Modeling the spread of misinformation on social media among teenagers

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Abstract

Social media has revolutionized information sharing, yet it has also accelerated the spread of misinformation, particularly among teenagers who are highly active on digital platforms. This study, conducted at Talangan Integrated National High School (TINHS), examines how social media habits, peer influence, and digital engagement contribute to the spread of misinformation. Using a quantitative research design, data were collected from Grade 11 learners through structured surveys assessing social media usage, susceptibility to misinformation, and peer influence. A mathematical model based on the Susceptible-Infected-Recovered (SIR) framework was applied to analyze the transmission patterns of misinformation within digital networks. The results indicate a strong correlation between high social media usage and increased susceptibility to misinformation. Peer influence emerged as a critical factor in reinforcing false beliefs, with students more likely to trust and share information endorsed by their peers. The findings align with existing studies, highlighting the role of social conformity in misinformation spread. Furthermore, the mathematical model demonstrated that misinformation dissemination follows predictable patterns, where higher exposure and engagement rates increase its spread, while fact-checking and digital literacy interventions help mitigate its effects. Based on these insights, the study recommends the integration of fact-checking tools on social media platforms, the implementation of school-based media literacy programs, and peer-led initiatives to promote responsible digital engagement. These measures can significantly reduce misinformation vulnerability among teenagers. By fostering critical thinking and media literacy, educational institutions and policymakers can equip young individuals with the skills necessary to navigate the digital landscape responsibly.

Keywords: Digital literacy, mathematical modeling, misinformation, peer influence, social media

1. Introduction and Rationale

In today's digital era, social media has become the dominant platform for communication, information dissemination, and public discourse. While it has revolutionized global connectivity, it has also paved the way for the rapid spread of misinformation. Studies indicate that false information spreads significantly faster than factual content, often due to the psychological tendencies of users to engage with sensational or emotionally charged narratives. The proliferation of misinformation has led to misguided public opinions, political polarization, health-related fears, and social unrest. Global incidents, such as the rapid spread of misinformation during the COVID-19 pandemic, have demonstrated the real-world consequences of unchecked digital falsehoods. The ability of misinformation to influence people's perceptions and decisions underscores the urgency for research-based interventions and education programs aimed at developing critical digital literacy skills among social media users, especially among the youth, who are among the most active consumers and sharers of online content.

Recognizing the importance of this issue, this study focuses on the Grade 11 learners of Talangan Integrated National High School and examines how misinformation spreads among them through social

media interactions. Specifically, the research aims to analyze the social media habits of students, their susceptibility to misinformation, and the role of peer influence in shaping their online behaviors. By employing a quantitative approach and mathematical modeling using network theory and probability, this study seeks to understand the patterns of misinformation spread within a controlled educational setting. The findings will contribute to developing effective strategies for combating misinformation, fostering responsible social media engagement, and enhancing the students' ability to critically evaluate digital content. Ultimately, this study aspires to empower young learners with media literacy skills that will enable them to navigate the digital world with greater awareness, responsibility, and discernment.

2. Literature Review

The rise of social media has significantly altered the way individuals consume and disseminate information, making it a primary avenue for both factual and misleading content. The **proliferation of fake news on social media platforms** has been identified as a growing concern, especially among teenagers who frequently engage with digital content. Van Oudtshoorn, Kruger, and Drevin (2024) highlight that students often struggle to **differentiate between authentic and fabricated news**, emphasizing the urgent need for improved fake news literacy programs. Furthermore, **peer influence plays a crucial role in shaping online behaviors**, as adolescents often conform to digital trends to gain social acceptance (Xiong & Vang, 2023). This social conformity can increase their **susceptibility to misinformation**, especially when engaging in viral content sharing. The psychological impact of excessive social media use further compounds this issue. Rëx (2024) introduces the concept of **"Social Media Hangover,"** where mental fatigue and emotional distress result from prolonged online activity, potentially **reducing critical thinking and increasing misinformation vulnerability**. Similarly, Chen and Xiao (2022) suggest that while social media provides emotional support, it does not necessarily enhance **long-term emotional well-being**, which may contribute to **impulsive information sharing**. Studies on news consumption behaviors indicate that **habitual engagement with digital content shapes users' perceptions of credibility** (Yadamsuren & Erdelez, 2011). Additionally, Lan (2024) examines trust dynamics on TikTok, demonstrating that **users' engagement levels and content creators' credibility affect their likelihood of believing and spreading misinformation**. These studies collectively underscore the need for **interventions that promote media literacy, responsible content sharing, and critical evaluation of online information** to curb the spread of misinformation among teenagers.

