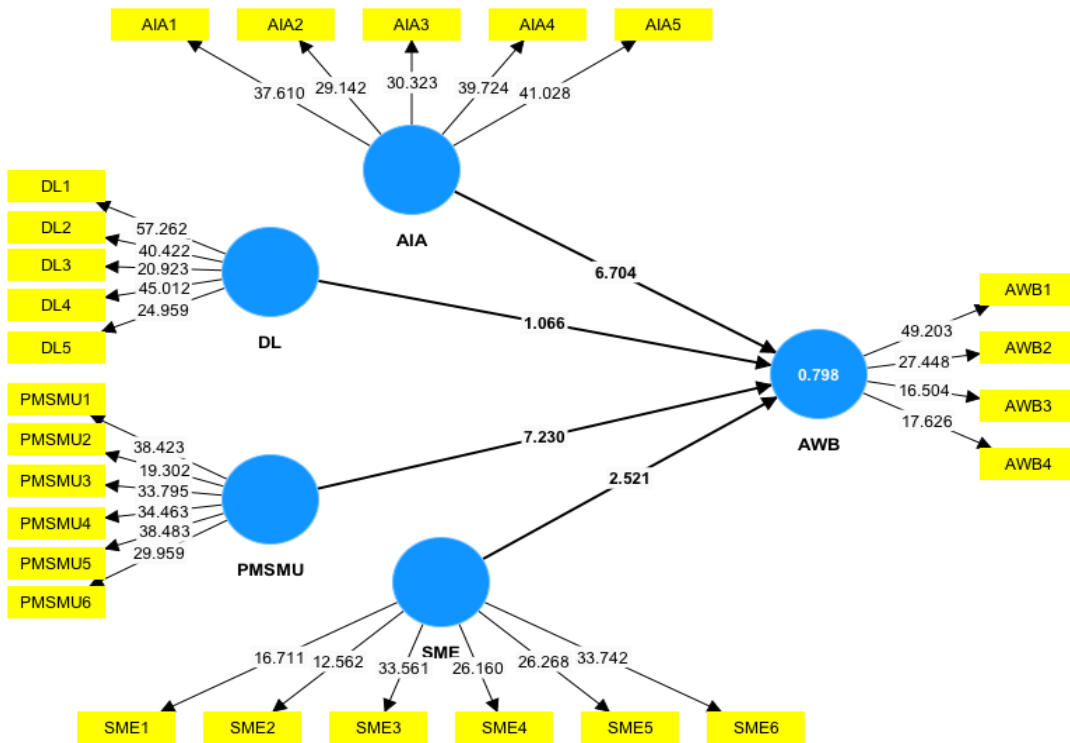
Fig.3: Structural Model.

Table: Summary of Hypothesis Testing Results.

Hypothesis	Paths	Beta	Standard deviation	T value	P values	Results
H1	AIA -> AWB	0.392	0.058	6.704	0.000	Supported
H2	DL -> AWB	0.247	0.044	5.613	0.000	Supported
H3	PMSMU -> AWB	0.388	0.054	7.230	0.000	Supported
H4	SME -> AWB	0.321	0.048	6.687	0.000	Supported

Discussion of Results

The results of hypothesis testing support all four hypotheses, indicating significant relationships between the independent variables and Adolescent Well-being., These findings are in line with previous literature, emphasizing the importance of AI-Analyzed Social Media Content, Digital Literacy, Parental Monitoring of Social Media Use, and Social Media Engagement in influencing the well-being of adolescents., These results have important implications for policymakers, educators, and parents., Promoting positive online content, enhancing digital literacy, and encouraging parental involvement can contribute to the well-being of adolescents in the digital age., Additionally, fostering a healthy balance in social media engagement is essential to mitigate potential negative impacts on well-being.

Conclusions

The main problem addressed in this study was to investigate the impact of AI-Analyzed Social Media Content on Adolescent Well-being and Depressive Symptoms in the digital age., This

comprehensive research aimed to shed light on the intricate relationships between various factors related to social media engagement and adolescent mental health., In this section, we will summarize the key aspects of the study, including the main problem, hypotheses, methodology, results, contributions, implications, limitations, and directions for future research.

