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# Do Digital Literacy and Collaboration Skills Matter for Cognitive Competence in Vocational Education?

**Amallia Putri Octavia, Mohammad Wildan Habibi***
Information Technology Education Study Program, Faculty of Engineering,
Universitas Negeri Surabaya, Indonesia.
***Corresponding Author. Email: mohammadhabibi@unesa.ac.id

**Abstract:** This study aims to analyze the relationships between digital literacy, collaboration skills, and the cognitive competence of vocational high school students. A quantitative approach with a correlational research design was employed. Data were collected through cognitive competence tests and questionnaires measuring students' digital literacy and collaboration skills. Multiple linear regression was used to examine the extent to which digital literacy and collaboration skills were individually and jointly associated with students' cognitive competence. The results revealed that digital literacy was positively and significantly associated with cognitive competence ($\beta$ = 0.302, $p$ = 0.004), whereas collaboration skills showed a positive but non-significant association with cognitive competence when analyzed separately ($\beta$ = 0.062, $p$ = 0.551). In the simultaneous analysis, digital literacy and collaboration skills were jointly and significantly associated with cognitive competence ($F$ = 9.224, $p$ < 0.001), with the model explaining 11.9% of the variance in cognitive competence ($R^2$ = 0.119). These findings indicate that digital literacy is a significant individual predictor of cognitive competence, whereas collaboration skills do not demonstrate a statistically significant individual contribution. However, when considered simultaneously, digital literacy and collaboration skills are significantly associated with cognitive competence. This study contributes to the literature on vocational education by providing empirical evidence regarding the relationships among digital literacy, collaboration skills, and cognitive competence among vocational students. However, the study is limited to one vocational specialization and two independent variables. Future research should therefore involve more diverse samples and incorporate additional relevant variables to provide a more comprehensive understanding of the factors associated with students' cognitive competence.

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## Introduction

The swift evolution of digital technology has significantly influenced every facet of life, including world of education (Jusman & Usman, 2025). During the Covid-19 pandemic, advances in digital technology facilitate online learning so that it allows students to search for information and knowledge independently (Hidayat et al., 2020). With digital technology, nearly all information can be retrieved promptly, conveniently, and without limitations (Rahmanita, 2020). Official data from BPS-Statistics Indonesia (2025) indicate that Indonesia's unemployment rate is highest among vocational education graduates. The unemployment rate among vocational education graduates was 8.63%, compared with 6.88% among general senior high school graduates and 5.39% among university graduates.

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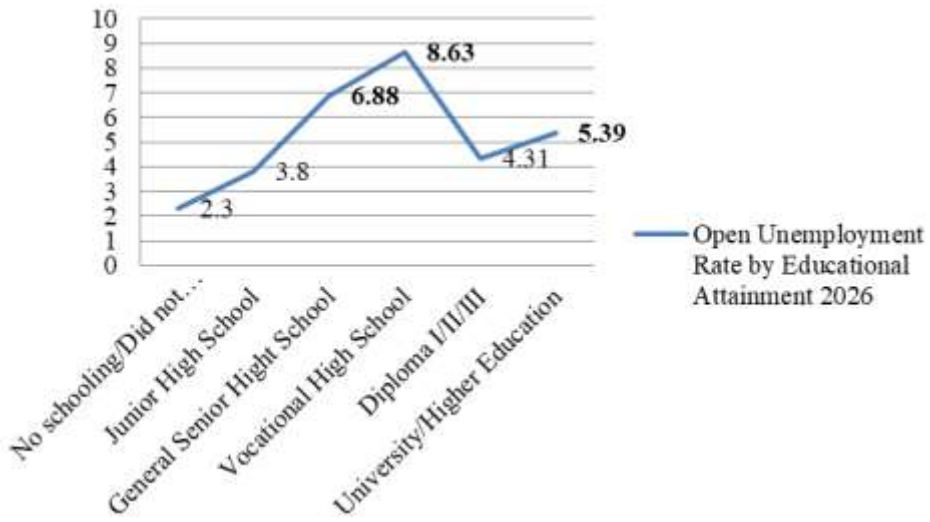