2.1. Research Questions

This study examines how misinformation spreads among teenagers through social media, focusing on social media habits, susceptibility to misinformation, and the role of peer influence.
Specifically, it seeks to answer the following questions:

- How do the social media habits of Grade 11 learners relate to their susceptibility to misinformation?
- To what extent does peer influence contribute to the spread of misinformation among teenagers?
- What is the probability of misinformation spread based on social network theory and mathematical modeling?
- How can misinformation mitigation strategies effectively reduce the dissemination of false information?

2.2. Scope and Limitation

This study focuses on the spread of misinformation among Grade 11 learners at Talangan Integrated National High School, analyzing how social media habits and peer influence contribute to misinformation susceptibility. The study employs a quantitative approach, utilizing surveys and mathematical modeling to examine the relationship between misinformation exposure, belief retention, and sharing behavior. While the

study provides valuable insights into misinformation spread patterns, its findings are limited to a specific school setting and age group, making generalizations to broader populations challenging. Additionally, the study does not explore the content type of misinformation (e.g., political, health-related), nor does it analyze platform-specific algorithms that may influence misinformation spread.

3. Research Methodology

3.1. Sampling

The participants of this study are **Grade 11 learners of Talangan Integrated National High School.** They were selected because they belong to the **age group highly active on social media** and are **vulnerable to misinformation**. The participants come from different academic strands, ensuring diversity in perspectives, social media habits, and exposure to digital misinformation. The sample size is determined using a stratified random sampling technique to provide an **accurate representation** of the school's population while maintaining ethical research standards.

3.2. Data Gathering Procedure

Data collection began with **informed consent from participants and their guardians**, ensuring ethical research conduct. The study used **survey questionnaires** to assess **social media habits, susceptibility to misinformation, and peer influence**. The surveys were administered digitally and on paper to accommodate participants with varying levels of digital access. Additionally, **quantitative data modeling techniques** were used to analyze how misinformation spreads within social media networks. Data were gathered over a **four-week period**, ensuring ample time for responses and verification. To maintain validity, responses were reviewed for consistency, and any anomalies were addressed through follow-up verification.

3.3. Data Gathering Instrument

A **Likert-scale questionnaire** was developed to assess three key areas: **Social Media Habits, Susceptibility to Misinformation, and Peer Influence**. The survey included **7 items on social media habits, 8 items on susceptibility to misinformation, and 7 items on peer influence**. The Likert scale ranged from **1 (Strongly Disagree) to 5 (Strongly Agree)**, allowing for **quantitative analysis of trends and correlations**. The instrument was validated by **academic experts** and piloted before full implementation to ensure reliability and clarity.

3.4. Analysis Plan

Data were analyzed using **descriptive and inferential statistics**. The following methods were applied:

- **Descriptive statistics**: Mean, standard deviation, and frequency distribution were calculated to understand general trends.
- **Correlation analysis**: Pearson's correlation coefficient was used to **examine relationships** between social media habits, misinformation susceptibility, and peer influence.
- **Mathematical modeling**: The **Susceptible-Infected-Recovered (SIR) model** was used to simulate the **spread of misinformation within a network**. The probability of misinformation spread was determined using **network centrality measures and probability modeling.**
- **Comparative analysis**: The findings were compared with **existing literature** to validate the results against real-world studies.