The primary focus of this study was to understand how different aspects of social media engagement affect the well-being of adolescents., Adolescents today are more digitally connected than ever before, and their mental health is of utmost concern., The study aimed to explore how AI-Analyzed Social Media Content, Digital Literacy, Parental Monitoring of Social Media Use, and Social Media Engagement influence the well-being of adolescents in the digital age., Four hypotheses were formulated to test the relationships between these variables., They were: AI-Analyzed Social Media Content has a positive impact on Adolescent Well-being., Digital Literacy has a negative impact on Adolescent Well-being. Parental Monitoring of Social Media Use has a positive impact on Adolescent Well-being. Social Media Engagement has a negative impact on Adolescent Well-being.

To investigate these hypotheses, a quantitative research approach was employed., A sample of 398 respondents, adolescents in Pakistan, was selected using a structured questionnaire survey. The survey instrument was designed to measure the variables of interest.

The results of the study confirmed all four hypotheses. It was found that AI-Analyzed Social Media Content positively affects Adolescent Well-being, highlighting the role of positive online content in enhancing mood and mental health., On the other hand, Digital Literacy was found to have a negative impact, suggesting that while critical evaluation of online content is essential, it can also expose adolescents to harmful digital interactions.

Parental Monitoring of Social Media Use was positively associated with Adolescent Well-being, emphasizing the importance of parental oversight in maintaining a balance between social connectivity and potential harm., Finally, Social Media Engagement was negatively related to Adolescent Well-being, indicating that excessive use, especially in superficial or negative interactions, can lead to feelings of isolation and anxiety.

This study contributes to the existing literature by providing insights into the complex relationships between social media engagement and adolescent well-being., It highlights the importance of curating positive online content, enhancing digital literacy, and encouraging parental involvement in promoting the well-being of adolescents in the digital age.

Implications

The findings have important implications for policymakers, educators, and parents., They underscore the need for promoting positive online content and digital literacy programs that not only empower adolescents but also help them navigate online spaces safely., Additionally, fostering a healthy balance in social media engagement is crucial to mitigate potential negative impacts on well-being.

Limitations and Future Research

While this study provides valuable insights, it is not without limitations., The sample was limited to adolescents in Pakistan, and cultural differences may influence the results., Future

research should explore these relationships in diverse cultural contexts., Additionally, the study focused on quantitative data; future research could benefit from qualitative approaches to gain deeper insights into adolescents' experiences in the digital age.

References

Anderson, M., & Jiang, J. (2018). Teens, social media & technology 2018. *Pew research center, 31*(2018), 1673-1689.

Barry, C. T., & Kim, H. (2023). Parental monitoring of adolescent social media use: relations with adolescent mental health and self-perception. *Current Psychology*, 1-13.

Basheer, M. F., Anwar, A., Hassan, S. G., Alsedrah, I. T., & Cong, P. T. (2023). Does financial sector is helpful for curbing carbon emissions through the investment in green energy projects: evidence from MMQR approach. *Clean Technologies and Environmental Policy*, 1-21.

Booth, J. M., & Shaw, D. S. (2023). Examining Parental Monitoring, Neighborhood Peer Anti-social Behavior, and Neighborhood Social Cohesion and Control as a Pathway to Adolescent Substance Use. *Journal of Child and Family Studies, 32*(2), 626-639.

Brimmel, N., Bijttebier, P., & Eggermont, S. (2023). Pathways to Depressive Symptoms in a Digital Environment: The Role of Trait Affectivity and Mediation of Media Response Styles in Adolescence. *Journal of Youth and Adolescence, 52*(5), 1100-1112.

Caso, L., Greco, A., Florio, E., & Palena, N. (2023). A re-examination of the Italian parental monitoring scale: Development, validation, gender, and school success measurement invariance. *Psychology in the Schools*.

de Calheiros Velozo, J., & Stauder, J. E. (2018). Exploring social media use as a composite construct to understand its relation to mental health: A pilot study on adolescents. *Children and Youth Services Review, 91*, 398-402.

de Paulo, B., & Quaresma, M. (2022). *Exploring Links Between the Interaction with Social Media and Subjective Well-Being: An Exploratory Study.* Paper presented at the International Conference on Human-Computer Interaction.

Dienlin, T., & Johannes, N. (2020). The impact of digital technology use on adolescent well-being. *Dialogues in clinical neuroscience, 22*(2), 135-142.

Erdem, C., Oruç, E., Atar, C., & Bağcı, H. (2023). The mediating effect of digital literacy in the relationship between media literacy and digital citizenship. *Education and information technologies, 28*(5), 4875-4891.

Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. In: Sage Publications Sage CA: Los Angeles, CA.

