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Digital Literacy and Intrinsic Motivation of High-Achieving Students in Chemistry Learning at Senior High School

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Abstract: *This study examines the digital literacy and intrinsic motivation of high-achieving chemistry students at SMA Negeri 1 Kerinci in the 2024/2025 academic year, and explores the relationship between these variables. The sample comprised science program students who participated in the National Science Olympiad (KSN). Using a mixed-methods sequential explanatory design, quantitative data were collected through questionnaires based on six digital literacy indicators and three intrinsic motivation indicators, followed by structured interviews for qualitative insights. Results showed that students demonstrated high digital literacy in "Uses to Produce Original Work" and "Considers Source," but lower performance in "Selects." Their intrinsic motivation was also high, particularly in learning activity, perseverance, and exam resilience. The Pearson correlation test indicated a significant positive relationship between digital literacy and intrinsic motivation ($r = 0.679$, $p < 0.05$), suggesting that improved digital literacy enhances students' internal drive to learn. Overall, the findings underscore the need to integrate digital literacy into chemistry learning strategies to foster greater motivation and holistic academic achievement among students.*

Keywords: *digital literacy; intrinsic motivatio;, high-achieving students; chemistry learning*

INTRODUCTION

The development of digital technology has had a significant impact on various sectors of life, including education. In the context of learning, particularly in complex subjects such as chemistry, the presence of the internet and digital devices provides new opportunities for students to access information, interact with learning resources, and develop deeper conceptual understanding (Hardika & Isroah, 2022). The use of digital technology in education has also been shown to be effective in enhancing students' understanding. A study by Wijayati et al. (2019) demonstrated a 52.8% improvement in students' comprehension through a digital learning strategy based on planning, implementation, and reflection. The integration of digital technology enables students to gain richer learning experiences through visualization, simulation, and interactive media, which contributes to improved understanding of abstract chemical

concepts (Patmanthara & Hidayat, 2018). For instance, research on the development of Android-based learning media has also proven effective in increasing students' interest and ability in chemistry learning (Kajin, 2018). Thus, the use of digital technology not only provides more engaging and meaningful learning experiences but also promotes the development of students' digital literacy.

Digital literacy is one of the essential skills for students in 21st-century learning. It not only encompasses technical abilities in operating technological devices but also cognitive skills to access, evaluate, manage, and communicate information effectively and ethically (Yusuf et al., 2022). Moreover, digital literacy involves critical thinking skills to navigate the flood of digital information and collaborative skills to use technology for active and meaningful learning (Hardika & Isroah, 2022). In chemistry learning, digital literacy allows students to select relevant information, evaluate the validity of scientific data, and apply concepts contextually (Patmanthara & Hidayat, 2018).

However, mastery of technology will not be optimal without a strong internal drive. Learning motivation, particularly intrinsic motivation—defined as the internal drive to learn without the influence of external rewards—has been identified as one of the key factors contributing to students' learning success (Dewi et al., 2024). Intrinsic motivation is characterized by curiosity, interest in the subject matter, and personal satisfaction in completing learning tasks (Ryan & Deci, 2000). Students with high intrinsic motivation tend to demonstrate persistence, active engagement, and a tendency toward deep learning (Eriany et al., 2013). In the context of chemistry learning, intrinsic motivation plays a crucial role in driving academic success, which requires higher-order thinking processes and perseverance in understanding abstract concepts.

The relationship between digital literacy and intrinsic motivation becomes increasingly relevant when examined among high-achieving students. High-achieving students, identified by their excellent academic performance, generally possess specific learning characteristics such as self-regulation, effective time management, and reflective thinking about their learning processes. They also tend to demonstrate more advanced digital literacy and stronger intrinsic motivation compared to other students. Therefore, analyzing the profile of digital literacy and intrinsic motivation in high-achieving students, as well as the relationship between the two in chemistry learning at senior high school, is essential to understanding.

Previous studies have mostly focused on the impact of technology on learning outcomes in general or on the development of digital learning media (Kajin, 2018; Wijayati et al., 2019). Meanwhile, research that specifically integrates digital literacy and intrinsic motivation within a single framework remains limited. Furthermore, studies that focus on high-achieving students as research subjects are still rare, although understanding their learning strategies can serve as a critical basis for developing more effective and adaptive learning models. This study offers a new contribution by examining the relationship between digital literacy and intrinsic motivation in supporting the academic success of high-achieving students in chemistry learning. The focus on high-achieving students provides a new dimension to explore how digital literacy and intrinsic motivation synergize in achieving optimal learning outcomes.