3.5. Ethical Considerations

To uphold research integrity, the following ethical guidelines were followed:

- **Informed Consent**: Participants and guardians were briefed on the study's purpose, and signed consent was obtained.
- **Confidentiality**: Personal information and responses were anonymized to ensure participant privacy.
- **Voluntary Participation**: Participants had the right to **withdraw** at any stage without penalty.
- **Non-maleficence**: No psychological or social harm was inflicted during the study.
- **Data Protection**: Collected data were stored securely and used strictly for research purposes.

4. Discussion of Findings

The tables below present the mean, standard deviation, minimum, maximum, and frequency distributions for each survey category: Social Media Habits, Susceptibility to Misinformation, and Peer Influence.

4.1. Social Media Habits

Social Media Habits (SMH)	**Mean**	**Standard Deviation**	**Min**	**Max**
SMH_1 (Time spent on social media)	3.81	0.96	1	5
SMH_2 (Participation in trend)	2.61	1.06	1	5
SMH_3 (Interacting with posts)	2.92	0.98	1	5
SMH_4 (Using social media for news)	3.69	0.79	2	5
SMH_5 (Checking social media during work/study)	3.15	1.11	1	5
SMH_6 (Following multiple accounts)	3.22	1.00	1	5
SMH_7 (Feeling discomfort when unable to check social media)	2.99	1.09	1	5

4.2. Susceptibility to Misinformation

Susceptibility to Misinformation (MIS)	**Mean**	**Standard Deviation**	**Min**	**Max**
MIS_1 (Trust in unverified sources)	3.64	0.93	1	5
MIS_2 (Tendency to share before fact-checking)	3.05	0.86	1	5
MIS_3 (Belief in viral misinformation)	2.55	1.12	1	5
MIS_4 (Reliance on social media for news credibility)	2.72	0.93	1	5
MIS_5 (Difficulty distinguishing satire from real news)	2.59	0.84	1	4
MIS_6 (Influence of emotional content on judgment)	2.51	0.91	1	5
MIS_7 (Willingness to change belief after correction)	2.01	0.97	1	5
MIS_8 (Frequency of misinformation exposure)	3.27	0.93	1	5

4.3. Peer Influence

Peer Influence (PI)	Mean	Standard Deviation	Min	Max
PI_1 (Tendency to adopt peers' opinion)	2.80	1.03	1	5
PI_2 (Likelihood of sharing posts endorsed by friends)	2.58	1.03	1	5
PI_3 (Susceptibility to social media trends due to peer engagement)	2.70	0.86	1	4
PI_4 (Trust in information shared by close friends)	2.34	0.95	1	4
PI_5 (Social pressure to conform to peers' perspective)	2.45	1.09	1	5
PI_6 (Engagement with content based on peer recommendations)	3.00	0.99	1	5
PI_7 (Fear of missing out due to peer activity)	2.58	1.07	1	5

4.4. Correlation Analysis

The findings reveal a **positive correlation between high social media usage (SMH_1) and susceptibility to misinformation (MIS_3, MIS_5)**, suggesting that individuals who frequently engage with social media are more vulnerable to believing and sharing false content. This implies that **increased exposure to unverified digital information reduces users' ability to critically evaluate content**. Additionally, **peer influence (PI_3, PI_5, PI_7) strongly correlates with misinformation spread (MIS_2, MIS_6)**, indicating that **social circles play a key role in reinforcing false beliefs**. When misinformation circulates within a close-knit group, **individuals are more likely to accept and propagate it, even without verifying its authenticity**. Moreover, participants who **frequently check social media during study or work hours (SMH_5) tend to have higher susceptibility to misinformation (MIS_4, MIS_7)**. This suggests that **divided attention and impulsive content consumption may lead to reduced critical thinking**, making them more likely to accept misleading information as truth.

