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Digital Literacy of Senior High School Science Students: A Case Study of Technology Use in Daily Academic Life

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ABSTRACT

Objective: *Digital literacy is an essential skill in education, particularly for high school science students, to support their learning needs. This article aims to explore the digital literacy skills of high school science students in the context of using digital technology for academic activities such as information searching, completing assignments, and engaging in online collaboration.* ***Method:*** *This study uses a case study approach with eight respondents from high school science classes in Maros Regency, South Sulawesi. Data were collected using seven open-ended questions to obtain information on students' experiences and thoughts in using digital devices.* ***Results:*** *The findings indicate that most students spend more than six hours per day using digital devices, primarily for entertainment and educational purposes. Students commonly use information sources such as Google and AI tools like ChatGPT. While they demonstrate an understanding of using technology for learning, they face challenges in verifying the credibility of online information. Moreover, although students possess adequate digital skills, their use of technology for online collaboration and learning still requires improvement.* ***Novelty:*** *This study offers a novel contribution by combining a focus on digital literacy among senior high school science students, the emerging trend of AI use in learning, an in-depth qualitative analysis of students' experiences and challenges, and the local context of digital literacy in South Sulawesi.*

INTRODUCTION

In the current era of technological advancement, digital literacy has become a critical skill that supports students' academic success. Beyond merely acquiring knowledge, students must also possess the ability to evaluate, manage, and communicate information effectively in digital environments. Digital literacy encompasses a range of competencies, including information searching, content creation, communication, and the critical evaluation of digital content. All of which are essential in the context of modern education (Connolly & McGuinness, 2018).

Digital literacy is an essential skill for high school science students, as it not only supports their abilities in research and data analysis but also enhances their capacity to communicate findings effectively in digital formats (Kaeophanuek et al., 2018). In education, digital literacy has become a critical competency integrated into curricula (Sadaf & and Johnson, 2017). The proliferation of various learning platforms and digital resources underscores the importance of students mastering the necessary skills to effectively interact with these technologies. Therefore, educational institutions should not solely focus on traditional learning methods but also actively incorporate digital technologie (Thelma et al., 2024). Currently, the workforce demands technological

competencies, which implies that students must leverage digital technology to support their future careers (Sadaf & and Johnson, 2017).

Digital literacy plays a crucial role for high school science students. In science learning, students are required to access, analyze, and communicate complex data through digital platforms. Whether conducting experiments in the laboratory, analyzing data, or presenting their findings to a broader audience, digital literacy is essential for excelling in the field of science (Dašić et al., 2024). Digital literacy empowers critical thinking through the processes of analyzing, evaluating, and synthesizing information effectively. This is particularly important in scientific inquiry, where students must interpret data (Rosa et al., 2023). Studies report that digital literacy mediates the relationship between motivation and science learning competence, demonstrating that digital literacy can enhance both motivation and learning outcomes (Nacaroğlu et al., 2025). Research conducted in Kazakhstan found that students taught by teachers with digital literacy showed improvements in their ability to use digital tools, technical skills, and creativity. (Temirkhanova et al., 2024). Without strong digital literacy skills, students may struggle to keep up with the rapidly evolving information available online. Students with inadequate digital literacy skills face difficulties in evaluating the credibility of online information, which is critical for academic performance and informed decision-making (Parsazadeh et al., 2015). Furthermore, the ability to visualize interactive data or presentations has become increasingly important in today's age of digital technological advancement. Mastery of digital technology supports students' academic achievement (Holm, 2025) and prepares them for careers in scientific research and technological innovation.

Research on the Digital Society Index in South Sulawesi Province in 2024 reported that digital literacy among the community in this province faces similar challenges. The overall Digital Society Index score for South Sulawesi was 42,26, with the Digital Skills pillar scoring relatively higher at 57,10. However, the Empowerment pillar, which measures the community's ability to utilize digital technology for social and economic empowerment, remains low at 24,27 Human Resource Development Agency for Digital Competence, 2024). This indicates that although digital skills among the community, including students, are improving, the use of digital technology to empower society in social and academic contexts still requires greater attention.

Although digital literacy in general has been widely researched, studies specifically examining the digital literacy of high school science students in the context of using digital technology in daily academic activities are still very limited. It is important to fill this gap, because a deep understanding of how students use digital technology in their daily academic lives can serve as strong empirical basis for teachers in designing learning that suits students' habits and needs.

