



Analysis of Communication, Collaboration, and Computational Thinking Skills of Students in the Computer and Network Engineering Program

Nasyiwa Ega Palupi^{1*}, Mohammad Wildan Habibi²
^{1,2}Universitas Negeri Surabaya, Surabaya, Indonesia



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ABSTRACT

Objective: This study aims to analyze the communication skills (COM), collaboration skills (COL), and computational thinking (CT) of vocational high school (VHS) students in the computer and network engineering (CNE) program in Kediri City, as well as to identify aspects that need to be strengthened to improve students readiness for the world of work. **Method:** This study used a survey method with a descriptive quantitative approach. The research sample consisted of 379 students selected using random sampling techniques. Data were collected through a closed questionnaire with a Likert scale consisting of 31 statements. Data analysis was performed using descriptive statistics to describe the student's skills levels. **Results:** The results showed that students COM, COL, and CT skills were generally in the good category, with averages of 27.55, 52.75, and 40.89, respectively. However, at the indicator level, there were still several aspects that needed to be strengthened, namely the ability to convey information with confidence in COM, contribution and work organization in COL, and decomposition and algorithm development in CT. **Novelty:** This study provides new insights into the state of 21st century skills among VHS students, particularly those in the CNE program in Kediri City, and suggests the importance of strengthening aspects of skills that are still lacking in order to improve the work readiness of VHS students in an increasingly competitive era.

INTRODUCTION

VHSs as part of vocational education play an important role in preparing competent graduates by developing hard skills and soft skills in line with the needs of an increasingly competitive world of work (Habibi & Rijanto, 2020; Nugroho, 2022). Vocational education must be oriented towards the job market to create adaptive and competitive human resources (Coordinating Minister for Human Development and Culture of the Republic of Indonesia Number 6, 2022). Soft skills such as adaptability and teamwork are crucial to career success in a dynamic work environment (Darmayanti et al., 2021; Makmuroh et al., 2024). This is further supported by evidence that COM, COL, analytical thinking, and problem solving will be in high demand in the global labor market until 2030, becoming the key to preparing for future work challenges (World Economic Forum, 2025). Mastering soft skills helps students adapt to the ever-changing demands of a career (Suryati et al., 2023; Zulfa et al., 2022). Therefore, the integration of adaptive skills into vocational school policies is key to preparing graduates for the world of work (Nuraini et al., 2023).

Many vocational schools have not paid sufficient attention to improving soft skills, which has an impact on students' readiness to enter the workforce (Astuti et al., 2023; Sandroto, 2021). Although vocational school students already possess hard skills, they struggle to develop soft skills such as COM and COL (Wibowo et al., 2024; Sabirin & Sulistiyarini, 2021). This gap hinders work readiness, as inadequate soft skills

make it difficult for graduates to adapt to the dynamics of work (Aufi & Irianto, 2023; Said et al., 2024). Additionally, the skills taught in vocational schools often do not align with the needs of the job market, which worsens graduates employment opportunities (Junedi et al., 2024). The development of soft skills is important to address this issue (Khoiri et al., 2021).

Effective COM skills support team interaction and problem solving (Sukmawati & Siswono, 2021). VHS students COM skills are quite good, while their COL skills are more prominent with an average score of 72.06% (Fajarwati et al., 2023). In addition, cooperation, COM, and critical thinking have a significant effect on VHS students readiness for field work practice, with a contribution of 64.1% (Nurmalitasari & Hakim, 2024). However, students CT skills still vary, with 35% in the high category, 40% in the medium category, and 25% in the low category (Setiarini et al., 2023). These findings emphasize that balanced soft skills development is essential to prepare students for the challenges of the working world. These competencies are particularly important in CNE programs, where students are expected not only to master technical skills but also to communicate effectively, collaborate in teams, and solve technical problems critically in real workplace situations.

The development of skills that support the work readiness of vocational school students is still not given enough attention in the learning process. The focus of education, which tends to emphasize the mastery of hard skills, means that students potential in COM, COL, and CT has not been optimally honed (Pika, 2023; R. A. Putra et al., 2020; Safitri et al., 2023). In fact, these three abilities are at the core of 21st century competencies that determine graduates success in facing a work environment that demands adaptation, cooperation, and effective problem solving. However, previous studies have generally discussed these skills separately or in relation to specific learning outcomes, so an integrated description of COM, COL, and CT skills among VHS students is still limited. This indicates the need for research that specifically examines the profile of these three skills in vocational education.

