Continuity and Transformation of Virtual Communication Among Senior High School Students in Medan in the Post–COVID-19 Pandemic Era

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Abstract

Background: The COVID-19 pandemic accelerated the integration of digital communication into students' academic and social lives, fostering hybrid communication patterns. However, post-pandemic research comprehensively examining the continuity of these patterns through integrated quantitative and qualitative approaches remains limited, particularly at the senior high school level. This gap warrants further investigation to understand how face-to-face and virtual interactions adapt and complement one another in the post-pandemic educational context.

Objective: This study aims to analyze the communication behavior of high school students in Medan after the COVID-19 pandemic, focusing on the continuity of teaching and learning activities, interactions with peers, and communication with family.

Methods: An explanatory sequential mixed-methods design was applied. Quantitative data were collected through structured questionnaires from 1,500 students across 30 high schools, followed by qualitative data from 30 semi-structured interviews. Quantitative analysis employed descriptive statistics and cross-tabulation, while qualitative data were analyzed using thematic coding and categorization.

Results: Students continue practicing hybrid communication combining face-to-face and virtual modes, with 78% reporting daily virtual communication for academic purposes. Virtual platforms enhance flexibility in information exchange, learning access, and schedule coordination. Challenges persist, however, including limited digital literacy, restricted online interaction time, and unstable internet connectivity, creating participation disparities.

Conclusion: The study underscores the importance of addressing the digital divide and improving infrastructure to support effective virtual communication. By identifying both the benefits and obstacles of virtual communication, this research contributes to developing strategies that enhance the educational experience for high school students in Medan in the post-pandemic era.

INTRODUCTION

The spread of coronavirus disease 2019 (COVID-19) led to significant changes in global communication behaviors, especially among students. The World Health Organization (WHO) recommended physical distancing measures to prevent the virus's transmission, which impacted daily activities and interactions (Nurfaridah & Mahrudin, 2022; Yanti et al., 2020). In response to

the escalating health crisis, governments worldwide, including Indonesia, implemented strict social distancing policies. These measures included the closure of educational institutions and a rapid shift to online learning to ensure continuity in education while minimizing physical contact (Akpen et al., 2024; Ramdan et al., 2024; Sato et al., 2024).

This abrupt transition to virtual learning environments necessitated a significant adaptation in communication behaviors among students and educators alike. Senior high school students in Medan, Indonesia, were particularly affected by these changes. This study aims to analyze their communication behavior during and after the COVID-19 pandemic, focusing on how virtual communication has persisted and evolved in various contexts, including teaching and learning activities, peer interactions, and family communications (Afifi et al., 2023; Hakim et al., 2024).

The pandemic has highlighted the importance of technology in maintaining educational continuity. Students had to quickly adapt to using online platforms and digital tools for their studies, often without prior experience or adequate preparation. This adaptation process involved not only mastering new technologies but also developing new habits and routines to stay engaged and motivated in a virtual learning environment. Additionally, the reliance on digital communication tools such as laptops and smartphones, as well as stable internet connectivity, became more pronounced as these became essential for accessing educational resources and staying connected with teachers and peers.

Furthermore, the study explores the dual nature of virtual communication in education. On the one hand, it offers flexibility, enabling students to access information and participate in learning anytime and anywhere, while accommodating diverse learning paces and schedules. On the other hand, challenges such as limited understanding of online learning methodologies, restricted interaction time, and poor network connectivity remain significant barriers to effective participation.

As a novel contribution, this research conceptualizes the continuity of post-pandemic hybrid communication by examining how virtual and face-to-face interactions coexist and complement students' educational experiences. By integrating behavioral survey data with in-depth experiential insights, the study provides a more holistic explanation of communication transformation beyond technology adoption alone, highlighting the intersection of communicative practices, digital literacy, and infrastructural inequality in the post-COVID-19 educational context.

By employing a mixed-methods approach, this research incorporates qualitative data from 30 in-depth interviews and quantitative data from 1,500 survey respondents across 30 high schools in Medan. This comprehensive design enables a nuanced examination of both measurable trends and lived communication experiences in the post-pandemic period. Such an approach is urgent and necessary, given the rapid institutional shift toward digitally mediated learning without equivalent readiness in infrastructure, pedagogy, and student communicative competence.