**Figure 1. Unemployment Rate by Educational Attainment 2026**

Vocational education is one of the formal educational institutions designed to produce graduates who have the competence and readiness to face competition in the world of work (Hanafi, 2012). However, the relatively high unemployment rate among vocational education graduates indicates that having vocational qualifications alone may not be sufficient to meet the demands of the labor market. This condition highlights the importance of developing students' digital literacy, collaboration skills, and cognitive competence, which are essential for adapting to technological changes, solving problems, and working effectively in the modern workplace. However, in learning practice, there are still some problems that show that students' competencies have not developed optimally, which can be seen in group work activities, where only one to two students actively complete assignments, while other students tend not to be involved and only have their names listed without making a real contribution (Le & Janssen, 2018). This condition shows the low involvement of students in group work. Dependence on one dominant student indicates weak collaboration skills, which may affect the equitable development of students' competencies (Han & Ellis, 2021).

Learning in vocational education, especially in the Network and Telecommunication Computer Engineering skill program, is certainly very dependent on technology. However, there are still students who use the internet only as a means of obtaining answers instantly without evaluating and understanding the information obtained, so that their digital literacy skills have not developed optimally (Alifah et al. 2021). Xu et al. (2025) highlighted that pupils who demonstrate strong proficiency in using digital tools and resources may have an advantage in the increasingly digitalized job market.

In this age of the Industrial Revolutions 4.0, students need to show that they are really good at more than just academics and technology. Critical thinking, Communication, Collaboration, and Creativity (4C) are relevant here because they reflect the abilities needed to thrive in today's technological world (Redhana, 2019). Collaboration skills are the ability to work together, actively participate, and respect each other's opinions in a group (Greenstein, 2012). Wahyuni (2022) stated that collaboration skills are a form of social interaction that appears in cooperative activities between individuals to achieve mutually agreed goals. For vocational education, especially the Network and Telecommunication Computer Engineering program, competency achievement is strongly influenced by proficiency in technology usage, digital literacy, and collaboration skills. Digital literacy describes the competence to retrieve, process, interpret, examine, and generate information

*Vol. 12, No. 3 : September 2026*
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*pp. 1368-1378*
*Email: jklppm@undikma.ac.id*

by utilizing digital technology, supporting the enhancement of analytical thinking and concept mastery (UNESCO, 2018).

Various research findings demonstrate that digital literacy combined with collaboration skills provides a meaningful contribution to strengthening vocational education students' cognitive abilities. Digital literacy have fundamental effect to vocational school students' academic performance, according to research by Wulandari et al. (2025). Students' conceptual comprehension and cognitive accomplishments may be enhanced by the right access, interpretation, and application of digital information. Relatedly, a meta-analysis by Salisa et al. (2024) indicated a robust correlation between digital literacy and critical thinking abilities, components of advanced cognitive competencies. Furthermore, the application of digital literacy in technology-based vocational learning supports improving students' ability to utilize technology to solve problems, improve learning outcomes, and prepare them for the demands of the digital world of work (Purmadi et al. 2022; Muslim & Ariyanto, 2025). On the other hand, international research published by Computers & Education on collaborative knowledge construction shows that through discussions, exchange of ideas, and knowledge building together, it has the potential to enhance students' cognitive involvement and foster cognitive competency development throughout collaborative learning (Ouyang et al. 2024). These studies confirm that digital literacy and collaboration skills are important elements in building students' cognitive competence, especially in the context of vocational education.