This study aims to analyze the profile of digital literacy and intrinsic motivation in chemistry learning from the perspective of high-achieving students at SMA Negeri 1 Kerinci and to identify the extent to which the two are related in supporting students' academic achievement. The findings of this study are expected to provide insights for the development of more effective learning

strategies aligned with the demands of 21st-century education.

METHODS

This study employed a mixed-methods approach with a sequential explanatory design, beginning with the collection and analysis of quantitative data, followed by the collection and analysis of qualitative data. The purpose of this design was to obtain a comprehensive understanding of students' levels of digital literacy and intrinsic motivation, both through numerical data and narratives of students' experiences, as well as the relationship between digital literacy and intrinsic motivation. The subjects of this study consisted of ten high-achieving students at SMA Negeri 1 Kerinci, selected purposively based on their participation in the National Science Olympiad (Kompetisi Sains Nasional/KSN) in the fields of chemistry, physics, biology, or mathematics.

The quantitative instrument was a closed-ended questionnaire using a 5-point Likert scale, developed based on six indicators of digital literacy proposed by Greenstein (2012) , namely: (1) finding information, (2) using multiple sources of information, (3) selecting appropriate sources, (4) evaluating information, (5) considering sources and message effects, and (6) using information to produce original work. The indicators of intrinsic motivation referred to Nababan (2014), which include: (1) high learning activity, (2) perseverance in completing tasks, and (3) resilience in facing examinations. Quantitative data were analyzed using SPSS software, covering normality testing (Shapiro-Wilk test), descriptive statistical analysis (mean, standard deviation, minimum and maximum values, frequency, and percentage) for each indicator, and Pearson's correlation test to determine the relationship between digital literacy and intrinsic motivation.

The qualitative instrument consisted of a structured interview guide, which was developed based on the same indicators as the questionnaire. The interviews were conducted to explore in greater depth students' experiences, perceptions, and reflections regarding the use of digital technology in learning, as well as the factors that influenced their learning motivation. Qualitative data were analyzed using a thematic analysis approach following Miles and Huberman's model, through three stages: data reduction, data display, and conclusion drawing. Data reduction was carried out by selecting relevant quotations from interview transcripts and grouping them into themes based on the indicators, which were then presented in the form of contextual narratives that enriched the quantitative findings.

This mixed-methods approach provided complementary analytical strengths, enabling a more holistic description of the relationship between digital literacy and intrinsic motivation in supporting students' academic achievement.

RESULT AND DISCUSSION

As an initial step prior to further statistical analysis, a normality test was conducted on the digital literacy and intrinsic motivation data. The results of the Shapiro–Wilk normality test showed that digital literacy had a significance value of 0.698, and intrinsic motivation had a significance value of 0.955. Thus, it can be concluded that the data for both variables were normally distributed. Consequently, the use of parametric statistical tests, such as Pearson's correlation test, was deemed appropriate to analyze the relationship between the two variables.

The normal distribution of the digital literacy indicators indicates that students' levels of ability in accessing, evaluating, and utilizing digital information were proportionally distributed within the studied group. A similar trend was observed for intrinsic motivation indicators, reflecting a balanced distribution in terms of students' learning enthusiasm, perseverance, and resilience in facing academic challenges. The normal distribution of both variables supports

the statistical assumptions for testing relationships between variables, ensuring that the results of the subsequent correlation analysis can be interpreted validly.

Digital Literacy

Descriptive statistics were conducted to provide an overview of the respondents' scores on each digital literacy indicator, as presented in Table 1.

Tabel 1. Descriptive statistics of digital literacy

	N	Minimum	Maximum	Mean	Std. Deviation
Finds	10	5	10	7.6	1.43
Use Multiple Sources	10	4	9	7.5	1.716
Selects	10	0	5	3	1.826
Evaluates	10	2	5	3.8	1.033
Considers Source	10	8	15	12.8	2.251
Uses to Produc Original Work	10	7	15	11.8	2.898
Valid N (listwise)	10				

Based on the analysis of ten respondents, the "Finds" indicator had a minimum score of 5, maximum of 10, a mean of 7.60, and a standard deviation of 1.430, indicating moderate variation among respondents in their ability to find information. The "Use Multiple Sources" indicator had a mean score of 7.50 with a standard deviation of 1.716, and a minimum and maximum of 4 and 9, respectively, suggesting differences in students' ability to utilize multiple sources. For the "Selects" indicator, the mean was only 3.00 with the highest standard deviation of 1.826 and a minimum score of 0, showing that some respondents had very limited ability in selecting information. Meanwhile, the "Evaluates" indicator had a mean of 3.80 with a standard deviation of 1.033, reflecting a relatively low but consistent ability across respondents in evaluating information. The "Considers Source" indicator showed the highest mean score of 12.80 with a standard deviation of 2.251, indicating that most respondents were quite capable of considering information sources. Finally, the "Uses to Produce Original Work" indicator had a mean of 11.80 with a standard deviation of 2.898, suggesting that respondents had relatively strong abilities in using information to produce original work, although with considerable variation among individuals. Overall, the data revealed varied levels of digital literacy skills across different aspects.