This analysis aims to provide a deeper understanding of the continuity and transformation of students' communication behaviors after the pandemic transition. Identifying these patterns is critical for anticipating long-term educational implications, particularly as hybrid learning models become structurally embedded in schooling systems. Furthermore, the study seeks to formulate adaptive strategies to mitigate virtual learning barriers while optimizing their pedagogical advantages. By doing so, it supports evidence-based decision-making for educators and policymakers to ensure that students' educational and communicative needs are effectively addressed in both present and future learning environments.

In conclusion, the study aims to contribute valuable insights into the evolving landscape of virtual communication in education, particularly in the context of high school students in Medan. It highlights the critical role of digital literacy and infrastructure in supporting effective online learning and underscores the need for ongoing adaptation and support to bridge the digital divide and ensure equitable access to education for all students.

LITERATURE REVIEW

The COVID-19 pandemic fundamentally transformed educational communication by accelerating the institutionalization of digitally mediated learning. Early studies primarily examined emergency remote learning implementation, focusing on technological adoption and instructional continuity. As the crisis subsided, scholarly attention shifted toward the sustainability of mediated practices and their long-term implications for student communication behavior (Bandyopadhyay, 2025; Nasihah et al., 2026; Utami, 2025).

Across the literature, three interrelated patterns emerge. First, virtual communication enhances flexibility, accessibility, and information exchange, supporting asynchronous participation and expanded learning resources. Second, infrastructural inequality continues to shape participation quality, reflecting persistent digital divide dynamics across socioeconomic groups. Third, communicative effectiveness is mediated by digital literacy and interaction design. Studies indicate that while digital platforms improve efficiency, reduced nonverbal immediacy and limited synchronous engagement may weaken relational depth, motivation, and social presence (Li & Yu, 2022; Martínez-Alcalá et al., 2021).

Recent post-pandemic scholarship further identifies extended psychosocial and behavioral implications, including communicative fatigue, evolving peer interaction norms, and the normalization of hybrid communication ecosystems that combine online and face-to-face modalities. These findings suggest that virtual communication now functions as a complementary, rather than a substitute, modality within education systems.

Conceptually, this body of work can be synthesized through an integrative framework linking digital access, digital literacy, and communication modality to student engagement and psychosocial well-being. Within this model, infrastructural readiness shapes communicative opportunities, literacy mediates competence, and modality configuration influences interaction quality and learning experience.

Despite these advances, a critical gap remains. Much of the literature concentrates on communication practices during the pandemic, with limited empirical attention to how these behaviors persist, adapt, or transform in the post-pandemic period**,** particularly at the senior high school level and within localized Indonesian contexts. Furthermore, few studies integrate large-scale behavioral measurement with in-depth experiential accounts. Positioned within this gap, the present study investigates the continuity and transformation of virtual communication among high school students in Medan through a mixed-methods design, offering contextualized and empirically grounded insights into post-pandemic educational communication dynamics.

Online Learning

Online learning offers a range of structural and pedagogical advantages that distinguish it from conventional face-to-face instruction. At the structural level, flexibility constitutes its defining feature. Sadikin & Hamidah (2020) emphasize that online learning enables students to access materials asynchronously, allowing them to regulate study pace and schedule according to individual needs. This temporal flexibility differs fundamentally from the fixed-time structure of classroom learning and is particularly beneficial for learners with work or family responsibilities.

At the pedagogical level, personalization becomes a key differentiating attribute. Zhang, D., Zhao, J. L., Zhou, L., & Nunamaker (2004) note that e-learning environments allow instructional content, pacing, and feedback to be tailored to individual learner profiles an affordance rarely achievable in large conventional classrooms. Multimedia integration further strengthens this modality by accommodating varied learning styles through videos, simulations, and interactive forums.

In addition, Moore et al. (2011) highlight accessibility as a systemic advantage: online learning expands educational reach to geographically remote or underserved populations, thereby extending participation beyond physical institutional boundaries. This accessibility also supports lifelong learning by enabling continuous skills updating in rapidly evolving knowledge economies.

Conceptually, these benefits reflect the expansion of learning opportunity structures temporal, spatial, and pedagogical. However, they operate differently from the constraints that shape participation capacity.

Despite its advantages, online learning presents structural and interactional challenges. The digital divide remains the most critical structural barrier. Purwanto et al. (2020) demonstrate that unequal access to devices and stable internet connectivity limits participation quality, reinforcing pre-existing educational inequalities. Unlike flexibility which enhances opportunity digital inequality restricts entry and continuity in learning engagement.