Previous studies have examined digital literacy and collaboration in relation to learning outcomes and cognitive-related abilities. Digital literacy is theoretically related to cognitive competence because it involves not only accessing information but also evaluating, interpreting, and organizing information from digital sources, which requires critical thinking and knowledge construction (Gilster, 1997, as cited in Subagjo, 2023). Similarly, collaboration skills are theoretically related to cognitive competence because interaction, discussion, exchange of ideas, and joint problem-solving can facilitate knowledge construction and the development of cognitive skills (Noroozi et al. 2013). These processes allow students to explain their reasoning, consider different perspectives, and construct knowledge through interaction with others. However, these variables have generally been investigated separately, while studies examining their simultaneous relationship with cognitive competence among vocational education students remain limited. In particular, empirical evidence focusing on students in the Computer Network and Telecommunication Engineering specialization is still scarce.

Based on the theoretical framework, previous research findings, and the identified research gap, this study hypothesized that digital literacy and collaboration skills are positively related to the cognitive competence of vocational education students, both partially and simultaneously. Thus, this study aims to analyze the relationship between digital literacy and collaboration skills toward the cognitive competence of vocational high school students.

## Research Method

This study employed a quantitative approach with a predictive correlational design to analyse the relationship between and predictive contributions of digital literacy (X1) and collaboration skills (X2) to students' cognitive competence (Y). Data analysis methods for determining the connection between students' cognitive domain competencies and their levels of digital literacy and collaboration include validity and reliability assessments as well as multiple linear regression. The population of this research consisted of 140 students enrolled in the 11th grade Computer Network and Telecommunication Engineering specialization at

*Vol. 12, No. 3 : September 2026*
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*pp. 1368-1378*
*Email: jklppm@undikma.ac.id*

SMK Nurut Taqwa and SMKN 1 Glagah. This research adopted the total sampling method, allowing the entire population to serve as the study sample.

Digital literacy and collaboration skills data were collected using Likert-scale instruments developed based on relevant theoretical frameworks. The digital literacy instrument was developed based on Gilster's framework, which consists of internet searching, hypertextual navigation, content evaluation, and knowledge assembly (Gilster, as cited in Subagjo, 2023). The collaboration skills instrument was developed based on Greenstein's indicators, including proactive participation, respect for group members, compromise, flexibility, responsibility, and productivity (Greenstein, as cited in Herdiansyah, 2025). Both instruments used a five-point Likert scale ranging from 1 to 5. Cognitive domain competence was measured using a multiple-choice test based on Bloom's Taxonomy, covering applying (C3), analyzing (C4), evaluating (C5), and creating (C6) (Bloom et al., as cited in Silaban et al., 2025). All data were collected offline. The statistical analyses were conducted using IBM SPSS Statistics version 22.

## Results and Discussion

### Validity Test

Instrument validity was examined through validity testing to verify the accuracy of the questionnaire measurements. A questionnaire is considered valid when it accurately measures the intended variable (Ghozali, 2018).

**Table 1. Validity test result of all variables**

| Variables | Calculated *r*-value | Critical *r*-value | Decision |
|---|---|---|---|
| Digital Literacy (X1) | 0.627-0.780 | 0.165 | Valid |
| Collaboration (X2) | 0.580-0.783 | 0.165 | Valid |
| Cognitive Domain Competence (Y) | 0.270-0.770 | 0.165 | Valid |

The validity test results showed that all items for digital literacy (X1), collaboration skills (X2), and cognitive domain competence (Y) met the validity criteria. The calculated *r*-values ranged from 0.627 to 0.780 for digital literacy, 0.580 to 0.783 for collaboration skills, and 0.270 to 0.770 for cognitive domain competence. All calculated *r*-values exceeded the critical *r*-value of 0.165 at a significance level of 0.05 (df = 138), indicating that all items were valid.

### Reliability Test

This examines questionnaire consistency items as measuring of variable or construct being studied. An instrument is considered reliable if it can provide consistent results (Ghozali, 2018).

**Table 2. Reliability test results of all variables**

| Variables | Cronbach's Alpha | Decision |
|---|---|---|
| Digital Literacy (X1) | 0.898 | Reliable |
| Collaboration (X2) | 0.909 | Reliable |
| Cognitive Domain Competence (Y) | 0.789 | Reliable |

Findings from the reliability evaluation of the three variables confirmed that each Cronbach's Alpha score surpassed the 0.60 criterion. Reliability assessment instrument examined minimum Cronbach's Alpha coefficient value 0.60 as the reference (Ghozali, 2018). The obtained outcome demonstrated that all measurement tools met the reliability standard.