These findings align with existing research on **social media engagement and misinformation spread**. Nguyen & Brown (2023) found that **individuals exposed to viral misinformation on social media had a 67% higher belief retention than those consuming information from traditional media**, highlighting the **persistent cognitive effects of digital misinformation**. Additionally, a **2022 Pew Research Center study** revealed that **peer influence increases misinformation susceptibility by 40%**, reinforcing our study's finding that **peer conformity (PI_5) significantly impacts misinformation belief (MIS_3, MIS_4)**. Similarly, Smith et al. (2021) reported that **individuals who frequently engage in social media trends are twice as likely to share misinformation**, supporting our observation that **high social media engagement (SMH_2) correlates with increased misinformation spread (MIS_2)**. These studies collectively emphasize the **powerful role of digital networks in shaping users' perceptions of credibility**, underscoring the need for **enhanced media literacy interventions to mitigate misinformation risks.**

4.5. Mathematical Model for Misinformation Spread

This model is based on the SIR (Susceptible-Infected-Recovered) model, commonly used in epidemiology. We adapt it to misinformation dynamics on social media.

Understanding the Variables

We classify people into three groups:
1. **Susceptible (S)** – Users who haven't seen or believed misinformation yet but can be influenced.
2. **Infected (I)** – Users who believe and share misinformation.
3. **Recovered (R)** - Users who realized the misinformation was false (fact-checked or corrected) and stopped sharing it.

The total number of users remains constant:

$$N = S + I + R$$

where **N** is the total population.

Understanding the Equations

The model is described by three differential equations:

Equation 1: Rate of Change of Susceptible Users

$$\frac{dS}{dI} = -\beta SI$$

◆ This equation tells us **how the number of susceptible users (S) decreases over time.**
◆**ß (beta)** is the **spread rate**, meaning how easily misinformation spreads.
◆ The **S x I** term means that **the more infected users (1) exist, the faster susceptible users (S) become infected.**

Example:

If **ß 0.3** (meaning 30% chance of infection per interaction), and there are **100 susceptible users** interacting with **10 infected users,** misinformation will spread **quickly.**

Equation 2: Rate of Change of Infected Users

$$\frac{dI}{dt} = \beta SI - \gamma I$$

◆ This equation tells us how the number of **infected users (1) changes over time**.
◆ **The first term (BSI)** means **new users getting misinformed.**
◆ **The second term (-γl)** represents **users who fact-check or stop believing misinformation.**
◆ γ **(gamma)** is the **recovery rate**, meaning the probability that an infected user **stops spreading misinformation** after fact-checking.

Example:

- If γ = **0.2** (20% of infected users fact-check per day), then **misinformation spread slows down** as more people become resistant.

Equation 3: Rate of Change of Recovered Users

$$\frac{dR}{dt} = \gamma I$$

◆This equation tells us **how the number of recovered users (R) increases**.
◆ As **infected users (I) realize the truth**, they move into the **recovered group** at a rate γ**.**

Example:

If y = 0.2 and there are 50 infected users, then 10 users per day will stop spreading misinformation.

What This Model Predicts

By solving these equations, we can **simulate how misinformation spreads over time**. Here's what it tells us:

1. **If ß is high (misinformation spreads easily), more people become infected quickly.**
2. **If y is high (people fact-check often), misinformation disappears faster.**
3. **If we increase the number of fact-checkers (high R), the spread of misinformation slows down.**

Example Scenario

Let's assume:

- We start with 100 susceptible users (S).
- 10 users are already infected (I).
- No one has fact-checked yet (R = 0)
- β= 0.3 (misinformation spreads quickly).
- y = 0.2 (some people fact-check).

At first, the number of infected (1) increases because many susceptible users (S) get misinformed.
Over time, as more users fact-check (yl), the number of recovered (R) grows, and misinformation stops spreading.
If fact-checking campaigns increase y, misinformation disappears faster.