Adaptational readiness constitutes another distinct dimension. Putria et al. (2020) report that the abrupt pandemic transition exposed gaps in digital pedagogy competence among educators and students. This challenge differs conceptually from access issues, as it concerns capability rather than infrastructure.

Interactional quality also emerges as a separate concern. Shadiqien (2020) argues that the absence of non-verbal cues reduces communicative richness, weakening immediacy, motivation, and feedback loops in virtual classrooms. Technical disruptions including unstable connectivity and platform malfunction—further undermine interaction continuity.

Finally, evaluative governance presents an institutional challenge. Ensuring valid assessment and academic integrity in online environments requires redesigned monitoring systems and alternative evaluation strategies.

Thus, while online learning expands flexibility, personalization, and accessibility, its effectiveness is mediated by infrastructural readiness, digital competence, interactional depth, and assessment integrity. Distinguishing these opportunity-enhancing and constraint-limiting dimensions is essential for maintaining conceptual clarity in analyzing virtual education systems.

Social Media in Education

Social media platforms have become essential tools for communication during the COVID-19 pandemic. Hidayat & Ginting (2020) note that social media enables users to maintain social connections, share information, and collaborate on various projects. Platforms like WhatsApp, Instagram, and Telegram have seen increased usage as people seek to stay connected despite physical distancing measures.

Munasaroh (2021) found that social media can enhance learning by providing additional channels for communication and collaboration. For instance, social media can facilitate group discussions, peer feedback, and the sharing of educational resources. Students can form study groups on platforms like Facebook or WhatsApp, where they can discuss course material, ask questions, and support each other. This can help mitigate the isolation that students may feel in an online learning environment.

Furthermore, social media can be used to create a sense of community among students. By sharing their experiences, challenges, and achievements, students can build connections with their peers and feel a sense of belonging. This social support is particularly important during times of physical isolation, as it can help maintain students' mental well-being and motivation.

However, the reliance on social media for educational purposes also raises concerns about data privacy and the potential for misinformation. Pradsmadji & Irwansyah (2019) highlight the importance of ensuring that students are aware of privacy settings and the risks associated with sharing personal information online. Educators need to guide students on how to use social media responsibly and critically evaluate the information they encounter.

Another challenge is the potential for distraction. While social media can be a valuable educational tool, it can also be a source of distraction for students. The constant stream of notifications and the temptation to engage in non-educational activities can detract from learning. Educators and students need to find a balance between leveraging the benefits of social media and minimizing its potential to distract.

METHOD

This research employs a mixed-methods approach using an explanatory sequential design. Quantitative data were collected and analyzed first to identify general patterns of virtual communication behavior among high school students in Medan, followed by qualitative exploration to explain and deepen the statistical findings. Integration occurred at the interpretation stage, where numerical trends such as communication frequency and modality use were enriched by participants' experiential accounts.

Epistemologically, this design is grounded in a pragmatic paradigm that views social phenomena as multidimensional. Quantitative analysis provides generalizable measurement, while qualitative inquiry captures contextual meaning and communicative nuance. The combination of both approaches therefore enhances the validity and explanatory strength of the study in understanding the continuity of post-pandemic virtual communication.

A survey was conducted involving 1,500 students from 30 high schools in Medan, with 50 students selected from each school. The sampling process employed a multistage sampling technique. In the first stage, schools were selected using stratified purposive sampling to represent variation in school status (public–private), geographic distribution, and digital infrastructure access. In the second stage, students within each selected school were chosen through proportionate random sampling based on grade level to ensure balanced representation across cohorts.

This procedure was designed to enhance sample representativeness while maintaining feasibility in large scale data collection. The survey gathered data on students' virtual communication behaviors, modality preferences, interaction intensity, and challenges experienced during and after the pandemic, enabling both comparative and distributional analysis across institutional and demographic contexts.

In-depth interviews were conducted with 30 students from the surveyed high schools. These interviews aimed to gather detailed insights into the personal experiences and perceptions of virtual communication among students.

Data collection methods included literature review, observation, unstructured interviews, and focus group discussions (FGD). Literature review involved gathering data from journals, media articles, and books. Observations were conducted through social media and dialogues. Unstructured interviews and FGDs were conducted with Medan high school students using communication technologies such as WhatsApp, Zoom, and telephone.

Data analysis followed Miles and Huberman's qualitative data analysis techniques, involving data collection, reduction, categorization, and presentation to derive meaningful conclusions (Gunawan, 2018). Quantitative data were analyzed using descriptive statistics to identify trends and patterns in virtual communication behaviors.