This study aims to analyze the level of COM, COL, and CT skills of VHS students. Specifically, this study seeks to answer the following research questions: (1) What is the level of COM skills among VHS students? (2) What is the level of COL skills among VHS students? and (3) What is the level of CT skills among VHS students?. The results of this analysis are expected to provide a realistic picture of students abilities as a basis for developing learning strategies that are more relevant to work needs. Theoretically, this research contributes to expanding the understanding of soft skills development in vocational education. Practically, the findings of this research can be used as a reference for educators and policy makers in designing learning programs that focus not only on mastering hard skills, but also on strengthening students soft skills so that they are better prepared to compete in the world of work.

RESEARCH METHOD

This study used a survey method with a population of 772 students from three VHS specializing in the CNE program in Kediri City. The sample size was determined using the Krejcie and Morgan table at a 95% confidence level and a 5% margin of error, requiring a minimum sample of approximately 260 respondents (Krejcie & Morgan, 1970). This study involved 379 students as samples, exceeding the

recommended minimum limit while strengthening data representation and anticipating non response and missing data. The sample was selected using random sampling techniques, taking into account age group and gender.

To obtain valid research results, it is important to follow procedures that are in accordance with quantitative research principles, particularly in survey methods. These research procedures include: (1) problem formulation, (2) determination of research objectives, (3) sample design, sample size, and selection of valid instruments, (4) data collection using questionnaires, (5) data analysis using descriptive statistics, and (6) interpretation of results to draw conclusions relevant to the research objectives (Damanik et al., 2025). The data collection technique in this study used a closed questionnaire, which enabled standardized data collection and efficient statistical analysis (Koo & Yang, 2025b). This questionnaire used a likert scale with five alternative answers to objectively measure respondents against the variables studied (Koo & Yang, 2025a). The 31 statement questionnaire was self developed by the researchers based on indicators derived from previous studies. COM indicators include respecting the other person, conveying information with confidence, and being a good listener (Ramadhina et al., 2024). COL indicators include responsibility, respect, contribution, work organization, and teamwork (Hidayati et al., 2023). Meanwhile, CT indicators include decomposition, pattern recognition, abstraction, and algorithm development (Faradillah et al., 2025).

The instruments used in this study consist of three parts that measure skills relevant to the topic being studied. Part A measures COM skills, part B measures COL skills, and part C measures CT skills.

Table 1. Instrument

Variable	Indicators	Statement	Number	Total Number
COM Skills	Respecting the other person	I always give my full attention when the other person is expressing their opinion.	A1	7
		I respect the differences in opinion expressed by the other person.	A2	
		I feel confident when conveying information in group discussions.	A3	
	Conveying information with confidence	I can explain ideas or information clearly without feeling confused.	A4	
		Being a good listener	I listen attentively when others are speaking.	
	I can understand the message conveyed by the speaker well.		A6	
	I give relevant responses after listening to information from others.	A7		
COL Skills	Responsibility	I always complete the tasks that are my responsibility on time.	B1	13
		I feel responsible for the results of team work that involves me.	B2	
		I ensure that all my tasks are completed properly and without negligence.	B3	
	Respect	I strive not to underestimate the opinions or suggestions of other team members.	B4	
		Contribution	I always provide useful ideas or suggestions in group discussions.	



Variable	Indicators	Statement	Number	Total Number
CT Skills	Work Organization	I try to contribute actively to every group project.	B6	11
		I feel that my contributions to the group have a positive impact on the achievement of work results.	B7	
		I can clearly divide tasks within the group so that the work runs smoothly.	B8	
		I ensure that each team member knows what to do.	B9	
	Teamwork	I help organize schedules and task assignments within the group to ensure that work is completed on time.	B10	
		I work well with others in a team to achieve common goals.	B11	
		I am ready to help other team members when they need assistance.	B12	
	Decomposition	I maintain good COM with team members so that work can be completed effectively.	B13	
		I can break down complex problems into simpler parts.	C1	
		I always start by breaking the problem down into easier to solve steps.	C2	
		I find it easy to break down problems into smaller parts before looking for solutions.	C3	
Pattern Recognition		I can recognize patterns in the data or information i receive.	C4	
		I can easily find patterns or hidden relationships within a problem.	C5	
Abstraction		I often use patterns I have learned to solve new problems.	C6	
	I can ignore irrelevant details to focus on the most important aspects of a problem.	C7		
	I often look for sommon patterns or basic principles in the problems i face.	C8		
Algorithm Development	I can develop detailed steps to solve a problem systematically.	C9		
	I often use algorithms or structured step by step sequences to solve problems.	C10		
	I feel comfortable creating step by step procedures to solve a problem.	C11		
Total				31