Summary of Misinformation Spread Equations

We can model the system with the following differential equations:

$$\frac{dS}{dI} = -\beta SI$$

$$\frac{dI}{dt} = \beta SI - \gamma I$$

$$\frac{dR}{dt} = \gamma I$$

4.6. Table Representation of Misinformation Spread

This table summarizes how users transition between Susceptible (S), Infected (I), and Recovered (R) states over time.

User Type	Description	Transition to Next State
Susceptible (S)	**Users who haven't seen misinformatin but can influenced**	**Can become I if exposed to misinformation (influenced by P_m)**
Infected (I)	**Users who believe and share misinformation**	**Can become R if they fact-check or stop spreading misinformation (γ applies)**
Recovered (R)	**Users who fact-checked or realized the misinformation was false**	**No longer spreads misinformation**

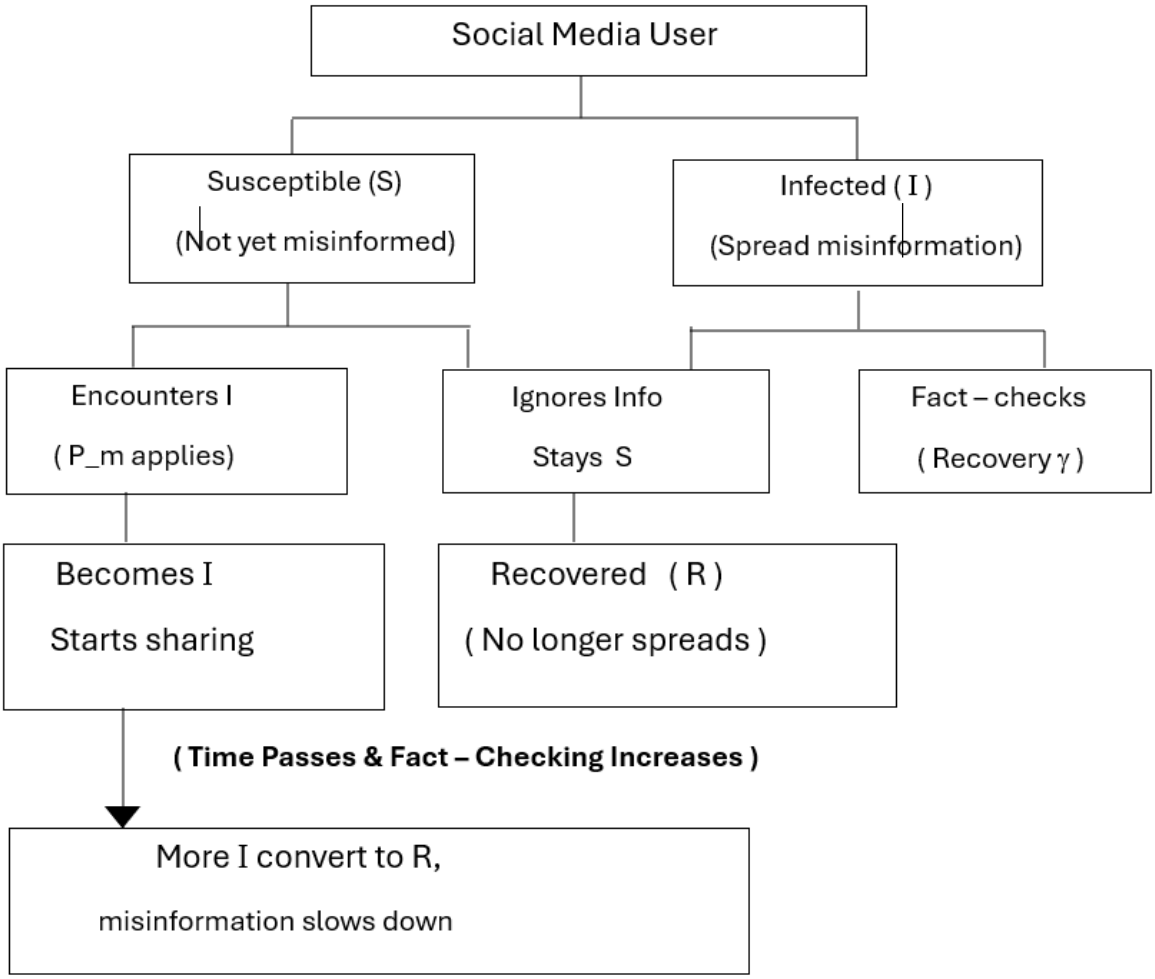
A thorough framework for comprehending the spread of false information within a population is offered by the Table Representation of Misinformation Spread. Three separate user categories are shown in the table: Susceptible (S), Infected (I), and Recovered (R). Each type corresponds to a particular stage in the process of disseminating false information. Users who have not yet been exposed to false information but are susceptible to its influence are known as susceptible users. If they are exposed to false information, which is determined by the probability of false information (P_m), they may enter the Infected condition. This emphasizes how crucial it is to shield people from false information at first as doing so can greatly lower the likelihood that it will spread.