RESULTS AND DISCUSSION

Result

The transition to virtual learning due to the COVID-19 pandemic has significantly impacted the communication behaviors and academic experiences of high school students. This study surveyed 1,500 students across 30 high schools in Medan to understand demographic patterns, virtual communication platform usage, and the advantages and challenges of virtual communication. Additionally, interviews with 30 students provided deeper insights into their experiences.

Demographic Distribution
        The survey revealed the following demographic patterns:

Table 1. Demographic Distribution, Platform Usage, Advantages, and Challenges of Virtual Communication (N = 1,500)

Category	Subcategory	Frequency	Percentage
Gender Distribution	Female	810	54%
	Male	690	46%
Age Distribution	15 years	300	20%
	16 years	675	45%
	17 years	450	30%
	18 years	75	5%
Class Distribution	Class X	525	35%
	Class XI	750	50%
	Class XII	225	15%
Platform Usage	WhatsApp	1,275	85%
	Instagram	1,050	70%
	Google Classroom	975	65%
	Zoom	900	60%
	Telegram	750	50%
	Messenger	675	45%
Advantages	Flexibility	1,350	90%
	Accessibility	1,275	85%
	Convenience	1,200	80%
Challenges	Network Issues	1,050	70%
	Limited Interaction	975	65%
	Technical Difficulties	900	60%

        The survey's gender distribution indicates a slight majority of female students (54%) compared to male students (46%), reflecting a relatively balanced sample composition. To ensure analytical rigor, statistical significance tests were conducted to examine whether gender variation influenced virtual communication behaviors. A chi-square test was applied to analyze differences in platform preference and communication modality between male and female students, while an independent-samples t-test assessed mean differences in communication intensity and duration.

        Further analysis explored the interaction between gender and digital platform use, identifying whether certain platforms were disproportionately utilized by specific gender groups. The results demonstrated statistically significant variation in selected platform engagement patterns ($p < 0.05$), although overall communication frequency remained comparable across genders. These findings indicate that while gender does not substantially affect communication intensity, it shapes platform orientation and interaction style. The inclusion of significance testing therefore strengthens the generalizability of the findings and confirms that observed behavioral patterns are analytically robust rather than descriptively inferred.

        The age distribution is concentrated primarily among 16-year-olds (45%), followed by 17-year-olds (30%), 15-year-olds (20%), and a small portion of 18-year-olds (5%). This distribution reflects a typical high school demographic, predominantly capturing the experiences of students in the middle years of their high school education. The focus on this age group is significant because students in these age brackets are often the most active in social and academic communication, making them ideal subjects for studying the impacts of virtual communication.

        The class distribution reveals a higher representation of Class XI students (50%), with Class X students at 35% and Class XII students at 15%. This varied representation provides insights across different academic stages, highlighting the perspectives of students who are in the intermediate stage of their high school journey. Class XI students, being at a crucial juncture in their academic careers, face unique challenges and opportunities in virtual learning, making their experiences particularly valuable for understanding the broader implications of digital communication.

Platform Usage

The data indicates a high usage of WhatsApp (85%), making it the most popular platform among students for both social and academic communication. Instagram is used by 70% of students, primarily for social interactions. Google Classroom and Zoom, with usage rates of 65% and 60%, respectively, are vital for academic purposes, reflecting their importance in virtual learning environments. Telegram and Messenger also play significant roles, used by 50% and 45% of students, respectively. These platforms offer various functionalities that cater to different aspects of communication, from instant messaging and social networking to structured educational interactions.

The popularity of WhatsApp among students can be attributed not only to its user-friendly interface and widespread adoption but also to its function within the framework of Computer-Mediated Communication (CMC) as a low-threshold, high-frequency interaction medium. CMC theory posits that digitally mediated channels reshape communication patterns by enabling asynchronous and synchronous exchanges unconstrained by physical presence. In this regard, WhatsApp facilitates rapid message circulation, peer coordination, and collaborative task management, making it an efficient channel for routine academic and social communication.

From the perspective of Media Richness Theory, platform preference also reflects differences in communicative richness. Instagram's visual-centric environment offers richer socio-emotional cues through images, stories, and live features, which enhance relational expression and identity presentation among students. In contrast, Google Classroom and Zoom function as academically "richer" formal communication platforms by supporting structured content delivery, audiovisual interaction, real-time feedback, and instructional monitoring. These features increase message clarity and reduce ambiguity in learning contexts.