### Multiple Linear Regression Analysis

Multiple linear regression analysis was used to examine the relationships between multiple independent variables and a dependent variable (Ghozali, 2018).

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*Vol. 12, No. 3 : September 2026*
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**Table 3. The results of multiple linear regression tests using SPSS**

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| 1 (Constant) | 9.878 | 1.219 | | 8.103 | .000 |
| Digital Literacy (X1) | .092 | .032 | .302 | 2.916 | .004 |
| Collaboration (X2) | .018 | .030 | .062 | .597 | .551 |

A significant level of 0.004, lower than 0.05, is shown by the findings of the multiple linear regression analysis for digital literacy. Furthermore, the critical *t*-value is 1.977, while the calculated *t*-value is 2.916, which is higher. In order to determine the outcome, we compared the calculated *t*-value to the essential *t*-value using a 0.05 significance level. Based on 140 observations, a critical *t*-value of 1.977 was found. By reject the null hypothesis and find a positive correlation between students' digital literacy and their cognitive competence in vocational education. Students' ability to access, comprehend, use, apply, and evaluate digital information in technology-based learning was shown to be connected with their level of cognitive competence. Students enrolled in vocational programs had a higher frequency of this competency. A significance level of 0.551 was also reached by the cooperation variable, surpassing the threshold of 0.05. Additionally, the computed *t*-value was 0.597, falling below the critical *t*-value of 1.977. Students' cognitive competence is positively, though non-significantly related to their level of collaboration in vocational education, hence there is no evidence to reject the null hypothesis. Collaboration was shown to have a positiveĺ but non-significant association with students' cognitive competence, whereas digital literacy was found to have a positive and significant relationship overall. Thus, digital literacy demonstrates a statistically significant individual contribution to cognitive competence, while collaboration does not demonstrate a statistically significant individual contribution.

**Simultaneous Test (*F*)**

To demonstrate influence occurs simultaneously, the primary goal of the simultaneous test (*F*) is to quantify mixed impact to independent variables (X) to dependent variable (Y) (Ghozali, 2013).

**Table 4. Simultaneous *F* test results using SPSS**

| Model | | Sum of Squares | df | Mean Square | *F* | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 71.708 | 2 | 35.854 | 9.224 | .000[b] |
| | Residual | 532.542 | 137 | 3.887 | | |
| | Total | 604.250 | 139 | | | |

In regards to outcome linear regression analysis to variables of digital literacy and cooperation, the crucial *F* value (3.06) was exceeded by the observed *F* statistic (9.224), and the significance score was 0.000 < 0.05. Based on 140 observations also significance threshold 0.05, critical *F* value was 3.06, and the evaluation criteria depended on comparing the computed *F* statistic > the critical *F* value. Hence, the results show cognitive competency is highly related with digital literacy and cooperation when both are included in the same regression model, even when their separate contributions vary when only partly examined.

**Coefficient of Determination Test ($R^2$)**

The assessment of $R^2$ serves for determining how strongly the independent variables associations or relate to the dependent variable (Ghozali, 2013).

*Vol. 12, No. 3 : September 2026*
*E-ISSN: 2442-7667*
*pp. 1368-1378*
*Email: jklppm@undikma.ac.id*

**Table 5. The results of the determination coefficient ($R^2$) test using SPSS**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .344[a] | .119 | .106 | 1.972 |

With an *R*-value of 0.344 from multiple linear regression, we can see that there is a correlation among students' cognitive competency and their level of digital literacy and cooperation. An $R^2$ value of 0.119 indicates that 11.9% of the variation in students' cognitive competency can be explained by digital literacy and cooperation. Meanwhile, the remaining 88.1% is explained by other characteristics or factors outside of this study model

**Discussion**

Student cognitive capacities in vocational education are positively and significantly impacted by digital literacy, according to this study's results. The beneficial effect of collaboration, on the other hand, is insignificant when considered in isolation. A concurrent examination, however, reveals that digital literacy and cooperation, when put together, contribute a substantial positive amount to cognitive competence 11.9%. While digital literacy stands on its own as a predictor of cognitive capacity, these findings also show that cooperation is an important component when taken into account with digital literacy.