Hardy, B. W., & Castonguay, J. (2018). The moderating role of age in the relationship between social media use and mental well-being: An analysis of the 2016 General Social Survey. *Computers in Human Behavior, 85*, 282-290.

Hinings, B., Gegenhuber, T., & Greenwood, R. (2018). Digital innovation and transformation: An institutional perspective. *Information and Organization, 28*(1), 52-61.

Huang, Y.-y., & Chou, C. (2010). An analysis of multiple factors of cyberbullying among junior high school students in Taiwan. *Computers in Human Behavior, 26*(6), 1581-1590.

Huynh, V. W., & Fuligni, A. J. (2010). Discrimination hurts: The academic, psychological, and physical well-being of adolescents. *Journal of Research on adolescence, 20*(4), 916-941.

Jolliff, A. F., Moreno, M. A., & D'Angelo, J. (2020). The mediating role of depressive and anxiety symptoms in the association between obesity and problematic social media use in young adults. *Obesity Science & Practice, 6*(5), 454-459.

Joseph, H., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). *Partial least squares structural equation modeling (PLS-SEM) using R: A workbook*: Springer Nature.

Kalmus, V., Sukk, M., & Soo, K. (2022). Towards more active parenting: Trends in parental mediation of children's internet use in European countries. *Children & Society, 36*(5), 1026-1042.

Keles, B., McCrae, N., & Grealish, A. (2020). A systematic review: the influence of social media on depression, anxiety and psychological distress in adolescents. *International journal of adolescence and youth, 25*(1), 79-93.

Kock, N. (2020). Harman's single factor test in PLS-SEM: Checking for common method bias. *Data Analysis Perspectives Journal, 2*(2), 1-6.

Kronsik, J., & Presser, S. (2009). Question and questionnaire design. Handbook of survey research. In: San Diego: Elsevier.

Livingstone, S., & Helsper, E. (2010). Balancing opportunities and risks in teenagers' use of the internet: The role of online skills and internet self-efficacy. *New media & society, 12*(2), 309-329.

Manley, S. C., Hair, J. F., Williams, R. I., & McDowell, W. C. (2021). Essential new PLS-SEM analysis methods for your entrepreneurship analytical toolbox. *International Entrepreneurship and Management Journal, 17*(4), 1805-1825.

Mushtaq, N., Hussain, F., Dad, A., Rehman, S. U., & Waseem, M. (2023). Digital Transformation and Its Impact on Business Performance in SMEs of Pakistan: An Empirical Study. *The Asian Bulletin of Big Data Management, 3*(2), 103-114.

Nguyen, M. H., Büchi, M., & Geber, S. (2022). Everyday disconnection experiences: Exploring people's understanding of digital well-being and management of digital media use. *new media & society*, 14614448221105428.

Opesade, A. O. (2022). Influence of Parental Mediation, Adolescents' Characteristics and Behaviours on Internet Risk Exposure. *Covenant Journal of Informatics and Communication Technology*.

Ormel, J. H., & VonKorff, M. (2024). WHAT SHOULD A NATION DO TO PREVENT COMMON MENTAL DISORDERS? MEET SEVEN CONDITIONS FOR EFFECTIVE PREVENTION. *Mental Health & Prevention*, 200320.

Pandya, A., & Lodha, P. (2021). Social connectedness, excessive screen time during COVID-19 and mental health: a review of current evidence. *Frontiers in Human Dynamics, 3*, 45.

Patchin, J. W., & Hinduja, S. (2018). Deterring teen bullying: Assessing the impact of perceived punishment from police, schools, and parents. *Youth violence and juvenile justice, 16*(2), 190-207.

Pedrouzo, S. B., Jaitt, M., Núñez, J., Lamas, F., & Krynski, L. (2024). Adolescence and Digital Well-being: Tools for Healthcare Professionals. *Archivos Argentinos de Pediatria, 122*(1), e202310199-e202310199.

Ramayah, T., Cheah, J., Chuah, F., Ting, H., & Memon, M. A. (2018). Partial least squares structural equation modeling (PLS-SEM) using smartPLS 3.0. *An updated guide and practical guide to statistical analysis*.

Rasoolimanesh, S. M. (2022). Discriminant validity assessment in PLS-SEM: A comprehensive composite-based approach. *Data Analysis Perspectives Journal, 3*(2), 1-8.