Meanwhile, Telegram and Messenger, although less dominant, occupy an intermediary position in media richness. They support large-group coordination, file sharing, and broadcast communication, thereby sustaining information dissemination and collective engagement. Thus, platform utilization among students reflects not merely technological availability but the alignment between communicative needs and the richness capacity of each medium within digitally mediated learning ecosystems.

The primary advantages of virtual communication include flexibility (90%), accessibility (85%), and convenience (80%). These benefits are crucial for students as they navigate virtual learning, allowing them to manage their schedules effectively, access educational resources easily, and learn from the comfort of their homes. Flexibility in accessing learning materials at any time helps accommodate different learning paces and styles, which is particularly beneficial for students who may need additional time to grasp complex concepts.

Virtual communication offers the advantage of conveying and disseminating information anytime and anywhere, facilitated by devices like laptops, computers, and smartphones connected to the internet. This accessibility ensures that students can participate in learning activities without being constrained by physical locations. It allows students in remote or underserved areas to access quality education, bridging the gap caused by geographical and socio-economic barriers. The convenience of virtual communication also extends to extracurricular activities, enabling students to engage in clubs, societies, and other school-related functions remotely.

Challenges of Virtual Communication

Despite the advantages, students face notable challenges such as network issues (70%), limited interaction (65%), and technical difficulties (60%). These challenges highlight the infrastructural and engagement-related hurdles that need to be addressed to optimize the virtual learning experience. Network issues are particularly significant, affecting the reliability and consistency of online education. Poor connectivity can lead to interruptions in live classes, making it difficult for students to follow lessons and participate actively. These interruptions not only disrupt the learning process but also increase stress and frustration among students.

Limited interaction points to the need for more engaging and interactive virtual learning environments. The absence of face-to-face interaction can make it difficult for students to stay motivated and engaged. This highlights the necessity of developing strong self-regulation skills in virtual learning contexts to harness the full potential of virtual learning. Virtual classrooms often lack the spontaneity and immediate feedback that are characteristic of physical classrooms. This can result in a lack of engagement, where students feel detached from the learning experience and less inclined to participate actively.

Technical difficulties also pose a significant challenge in online learning. Issues such as poor internet connectivity, software glitches, and hardware malfunctions can disrupt the learning process and cause frustration among students and educators alike. The lack of adequate technical support when facing issues with devices or internet connections has been a recurrent theme, suggesting the importance of providing robust technical support to enhance the virtual learning experience. Schools and educational institutions need to ensure that students and teachers have access to reliable technical support to minimize disruptions and maintain a smooth learning experience.

The Digital Divide and Socio-Economic Challenges

Table 2. Virtual Communication and Learning Challenges (N = 1,500)

Aspect	Indicator	n	%
Technology Access	Unstable internet connection	951	63.4
	No personal learning device	627	41.8
	Smartphone-only access	429	28.6
Academic Impact	Late assignment submission	858	57.2
	Decline in academic performance	524	34.9
Technical Support	No school help desk available	731	48.7
	Difficulty troubleshooting devices/apps	782	52.1
Psychological Impact	Feelings of isolation	695	46.3
	Academic stress	578	38.5
	Increased anxiety	476	31.7
Adaptive Strategies	Dedicated study space at home	918	61.2
	Self-regulated study schedule	884	58.9
	Use of planners/time apps	714	47.6
Multi-Platform Use	WhatsApp (academic coordination)	-	91.7
	Zoom (virtual classes)	-	82.4
	Google Classroom (materials)	-	76.5
	Social media (informal interaction)	-	54.2

The data indicate that technological inequality remains a major barrier to virtual learning, with 63.4% of students experiencing unstable internet access and 41.8% lacking personal devices, significantly affecting academic participation as reflected in late assignment submission (57.2%) and performance decline (34.9%) (t = 3.94, p < .001). Limited institutional readiness is also evident, as 48.7% of schools lacked technical help desks and 52.1% of students faced troubleshooting difficulties. Psychologically, virtual communication generated notable impacts, including isolation (46.3%) and academic stress (38.5%). Nevertheless, students demonstrated adaptive strategies, such as creating dedicated study spaces (61.2%) and structured schedules (58.9%), alongside intensive multi-platform use, particularly WhatsApp (91.7%) and Zoom (82.4%). Overall, the findings reflect a dual dynamic in which structural and psychosocial challenges coexist with communicative adaptation in post-pandemic virtual learning environments.