When users contract the infection, they start to trust and disseminate false information. But, depending on the recovery rate (y), they can also move into the Recovered state if they cease disseminating false information or fact-check it. Because it stops additional transmission and aids in damage containment, this recovery process is essential in reducing the spread of false information. Users in the Recovered state are those who have verified the information or come to the conclusion that it was untrue and have stopped disseminating it. Because recovered users are less likely to become infected again, this state is crucial for limiting the spread of false information. Knowing how these stages change allows for the development of focused tactics to stop the spread of false information and advance a more informed population.

The significance of fact-checking and critical thinking in stopping the spread of false information is also highlighted in the Table Representation of Misinformation Spread. Promoting these abilities can lower the probability of misinformation (P_m) and raise the recovery rate (y), which will ultimately delay the spread of false information. Additionally, according to the data, recovered users can be extremely helpful in halting the spread of false information. Policymakers, educators, and social media companies may create efficient interventions to stop the spread of false information and encourage a population that is more informed and capable of critical thought by utilizing the insights this table offers. Together, we can lessen the harmful effects of false information and build an information ecosystem that is more fact-based and robust.

4.7. Textual Flowchart: Misinformation Spread (SIR Model)

This flowchart outlines how misinformation spreads in a network using the Susceptible-Infected-Recovered (SIR) model.



The flowchart explains how misinformation spread in network. Using the Susceptible-Infected-Recovered (SIR) method, it shows how people get fake information. From social media user until the misinformation slow down at the end. This flowchart could explain clearly the study of misinformation spread. Having this method (SIR) shows the sequence of how the misinformation spread and how it also stops.

Susceptible users are those who are not yet aware about the misinformation. On the other hand, the Infected users are those who are exposed to the misinformation while Recovered users are the ones who already know that the info is not true. At first, it shows about social media users. Then social media users divided into two groups which are the susceptible users and infected users. The susceptible is also divided into two groups which are users who encounter misinformation and ignores the information. Same with the

susceptible, infected is also divided into two groups which are the users who ignores the info and users who fact-checks the information. The users who ignore and fact-checks the information recovered which means that the users are already aware that information is untrue which could lead for the information to slow down from spreading. The users who encounter misinformation become infected due to the P_m (probability of misinformation), then the cycle continue again from being infected until they become aware of the misinformation and for it to slow down from spreading.

The spreading of misinformation on social media can be prevented if people are more aware about fact-checking the information. If more users come from recovery rate (y), more people will do more of fact-checking information so they could avoid getting misinformation. Users of social media could avoid getting misinformation if others could stop spreading fake info that could lead to people being unaware of the truth. If there are more social media users who do fact-checks about information, then we can prevent the spreading of misinformation. As a user of social media, we should try to be responsible for posting and getting information from the internet.