The instrument, which was self developed by the researchers based on indicators adapted from previous literature, was tested on 14 students to ensure reliability, which measures the consistency and accuracy of the measuring tool. The instrument is considered reliable if the Cronbach's Alpha value exceeds 0.70 (Streiner, 2003). This value indicates good internal consistency, which means the instrument is reliable. The reliability results are shown in Table 2.

Table 2. Instrument Reliability Results

Variable	Cronbach's Alpha	Total Number
COM Skills	0.793	7
COL Skills	0.915	13
CT Skills	0.940	11

This study involved 379 students who answered 31 statements. The validity of the instrument was tested using SPSS, using a correlation threshold of 0.113. Items with correlations below this threshold were considered invalid and were excluded. The findings in table 3 show that all 31 items are valid, with correlation values exceeding 0.113. In addition, the reliability column shows values above 0.70, confirming that this questionnaire is valid and reliable.

Table 3. Item Validity and Reliability Results of the Instrument

Statement Number	Corrected Item-Total Correlation (Item Validity)	Cronbach's Alpha if Item Deleted (Item Reliability)
A1	.446	.925
A2	.423	.925
A3	.451	.925
A4	.452	.925
A5	.513	.924
A6	.491	.924
A7	.527	.924
B1	.479	.924
B2	.530	.924
B3	.510	.924
B4	.421	.925
B5	.575	.923
B6	.573	.923
B7	.565	.923
B8	.566	.923
B9	.573	.923
B10	.536	.924
B11	.664	.922
B12	.464	.925
B13	.558	.924
C1	.545	.924
C2	.569	.923
C3	.535	.924
C4	.509	.924
C5	.543	.924
C6	.547	.924
C7	.353	.926
C8	.530	.924
C9	.592	.923
C10	.515	.924
C11	.543	.924

Data analysis uses descriptive statistics to describe VHS students perceptions of COM, COL, and CT skills. Descriptive statistics were used to summarize the data using the mean represents the average score, the median indicates the middle score when the data are ordered, the mode shows the most frequently occurring score, and highest and lowest scores. Score categorization is determined using the ideal mean (Mi) and ideal standard deviation (SDi). The ideal mean is calculated using the formula

$M_i = (\text{maximum score} + \text{minimum score}) / 2$, while the ideal standard deviation is calculated using the formula $SD_i = (\text{maximum score} - \text{minimum score}) / 5$. Score interpretation can be seen in table 4.

Table 4. Score Categories

Categories	COM	COL	CT
Very Good	$X > 29.40$	$X > 54.60$	$X > 46,20$
Good	$23.80 < X \leq 29.40$	$44.20 < X \leq 54.60$	$37,40 < X \leq 46,20$
Fair	$18.20 < X \leq 23.80$	$33.80 < X \leq 44.20$	$28,60 < X \leq 37,40$
Low	$12.60 < X \leq 18.20$	$23.40 < X \leq 33.80$	$19,80 < X \leq 28,60$
Very Low	$X \leq 12.60$	$X \leq 23.40$	$X \leq 19,80$

RESULTS AND DISCUSSION

Results

The distribution of 379 respondents in this study can be seen in more detail in Figure 1, which illustrates the distribution of respondents based on age group and gender.