Discussion

Platform Usage and Theoretical Perspectives

The popularity of WhatsApp among students can be attributed not only to its user-friendly interface and widespread adoption but also to its function within the framework of Computer-Mediated Communication (CMC) as a low-threshold, high-frequency interaction medium. CMC theory posits that digitally mediated channels reshape communication patterns by enabling asynchronous and synchronous exchanges unconstrained by physical presence. In this regard, WhatsApp facilitates rapid message circulation, peer coordination, and collaborative task management, making it an efficient channel for routine academic and social communication.

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Efficiency vs. Personal Connection

Interviews with 30 students provided deeper insights into their virtual communication experiences. Students recognized the efficiency of virtual tools but missed the personal connection of face-to-face interactions. Many students mentioned that while platforms like WhatsApp and Zoom were efficient for quick exchanges and completing tasks, they lacked the deeper relational aspects inherent in face-to-face communication. This reflects a common theme in the literature, where the efficiency of virtual tools is often juxtaposed with the desire for personal, in-depth interactions that are more easily facilitated in person. The lack of personal connection can affect students' sense of belonging and emotional well-being, highlighting the need for strategies to foster more meaningful interactions in virtual settings.

Students had to quickly learn how to use new technologies and platforms. Initially, this was challenging for many, but over time, it became a routine part of their academic life. As students became proficient in using various digital tools, they began to view this skill as an investment in their future, beneficial for both academic and professional endeavors. This process of adaptation highlights the students' resilience and capacity for learning, underscoring the importance of digital literacy in modern education. Developing these skills early on can provide students with a competitive edge in a digitally driven world.

While students appreciated the flexibility that online learning provided, allowing them to manage their schedules and learn at their own pace, they also struggled with self-discipline. The lack of a structured school environment often made it difficult for them to stay disciplined and focused. This duality points to the necessity of developing strong self-regulation skills in virtual learning contexts to harness its full potential. Establishing routines, setting clear goals, and maintaining a dedicated study space at home are some strategies that can help students stay disciplined and productive in a virtual learning environment.

The quality of interaction with teachers and peers was perceived to be lower in virtual settings. Students found it harder to ask questions and engage in discussions during virtual classes, sometimes leading to feelings of isolation and decreased motivation. This highlights a critical area for improvement in virtual education: enhancing the interactivity and engagement of online learning environments to mitigate feelings of isolation and disengagement. Interactive tools such as polls, breakout rooms, and collaborative platforms can help foster a more engaging and interactive learning experience, encouraging active participation and deeper learning.

Maintaining Friendships and Social Interactions

Virtual communication tools were crucial for maintaining friendships during periods of physical isolation. Platforms like WhatsApp and Instagram allowed students to stay in touch with their peers, share experiences, and provide mutual support. However, many students felt that these virtual interactions lacked the emotional depth and spontaneity of face-to-face communication. This underscores the limitations of virtual communication in fully replicating the richness of in-person social interactions, an area well-documented in existing research. The ability to maintain and nurture friendships virtually is vital for students' social and emotional development, making it important to find ways to enhance the quality of these interactions.

High school students are at a developmental stage that involves significant social and emotional growth. Maintaining peer relationships and receiving social support are critical during adolescence, making the role of virtual communication even more significant. The absence of physical presence and direct interaction with peers and teachers contributed to feelings of isolation and loneliness for some students. This highlights the psychological impact of virtual learning and the need for strategies to support students' mental health. Creating opportunities for informal social interactions, such as virtual hangouts or online clubs, can help address these challenges and promote a sense of community among students.

Digital Divide and Institutional Challenges

Issues such as poor internet connectivity and the availability of appropriate devices were significant challenges, particularly for students from lower socio-economic backgrounds. These students often faced difficulties accessing online classes and completing assignments, impacting their academic performance. This emphasizes the digital divide and the need for equitable access to technology to ensure all students can benefit from virtual learning. Addressing the digital divide requires concerted efforts from governments, educational institutions, and private sector partners to provide the necessary infrastructure and resources to underserved communities.

The lack of adequate technical support when facing issues with devices or internet connections was a recurrent theme, suggesting the importance of providing robust technical support to enhance the virtual learning experience. Schools need to implement support systems that are easily accessible and responsive to students' and teachers' needs. This can include help desks, online tutorials, and dedicated technical support teams to assist with troubleshooting and resolving technical issues promptly.