From its very characteristics, we may deduce that digital literacy has made a substantial contribution to cognitive ability. Having digital literacy means you can use technology, but it also means you can interpret, evaluate, and critically apply information. This competency is associated with mental operations including learning, applying, assessing, and problem-solving. In a digital setting, it is crucial to comprehend and use information critically, as emphasised by Gilster's (1997) theory, which supports this discovery. In line with other studies conducted by Nurfatma and Sulistyaningrum (2024), Nadiyah et al. (2024), and Putri et al. (2025), this study confirms that high levels of digital literacy are linked to enhanced cognitive abilities, including critical thinking skills and learning outcomes. These findings are further supported by the work of Li et al. (2025), who found a positive and statistically significant relationship between students' digital literacy and their exam scores.

Unlike previous studies, this one focused on students' cognitive capacities within the context of vocational education, namely in the Computer and Network Engineering and Telecommunications majors. Consequently, this research provides more targeted empirical proof of how digital literacy helps bolster cognitive capacities within the framework of vocational education.

Meanwhile, collaboration showed a positive but insignificant impact on cognitive abilities when viewed separately. The absence of meaningful partial influence may be due to the characteristics of cognitive evaluation in vocational education that emphasize individual achievement rather than group achievement. Although the students engage in group activities, cognitive abilities are ultimately reflected through individual assignments or exams. Therefore, engaging in collaborative activities does not necessarily guarantee an increase in the individual's cognitive abilities, especially if the collaboration is not accompanied by the individual's active participation in analyzing, evaluating, and building knowledge. The impact of collaboration can also be influenced by the quality of interaction, level of involvement, and the design of learning activities.

These findings provide different insights compared to previous studies that reported the positive impact of collaborative learning on students' cognitive learning outcomes, as shown by Nasution et al. (2023) and Aifah and Astriani (2024). This difference may have to do with the variation between students' general collaboration abilities and the implementation of organized collaborative learning. Previous studies focused more on collaborative learning

*Vol. 12, No. 3 : September 2026*
*E-ISSN: 2442-7667*
*pp. 1368-1378*
*Email: jklppm@undikma.ac.id*

activities specifically designed to improve learning outcomes, while this study examined collaboration as an individual variable. Therefore, the relationship between collaboration and competence in the cognitive realm may be contextual and highly dependent on how collaborative activities are applied in the learning process.

Although collaboration did not show a significant association with cognitive competence when analyzed independently, the simultaneous analysis revealed that digital literacy and collaboration were jointly and significantly associated with cognitive competence. The model explained 11.9% of the variance in cognitive competence ($R^2$ = 0.119; adjusted $R^2$ = 0.106). This finding indicates that the two independent variables, when considered together in the regression model, were significantly associated with cognitive competence, although their individual relationships differed. The simultaneous significance does not indicate that collaboration was individually significant or that an interaction between digital literacy and collaboration was established. Rather, it demonstrates that the combination of the two variables was significantly related to variations in students' cognitive competence.

The scientific contribution of this research lies in providing empirical evidence that digital literacy and collaboration may demonstrate different patterns of association with cognitive competence among vocational education students. Digital literacy showed a positive and significant individual association, whereas collaboration showed a positive but non-significant association. However, both variables were jointly associated with cognitive competence. This finding adds to previous research by highlighting that the relationship between collaboration and cognitive competence may depend on how collaboration is structured and how cognitive competence is assessed. Research in vocational education by Paeßens et al. (2023) found that collaborative problem-solving could foster cognitive performance, while also highlighting the challenge of distinguishing individual performance within collaborative settings. Similarly, Eshuis et al. (2019) demonstrated that collaboration among technical vocational students was more effective when supported by individual accountability, peer assessment, and joint reflection. These findings support the interpretation that collaboration may not automatically correspond to higher individual cognitive competence unless collaborative activities are deliberately designed to engage each student in the learning process.