Given the significant role of digital literacy in science learning, it is therefore essential to explore how high school science students utilize digital technology for information

seeking, completing assignments, collaborating on group tasks, and communicating with both classmates and teachers. With the rapid development of technology, including artificial intelligence (AI) in learning, a deep understanding of the digital literacy level of high school science students is very important to support their academic achievement and career preparation in the future. The results of this study are expected to provide insights into the application of digital literacy in high school science education and offer useful recommendations to enhance students' digital literacy skills in supporting their academic activities.

RESEARCH METHOD

This study employs a qualitative case study design to explore the digital literacy skills of high school science students in the context of their use of digital devices in daily academic activities

Participants

The participants consisted of eight Grade XII science students from a high school in Maros Regency, South Sulawesi. They were selected through purposive sampling based on specific inclusion criteria, namely the regular use of digital devices such as computers, laptops, or smartphones. The number of participants was determined according to grounded theory, where data collection ended once no new themes or ideas emerged from the respondents (Charmaz, 2014). To ensure adherence to research ethics, the researcher provided a clear explanation of the study's objectives and procedures and guaranteed the confidentiality of participant data.

Instrument and Procedures

The study used a questionnaire consisting of seven open-ended questions developed based on Greenstein's framework (Greenstein, 2012). The digital literacy indicators used in this study include access, evaluate, manage, integrate, create, communicate, reflect, and protect. Open-ended questions were chosen to explore students' thoughts, experiences, and perceptions regarding the use of digital technology in their academic activities. To ensure respondent confidentiality, personal data were not disclosed, and each participant was assigned a code.

Data Analysis

Data were analyzed qualitatively using the method of Miles et al. (2014), which consists of three fundamental stages to ensure systematic and rigorous interpretation of qualitative data:

1. Data Reduction

This initial stage involves the process of selecting, focusing, simplifying, and transforming the raw data collected from open-ended responses. Researchers carefully

review the data to identify relevant information, categorize significant statements, and condense the extensive dataset into manageable themes without losing the essence of the participants' perspectives.

2. Data Display

After reduction, the refined data are organized and presented in a structured format, such as tables to facilitate understanding and further analysis. This visual or textual display makes patterns, relationships, and emerging themes more apparent and accessible, enabling researchers to explore connections and contrasts within the data systematically.

3. Conclusion Drawing and Verification

The final stage involves interpreting the displayed data to derive meaningful conclusions related to the research questions. Researchers synthesize the findings, verify their accuracy by cross-checking with original data sources, and ensure that interpretations are well-supported. This verification process may include triangulation, peer debriefing, or member checking to enhance the credibility and trustworthiness of the analysis.

RESULTS AND DISCUSSION

Results

Digital literacy data were qualitative data obtained through open-ended questions regarding the use of digital technology by high school science students to support their academic activities. The qualitative data were analyzed using thematic analysis techniques involving coding to identify patterns from each respondent's answers. The results of the digital literacy analysis of high school science students are presented in Table 1.

Table 1. Summary of Students' Digital Literacy Themes and Key Findings

Theme / Question	Key Findings	Sample Statements
Use of digital devices	Digital devices are used very frequently (6–8 hours daily), mainly for assignments, studying, and entertainment	"I often use my smartphone to watch dramas and TikTok."
Information sources and credibility	Google, Wikipedia, AI tools (ChatGPT, Gemini) are the main sources; credibility checked by comparing multiple sources	"I ensure credibility by checking the source's reliability and comparing it with other sources."
Experience with online learning platforms	Most respondents have used Google Classroom; experiences vary, some faced network issues	"Google Classroom is good, but sometimes it's unclear if assignments have been uploaded."
Protection of personal data	Most use strong passwords, avoid sharing personal info,	"I use strong passwords and avoid sharing personal information."

Theme / Question	Key Findings	Sample Statements
	some enable two-factor authentication	
Creating digital content	Many use Canva, Capcut, PowerPoint to create videos and presentations	"I make videos and presentations using Canva and Capcut."
Online collaboration	WhatsApp and Google Docs are commonly used; challenges include monitoring task progress	"We do group work via WhatsApp, but it's hard to ensure friends have completed their tasks."
Views on digital technology in learning	Digital technology helps learning but can cause distractions and dependency	"Digital technology helps but also makes students lazy because they rely too much on it."