Subsequent qualitative analysis was conducted using structured interviews. Regarding the "Finds" indicator, most respondents demonstrated strong abilities in searching for and filtering accurate chemistry information online. They generally relied on credible sources such as scientific journals and educational websites, while also comparing multiple sources to distinguish fact from opinion. Although some students struggled to identify the right keywords, they often overcame this by trying alternative search terms, consulting experts, or referring to textbooks and other sources. Overall, respondents displayed good initiative and independence in seeking and managing relevant information.

The "Use Multiple Sources" indicator revealed that most respondents were able to effectively use digital spaces to discuss chemistry topics, although some faced technical challenges. They engaged in online platforms such as discussion groups and specialized forums to exchange ideas. While issues such as internet connection or incompatible file formats occasionally hindered them, students resolved these challenges using file converters or technical

assistance. This demonstrates their competence in utilizing multiple sources and digital formats to support their learning.

For the "Selects" indicator, respondents generally showed adequate ability to choose reliable and relevant sources of chemistry information to solve real-life problems. They often verified information against trusted references such as textbooks, reliable websites, and previously validated sources. Some also categorized information by relevance, accuracy, and complexity of the issue, reflecting their decision-making skills in choosing suitable sources for specific contexts.

The "Evaluates" indicator revealed that respondents could critically assess contradictory information by checking the credibility of authors and sources, and identifying potential bias. They often cross-checked with additional sources such as scientific journals, educational websites, or expert consultation. Some synthesized information from multiple references or prioritized sources recognized as more authoritative. This indicates their capacity to authenticate information and ensure accuracy and reliability.

For the "Considers Source/Message Effect" indicator, respondents showed awareness of digital safety, copyright issues, and media addiction risks. They generally avoided sharing personal information with untrustworthy sources, cited references properly, and used strong passwords. Students also recognized that information sources could contain bias influencing decision-making, and thus sought verification before sharing information. To mitigate media addiction, many limited screen time, maintained strict schedules, and pursued alternative offline activities.

Finally, regarding the "Uses to Produce Original Work" indicator, respondents demonstrated good skills in applying digital tools to create original outputs and collaborate with peers on chemistry projects. They used platforms such as Google Drive, PowerPoint, and other applications to organize information, develop presentations, create educational videos, and write reports. Despite challenges in analyzing and synthesizing information from various sources, they addressed these by cross-checking, validating with trusted sources, and seeking help from teachers or peers. Respondents also acknowledged the importance of citing references to avoid plagiarism, strengthen credibility, and ensure accuracy.

Intrinsic Motivation

Descriptive statistical analysis was conducted to describe the level of students' intrinsic motivation in learning, which consists of three main indicators: High Learning Activity, Perseverance in Completing Assignments, and Resilience in Facing Exams, as presented in Table 2.

Table 2. Descriptive statistical test of intrinsic motivation

	N	Minimum	Maximum	Mean	Std. Deviation
High Learning Activity	10	13	20	15.9	2.025
Perseverance in Completing Assignments	10	7	10	8.7	1.252
Resilience in Facing Exams	10	6	10	7.9	1.449
Valid N (listwise)	10				

Based on the data obtained from respondents, the indicator High Learning Activity shows a minimum score of 13 and a maximum of 20, with a mean of 15.90 and a standard deviation of 2.025. This indicates that, in general, students demonstrate a relatively high level of learning activity, with moderate variation among individuals. For the indicator Perseverance in Completing Assignments, the mean score is 8.70 with a standard deviation of 1.252, and the score range varies between 7 and 10. This suggests that most students exhibit a fairly consistent level of perseverance in completing their assignments. Meanwhile, the indicator Resilience in Facing Exams records a mean score of 7.90, with a standard deviation of 1.449 and a minimum and maximum score of 6 and 10, respectively. These results indicate that while some students show strong resilience, there remains a degree of variation in their readiness and endurance in facing academic challenges such as examinations. Overall, the three indicators reflect a generally positive level of intrinsic motivation among students, albeit with different levels of variation.