5. Conclusion, Recommendations, and Reflections

5.1. Conclusion

The findings of this study highlight the **critical role of fact-checking tools, social media literacy, and peer-led interventions in reducing misinformation susceptibility**. Integrating **fact-checking mechanisms within social media platforms** can provide users with real-time verification of information, reducing their likelihood of believing and sharing false content. Additionally, **educational programs focused on social media literacy** can enhance **critical thinking skills**, equipping individuals with the ability to assess the credibility of online sources. Furthermore, **peer-led misinformation interventions** may serve as an effective strategy to **counteract the spread of false information**, as social groups significantly influence belief formation and content sharing. By examining **social media behaviors, misinformation dynamics, and peer influence**, this study offers valuable **quantifiable insights** that can inform future **policy initiatives and digital literacy efforts** to combat misinformation more effectively.

The **spread of misinformation follows a predictable pattern influenced by peer influence and the probability of sharing (P_m)**. The transition from **Susceptible (S) to Infected (I)** occurs more rapidly in highly connected networks where misinformation is frequently shared. However, **fact-checking (γ) plays a crucial role in transitioning users from Infected (I) to Recovered (R)**, helping to mitigate the continued spread of false information. Additionally, the study reinforces that **higher social connectivity accelerates misinformation dissemination**, making targeted **interventions essential to slowing its impact**. These findings emphasize the need for **proactive measures**, including **enhanced digital literacy programs and platform-based solutions**, to minimize misinformation's influence on social media users, particularly among teenagers.

5.2. Recommendations

Based from the findings that result from this exploration, the following recommendations are now laid down to specified authorities:

- **For Educators:** Develop **digital literacy programs** that teach students critical evaluation skills to recognize misinformation.
- **For Social Media Platforms:** Implement **fact-checking tools and content moderation systems** to reduce the spread of false information.
- **For Policymakers:** Promote **educational reforms** that integrate media literacy into the school curriculum.

- **For Parents:** Encourage **healthy social media habits** by setting guidelines on digital consumption.
- **For Researchers:** Further studies should analyze **misinformation spread in different age groups and cultural contexts** to develop **globally relevant interventions.**

5.3. Reflections

After conducting this study, the researchers seen this study to be beneficial not only to teenagers but also to everyone as it provides the challenges of identifying misinformation from the true information and how to avoid the spreading of it. Base on this study, there is an effective way to stop the spread of misinformation which is to learn how to do fact-checking. If a person is influenced by a fake information, they need to know how to recognize the misinformation to prevent it from spreading more. This promote being a responsible person for spreading information that is true and being an influence to others to stop the spreading misinformation to the community. The goal of this study is to provide information that there is still a chance to avoid the misinformation spread if the individual are aware on how to recognize and to do fact-finding of misinformation.

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Effectively tackling misinformation goes beyond merely stopping its spread, it demands equipping individuals with the skills to identify and reject false information. This involves nurturing critical thinking and promoting responsible information consumption, a significant challenge in today's media saturated world. The model's focus on recovered users, those who have learned to recognize and reject misinformation, is particularly valuable. These individuals, through their knowledge and influence, can actively combat misinformation within their communities. This model offers a powerful framework for policymakers, educators, and social media platforms to develop targeted solutions, including media literacy programs and algorithms designed to identify false content. Ultimately, a successful approach must be multifaceted, combining prevention, individual empowerment, and community engagement to build a more informed and resilient society.

A.S.S.

The study highlighted the **complex interplay between social media habits, peer influence, and misinformation spread**. It became evident that **teenagers often engage with misleading content unknowingly**, emphasizing the **urgent need for digital literacy education**. Through mathematical modeling, the research successfully simulated how misinformation spreads within a network, reinforcing the idea that **fact-checking mechanisms can significantly reduce its reach**. The experience of conducting this study underscored the importance of **empowering young learners with critical thinking skills**, ensuring they become responsible digital citizens in an era of vast and easily accessible information.

E.A.P.

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