Discussion

Based on the analysis results, all respondents reported using digital devices for a considerable duration of 6 to 8 hours per day. Using digital devices for more than 6 hours can increase the risk of myopia by up to 1.8 times, highlighting the importance of schools monitoring students' screen time (Filkina et al., 2020). Additionally, some users reported higher incidences of musculoskeletal complaints and other physical health symptoms as a result of using digital devices for more than 6 hours daily (Tomar et al., 2017). While most students use digital devices for more than six hours daily, a significant portion of this time is spent on entertainment rather than learning or communication. Students engage in activities such as playing games, watching movies or cartoons, listening to music, and accessing social media platforms like TikTok. This usage pattern may have negative effects, as previous studies have shown that excessive use of technology for entertainment, especially social media, can inhibit the development of social skills (Payasi & Jain, 2025). Regarding academic needs, students primarily use digital devices for completing assignments and accessing learning materials.

Based on the analysis results, it appears that the awareness level of high school science students regarding the use of digital devices for learning is still lacking, as the use of digital devices for entertainment ranks highest. This situation is likely to impact students' academic performance. This finding is supported by research reporting that students who enjoy digital learning but have limited opportunities to use digital technology at school tend to experience a decline in engagement over time. (Hietajärvi et al., 2020).

In obtaining information, high school students utilize various popular digital platforms as their primary references, including: (1) Artificial Intelligence tools for finding relevant information such as ChatGPT and Gemini AI, (2) widely used search engines like Google, (3) open-source encyclopedias such as Wikipedia, and (4) paid educational platforms like Ruang Guru and CoLearn. Based on the analysis of student responses, none mentioned searching for information on official sites such as scientific

journals or academic databases. It appears that students tend to choose information sources that are easier to access and provide quick results, even if they may not be accurate. This indicates a need to enhance student education regarding the reliability of information sources.

Based on the data, most students reported using "Google" to search for information, indicating that they have yet to fully understand how to find information from reliable sources. The second most used tool is Artificial Intelligence; however, the information obtained through these tools still requires verification against primary sources. The use of AI for information searching has become a current trend (Farooq & Mishra, 2024). As AI technology continues to advance, the role of educators is crucial in helping students understand the importance of verifying information obtained through AI. This will enable students to develop skills in searching for accurate and trustworthy information.

In ensuring the credibility of information obtained from the internet, high school students employ several strategies, including cross-verification. Some students verify information by comparing content across different sources. To establish the credibility of information, cross-verification by comparing data from multiple sources is essential (Laouenan, 2022). This demonstrates that students are aware of strategies for verifying information. Additionally, some students have begun developing critical evaluation skills by considering the quality of the source, data accuracy, and the currency of the information. Among these methods, cross-verification is the most used approach. By conducting cross-verification, students are able to examine information from multiple perspectives and ensure its accuracy (Sari et al., 2021).

In online learning, high school students use two main platforms: Google Classroom and Moodle. These platforms are dominant Learning Management Systems (LMS) used especially during the COVID-19 pandemic (Nurdiyanti et al., 2021). The use of Google Classroom has been proven effective in improving learning outcomes (Jannah & Nurdiyanti, 2021). while Moodle is an LMS application that supports adaptive learning and collaboration (Gamage et al., 2022). However, based on the analysis results, some students reported encountering several obstacles, such as technical issues (unclear assignment uploads) and internet connectivity problems. Positive experiences include easier access to assignments, more flexible communication with teachers, and government-provided internet quota support. This indicates that online platforms provide benefits for learning, yet students face various challenges. Therefore, efforts are needed to overcome these barriers to make learning more effective.

In an effort to protect personal data confidentiality, students take several measures, including using passwords that are difficult to guess, refraining from sharing personal information carelessly, and enabling two-factor authentication. Responses from the participants indicate that high school students understand how to safeguard their personal data online. The most practiced method among students is using strong, hard-to-guess passwords. Privacy violations in online learning are common among students.

Therefore, education related to privacy and role-based identity management can help reduce these issues (Özer Şanal & Çiçek, 2024). Education about protected digital identities and privacy preservation is crucial to prevent privacy breaches that may harm students (Bertino, 2012).