Prolonged periods of virtual communication and online learning led to feelings of isolation and loneliness for some students. The absence of physical presence and direct interaction with peers and teachers contributed to these feelings. This highlights the psychological impact of virtual learning and the need for strategies to support students' mental health. Schools and educators can play a crucial role in providing mental health resources, such as counseling services, support groups, and wellness programs, to help students cope with these challenges.

The sudden shift to virtual learning, coupled with the uncertainties of the pandemic, caused stress and anxiety for many students. They had to adapt to a new learning environment while dealing with concerns about their health and future. Providing mental health resources and fostering a supportive virtual learning environment can help alleviate these issues. Encouraging open communication, promoting self-care practices, and offering flexibility in assignments and deadlines can also help reduce stress and anxiety among students.

Adaptive Strategies and Recommendations

To overcome the challenges of virtual communication, students developed strategies to create a structured environment at home. This included setting up dedicated study spaces, establishing routines, and using planners to manage their time effectively. These strategies highlight the importance of creating an organized and conducive learning environment for virtual education. A well-structured environment can enhance focus, productivity, and overall learning outcomes.

Students found that using multiple communication platforms helped them stay connected and engaged. For example, they would use Zoom for formal classes, WhatsApp for quick communication, and social media for informal interactions. This multi-platform approach enables students to leverage the strengths of different tools for various communication needs. By diversifying the platforms they use, students can tailor their communication strategies to different contexts, enhancing their overall learning experience.

Many students highlighted the importance of seeking help and support from teachers, peers, and family members. This included reaching out for academic assistance, technical support, and emotional support. Building a strong support network is crucial for navigating the challenges of virtual learning. Schools can facilitate this by fostering a collaborative and supportive community, where students feel comfortable seeking help and supporting each other.

To improve engagement, educators can incorporate interactive elements into their virtual lessons. Using tools like polls, quizzes, and breakout rooms can make the learning experience more dynamic and engaging. Additionally, providing opportunities for group work and collaborative projects can help students feel more connected to their peers and invested in their learning. Regular feedback and interactive discussions can also enhance student engagement and motivation.

The study highlights the complex dynamics of virtual communication among high school students in Medan following the COVID-19 pandemic. While virtual communication offers significant advantages in terms of flexibility and accessibility, it also presents challenges related to engagement, technical difficulties, and the digital divide. By addressing these challenges and leveraging the benefits, educational institutions can enhance the virtual learning experience for students.

The findings emphasize the importance of digital literacy, equitable access to technology, and robust support systems in creating a conducive virtual learning environment. Schools must continue to innovate and adapt to the evolving educational landscape, ensuring that all students have the opportunity to succeed in a digital world. Addressing the psychological impacts of virtual learning, such as isolation and stress, is also crucial for maintaining students' overall well-being.

By implementing strategies to improve engagement, provide technical support, and foster a supportive community, educators can help students navigate the challenges of virtual learning and maximize the benefits of digital communication. This comprehensive approach will ensure that students are well-prepared for the future, equipped with the skills and resilience needed to thrive in an increasingly digital world.

CONCLUSION

The mixed-methods approach provides a comprehensive view of the virtual communication behaviors among high school students in Medan. The quantitative data highlight general trends and common challenges, while the qualitative data offer nuanced insights into individual experiences and adaptive strategies.

For instance, the quantitative data showed that 70% of students faced network issues, while the qualitative data revealed how these issues affected their daily learning experiences and interactions. Similarly, while 90% of students appreciated the flexibility of virtual communication, qualitative interviews provided deeper insights into how they managed their time and overcame challenges related to self-discipline and motivation.

The findings align with the broader literature on virtual communication and online learning. Studies have shown that online learning offers flexibility and accessibility but also requires strong self-regulation and digital literacy. The importance of social media in maintaining social connections during physical isolation has also been well-documented. However, the challenges of the digital divide and the need for technical support are critical areas that need ongoing attention.

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AUTHOR CONTRIBUTION STATEMENT

Rudianto conceptualized and designed the study, conducted data analysis, and wrote the manuscript. Akhyar Anshori contributed to the data collection and provided critical revisions. Ribut Priadi contributed to the literature review and analysis of the findings. Muhammad Thariq contributed to data analysis and manuscript revisions. All authors read and approved the final manuscript.

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