Interview findings regarding High Learning Activity revealed that students at SMA Negeri 1 Kerinci demonstrated strong motivation for independent learning by employing various strategies to sustain their enthusiasm, such as listening to music, seeking inspiration from interesting topics, and managing study time effectively. They consistently reviewed and revised their chemistry assignments carefully, often studying beyond school hours, albeit with varying intensity, and making efforts to improve their study time management. However, some students felt that their study time was not yet fully optimal, suggesting that there is still room for improvement in time management skills.

In terms of Perseverance in Completing Assignments, students consistently strived to find references and learning resources by utilizing various media, including books, the internet, and other digital sources, to broaden their understanding. They remained motivated in completing chemistry assignments, even when the tasks were difficult and time-consuming, by breaking them into smaller parts, recalling their long-term goals, and maintaining their enthusiasm through short breaks or peer discussions. This reflects their perseverance in learning and striving for optimal results.

Regarding Resilience in Facing Exams, students showed proactive efforts to deepen their understanding of chemistry concepts by engaging with teachers and peers. They asked clear and polite questions, both in person and through group chats, and actively participated in discussions to strengthen comprehension. In collaborative learning contexts, they utilized digital platforms and online forums to discuss, share information, and collaboratively seek solutions. This collaborative approach helped them overcome difficulties and prepare more effectively for examinations.

These findings are consistent with previous research indicating that students with high learning motivation tend to exhibit positive learning behaviors, such as persistence in academic activities. Highly motivated students often engage in behaviors such as seeking recommended learning resources, checking assignments for completeness before submission, sustaining interest in subjects, revising assignments based on teacher feedback, and continuing to work on tasks until satisfactory results are achieved (Herlina et al., 2015).

Correlation Between Digital Literacy and Intrinsic Motivation

After obtaining a detailed quantitative and qualitative overview of students' digital literacy and intrinsic motivation in chemistry learning at SMA Negeri 1 Kerinci, a Pearson correlation test was conducted. This test aimed to determine the extent to which the two variables are interrelated in supporting students' academic achievement. The results

of the correlation test are presented in Table 3.

Table 3. Correlation test between digital literacy and intrinsic motivation

		Literasi Digital	Motivasi Intrinsik
Literasi Digital	Pearson Correlation	1	0.679
	Sig. (2-tailed)		0.031
	N	10	10
Motivasi Intrinsik	Pearson Correlation	0.679	1
	Sig. (2-tailed)	0.031	
	N	10	10

The analysis results indicate a significant positive correlation between the two variables, with a correlation coefficient of 0.679 and a significance value (Sig. 2-tailed) of 0.031. Since the significance value is lower than 0.05, this relationship is statistically significant. The correlation value, which falls within the range of 0.60–0.79, suggests that the relationship between Digital Literacy and Intrinsic Motivation is categorized as strong. This means that the higher the level of digital literacy students possess, the higher their intrinsic motivation in learning, and vice versa. These findings highlight that mastery of digital literacy can be one of the key factors supporting the enhancement of students' intrinsic motivation in learning.

CONCLUSION

Based on the results of both quantitative and qualitative data analysis, the descriptive statistics revealed that students' digital literacy skills varied across indicators, with the highest scores observed in Considers Source/Message Effect and Uses to Produce Original Work. These results reflect students' strong awareness of the importance of credible sources of information as well as their ability to utilize information to produce original work. In contrast, the Selects indicator showed the lowest average score, highlighting the need to improve students' ability to choose accurate and relevant information.

In general, the in-depth interviews reinforced the quantitative findings, showing that students demonstrated skills in searching, verifying, evaluating, and utilizing digital information to support the chemistry learning process. Although challenges remained, such as limited access to information or difficulties in identifying appropriate keywords, students displayed adaptive attitudes and effective problem-solving strategies, including consulting teachers or using various digital platforms.

The overall picture of students' intrinsic motivation was relatively high, as indicated by their active participation in learning, perseverance in completing assignments, and resilience in facing examinations. Respondents exhibited self-initiative in learning, optimal use of learning media, and a collaborative spirit in overcoming academic challenges. This reflects the presence of an inner drive among students to continuously develop themselves and achieve better learning outcomes.

The correlation test between digital literacy and intrinsic motivation, with a Pearson correlation coefficient of 0.679 ($p = 0.031$), indicates that the higher the students' digital literacy, the higher their intrinsic motivation, and vice versa. Thus, mastery of digital literacy not only supports students' technical abilities in accessing and managing information but also strengthens their perseverance and enthusiasm for engaging in the learning process more independently and productively. It can therefore be concluded that digital literacy and intrinsic motivation among students at SMA Negeri 1 Kerinci are positively and significantly correlated.

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