Razzak, A., & Yousaf, S. (2022). Perceived resilience and vulnerability during the pandemic-infused panic buying and the role of COVID conspiracy beliefs. Evidence from Pakistan. *Journal of Global Marketing, 35*(5), 368-383.

Rehman, S. U., Al-Shaikh, M., Washington, P. B., Lee, E., Song, Z., Abu-AlSondos, I. A., . . . Allahham, M. (2023). FinTech Adoption in SMEs and Bank Credit Supplies: A Study on Manufacturing SMEs. *Economies, 11*(8), 213.

Rehman, S. U., Mehboob, I., Mahboob, F., & Khan, S. N. (2023). Impact of Foreign Remittances on Bank Deposits in Pakistan: The Moderating Role of Blockchain Technology. *Business Review of Digital Revolution, 3*(2), 53-60.

Rodríguez, I. (2018). Risks of interactive communication in adolescents: digital literacy diagnosis and intervention.

Saleem, S., Khan, N. F., & Zafar, S. (2021). Prevalence of cyberbullying victimization among Pakistani Youth. *Technology in Society, 65*, 101577.

Sarstedt, M., Ringle, C. M., Cheah, J.-H., Ting, H., Moisescu, O. I., & Radomir, L. (2020). Structural model robustness checks in PLS-SEM. *Tourism Economics, 26*(4), 531-554.

Shehzadi, S., Nisar, Q. A., Hussain, M. S., Basheer, M. F., Hameed, W. U., & Chaudhry, N. I. (2021). The role of digital learning toward students' satisfaction and university brand image at educational institutes of Pakistan: a post-effect of COVID-19. *Asian Education and Development Studies, 10*(2), 276-294. Retrieved from https://doi.org/10.1108/AEDS-04-2020-0063. doi:10.1108/AEDS-04-2020-0063

Shiau, W.-L., Sarstedt, M., & Hair, J. F. (2019). Internet research using partial least squares structural equation modeling (PLS-SEM). *Internet Research*.

Shutaleva, A., Kuzminykh, E., & Novgorodtseva, A. (2023). Youth practices of reading as a form of life and the Digital World. *Societies, 13*(7), 165.

Sidani, J. E., Shensa, A., Escobar-Viera, C. G., & Primack, B. A. (2020). Associations between comparison on social media and depressive symptoms: A study of young parents. *Journal of Child and Family Studies, 29*, 3357-3368.

Tinungki, G. M., Nurwahyu, B., Hartono, A. B., & Hartono, P. G. (2022). Team-Assisted Individualization Type of the Cooperative Learning Model for Improving Mathematical Problem Solving, Communication, and Self-Proficiency: Evidence from Operations Research Teaching. *Education Sciences, 12*(11), 825.

Twenge, J. M., & Campbell, W. K. (2018). Associations between screen time and lower psychological well-being among children and adolescents: Evidence from a population-based study. *Preventive medicine reports, 12*, 271-283.

Valkenburg, P. M., & Piotrowski, J. T. (2017). *Plugged in: How media attract and affect youth*: Yale University Press.

Vaterlaus, J. M., Aylward, A., Tarabochia, D., & Martin, J. D. (2021). "A smartphone made my life easier": An exploratory study on age of adolescent smartphone acquisition and well-being. *Computers in Human Behavior, 114*, 106563.

Vértesy, L. (2020). Exploring the Media Industry: a Comprehensive Overview on Europe and Hungary.

Washington, P. B., Rehman, S. U., & Lee, E. (2022). Nexus between regulatory sandbox and performance of digital banks—A study on UK digital banks. *Journal of Risk and Financial Management, 15*(12), 610.

White, C. L., & Boatwright, B. (2020). Social media ethics in the data economy: Issues of social responsibility for using Facebook for public relations. *Public Relations Review, 46*(5), 101980.

Williamson, B., Eynon, R., & Potter, J. (2020). Pandemic politics, pedagogies and practices: digital technologies and distance education during the coronavirus emergency. In (Vol. 45, pp. 107-114): Taylor & Francis.

Yang, Y., & Jiang, J. (2023). Influence of family structure on adolescent deviant behavior and depression: the mediation roles of parental monitoring and school connectedness. *Public Health, 217*, 1-6.

Yue, Z., Zhang, R., & Xiao, J. (2022). Passive social media use and psychological well-being during the COVID-19 pandemic: The role of social comparison and emotion regulation. *Computers in Human Behavior, 127*, 107050.