The findings also have practical implications for vocational education. Teachers should provide learning activities that require students to explore, comprehend, evaluate, and apply digital information to technical problems in order to strengthen digital literacy. At the same time, collaborative activities should not be limited to simply placing students into groups. They should include clear roles, individual accountability, peer evaluation, and structured reflection to encourage active participation from every student. Eshuis et al. (2019) showed that structured support and reflection can improve the quality of collaboration and knowledge acquisition among vocational students, while Benning (2024) identified individual assessment and peer evaluation as mechanisms that can help reduce free-riding in group projects. Therefore, project-based and problem-based learning activities that integrate digital information processing with structured collaboration may provide meaningful opportunities for students to develop both competencies.

This study has several limitations. First, the sample consisted of 140 students from two schools and was limited to one vocational specialization, namely Computer Network Engineering and Telecommunications, which may limit the generalizability of the findings to other vocational education contexts. Second, this study examined only two independent variables, whereas cognitive competence may also be associated with other factors, such as

*Vol. 12, No. 3 : September 2026*
*E-ISSN: 2442-7667*
*pp. 1368-1378*
*Email: jklppm@undikma.ac.id*

learning motivation, critical thinking skills, self-regulated learning, and student engagement. Third, the study did not directly examine the structure and quality of collaborative activities or measure the occurrence of free-riding. Future research should therefore involve students from more diverse vocational education backgrounds, include additional relevant variables, and investigate how individual accountability, participation, task structure, and the quality of collaboration influence the relationship between collaboration and cognitive competence.

## Conclusion

The results of this study show that digital literacy was positively and significantly associated with cognitive competence among vocational education students, whereas collaboration skills showed a positive but non-significant association when examined individually. When analyzed simultaneously, digital literacy and collaboration skills were jointly and significantly associated with cognitive competence, with the regression model explaining 11.9% of the variance ($R^2$ = 0.119; adjusted $R^2$ = 0.106). These findings indicate that digital literacy has a more evident individual association with cognitive competence, while the relationship between collaboration skills and cognitive competence may depend on the structure and quality of collaborative learning activities and the extent of individual participation and accountability. The findings highlight the importance of strengthening students' digital literacy while designing collaborative learning activities that maintain individual cognitive accountability. However, this study was limited to 140 students from two schools within one vocational specialization and examined only two independent variables. Future research should involve more diverse vocational education contexts and examine additional variables, such as learning motivation, critical thinking skills, self-regulated learning, and student engagement.

## Recommendation

The results of this study suggest that teachers should design Project-Based Learning (PjBL) or Problem-Based Learning (PBL) activities that integrate digital technology, collaboration, and individual cognitive accountability. In the Computer Network Engineering and Telecommunications laboratory, group projects can be organized by assigning each student a specific individual responsibility, such as identifying problems, searching and evaluating digital information, developing troubleshooting procedures, performing practical tasks, or documenting solutions. Each student should also complete an individual worksheet or reflection that requires them to explain the procedures, justify their decisions, and evaluate the solutions developed by the group. In addition, individual quizzes or competency checks can be conducted after group activities to assess each student's cognitive understanding. This design allows students to benefit from collaborative interaction while ensuring that their individual cognitive competence is assessed and reducing the possibility of a free-rider effect.

However, this study has limitations because it involved 140 students from only one concentration of expertise and examined only two independent variables. Therefore, future research should involve students from different vocational fields and include additional variables, such as learning motivation, critical thinking skills, and self-regulated learning, to provide a more comprehensive understanding of factors associated with cognitive competence.

*Vol. 12, No. 3 : September 2026*
*E-ISSN: 2442-7667*
*pp. 1368-1378*
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