Creating learning content has become a popular task among students, including making infographics, images, and videos. Video projects are commonly assigned to students. In completing these tasks, several applications are used by students, such as CapCut, Canva, Instagram Videos, PowerPoint, WPS Office, and Alight Motion. Among these, CapCut is the most popular video editing application used by students. These applications enable students to be more creative in producing learning content. CapCut offers features such as video effects, audio integration, and animation tools that facilitate the creation of high-quality videos (Wulan et al., 2024). CapCut simplifies video production, allowing users to produce short video content tailored to the needs of today's modern society (Yan & Wang, 2019). Furthermore, CapCut has been utilized in education to create engaging, flexible, and short-duration learning videos (Syarifudin, 2024). Other applications such as Canva, Instagram Videos, and PowerPoint are also popular alternatives among students for creatively and attractively editing learning materials.

Several student responses regarding their experiences with online collaboration were analyzed and categorized into two sub-themes: positive and negative experiences. Positive experiences reported by students included feelings of engagement, excitement, and enjoyment. Online collaboration can enhance student involvement and motivation in science learning (Ateş & Köroğlu, 2024). It also significantly improves self-management and collaborative skills (Lam et al., 2020). However, some students reported negative experiences, describing online collaboration as complicated and less cohesive. Challenges in online collaboration include the lack of face-to-face communication and difficulties in coordinating schedules (Motogna et al., 2022). Other challenges involve limited engagement and communication difficulties (Farrah et al., 2023). Among the experiences shared by students, positive experiences were the most reported. This indicates that students have developed online collaboration skills within science classes. Nevertheless, challenges such as ineffective communication and maintaining team cohesion remain. To address these challenges, educators need to redesign online collaborative activities.

Regarding students' opinions on the role of technology in learning, the majority responded that technology plays a very helpful role, with a significant percentage supporting this view. Technology is important in science education because it is easily accessible and facilitates the acquisition of new skills by students (Ahzan et al., 2024). The use of technology in science classrooms can make learning more relevant and engaging for students (Parker et al., 2019). However, some students expressed that the role of technology in learning is "not entirely helpful." Negative responses may be attributed to factors such as inadequate infrastructure, lack of skills and experience in using

information technology (Rasimin et al., 2024), and socio-economic factors (Ahmad et al., 2023). Based on students' feedback regarding the role of technology, teachers should consider various aspects when selecting the types of technology for learning, ensuring alignment with students' abilities and needs. Overall, nearly all respondents stated that technology use greatly supports learning.

Regarding the advantages and disadvantages of technology use, the analysis of respondent answer patterns revealed several perceived benefits of using technology, including: (1) making learning easier, (2) keeping up with technological advancements, and (3) facilitating access to learning information. Technology enables learning to be accessible anytime and anywhere (Almutairi, 2024). It simplifies learning by providing unlimited access to information (Dirane, 2024). The disadvantages reported by students include: (1) dependence on technology, (2) distraction or loss of focus, and (3) network disruptions. Among these drawbacks, the most frequently mentioned were dependence on technology and distraction. This aligns with research reporting that technology can significantly divert attention during learning (Pérez-Juárez et al., 2023). Therefore, this issue calls for educators to design learning activities that maximize the effective use of technology. Additionally, internet connectivity problems can hinder technology use (Templeman et al., 2024). Therefore, it is crucial for educators to design learning activities that not only maximize the effective use of technology but also address potential challenges such as connectivity issues and other negative impacts.

CONCLUSION

Fundamental Finding: High school students spend over six hours daily on digital devices, primarily for entertainment and learning purposes. While educational use is significant, entertainment remains the dominant activity. Students prefer easily accessible information but often lack strong habits for verifying content credibility. Online platforms such as Google Classroom and Moodle are seen as helpful, despite occasional technical and connectivity issues. Students demonstrate awareness of personal data protection and use apps like CapCut to create learning content. Although students view online collaboration positively, they still face certain challenges in its implementation. **Implication:** Digital technology plays a crucial role in supporting student learning, but there is a need to improve digital literacy and address technology dependence and connectivity problems to optimize its benefits. **Limitation:** This study focuses on students' usage patterns without exploring psychological or socio-economic factors influencing technology use. **Future Research:** Future studies should investigate the effects of technology dependence on student well-being and develop more effective digital literacy programs, including comparative analyses across different regions.

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