Figure 1. Respondent Distribution Chart

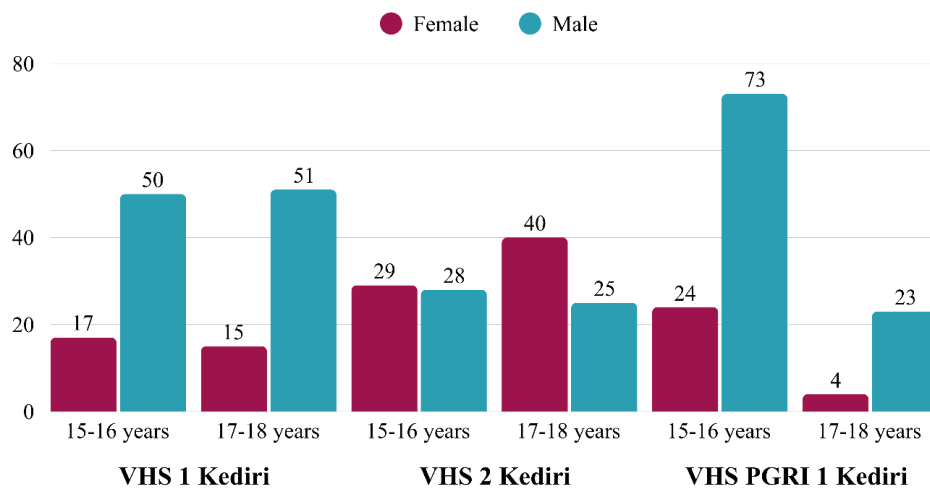


Figure 1 also shows a noticeable gender imbalance in several schools, particularly in VHS PGRI Kediri, where male students dominated the respondent distribution. This condition reflects the demographic characteristics commonly found in CNE programs and is presented as descriptive information about the respondents involved in this study. Table 5 shows the accumulation of respondents answers from the COM skills analysis instrument, which illustrates the extent to which respondents have COM skills as measured by various predetermined indicators.

Table 5. Response Result on COM Skills

Statement Number	Very Disagree	Disagree	Neutral	Agree	Strongly Agree
A1	5	9	29	159	177
A2	4	4	20	140	211
A3	8	56	102	162	51
A4	17	90	119	124	29
A5	5	6	26	150	192
A6	5	18	63	212	81
A7	8	23	75	183	90

Table 6 displays the accumulation of respondents answers to the COL skills instrument, showing the level of respondents COL skills based on the predetermined indicators.

Table 6. Response Results on COL Skills

Statement Number	Very Disagree	Disagree	Neutral	Agree	Strongly Agree
B1	3	32	77	154	113
B2	0	14	46	159	160
B3	3	28	71	154	123
B4	5	6	27	134	207
B5	8	29	104	169	69
B6	3	9	52	163	152
B7	3	26	85	177	88
B8	5	29	79	168	98
B9	4	16	57	167	135
B10	4	32	84	168	91
B11	2	11	39	164	163
B12	7	11	62	151	148
B13	2	7	31	140	199

Table 7 shows the accumulation of respondents answers on the CT skills instrument as an illustration of respondents skill levels based on the established indicators.

Table 7. Response Results on CT Skills

Statement Number	Very Disagree	Disagree	Neutral	Agree	Strongly Agree
C1	6	48	96	171	58
C2	3	33	71	188	84
C3	4	52	100	147	76
C4	2	38	100	179	60
C5	7	54	98	172	48
C6	3	22	65	185	104
C7	15	39	78	163	84
C8	2	19	81	187	90
C9	4	45	106	154	70
C10	7	59	105	139	69
C11	4	30	79	160	106

Discussion

The description of VHS student perception of COM skills in the CNE program can be seen in table 8.

Table 8. Description of COM Skills Perception

Variable	Mean	Median	Mode	Std. Dev	Var	Min	Max
COM Skills	27.55	28	27	3.979	15.836	7	35

Based on Table 8, the average COM skill of 27.55 is in the good category because it falls within the range of $23.80 < X \leq 29.40$. The median is 28 and the mode is 27. The standard deviation of 3.979 indicates that there is variation in scores between students, although it is not too large. This is supported by a variance of 15.836, which shows that students COM skills are not yet completely uniform. Meanwhile, the minimum score of 7 is in the very low category, and the maximum score of 35 is in the very good category. Thus, students COM skills are generally in the good category, although there are still differences in ability among students.

Furthermore, to obtain a more complete picture of the perception of COM skills of VHS students CNE program in Kediri City, the data was grouped based on age group and gender. The description of the perception of COM skills after grouping can be seen in Table 9.

Table 9. Grouping of COM Skills Perceptions

Group		Mean	Median	Mode	Std. Dev	Var	Min	Max
15-16 years	Male	27.52	27	31	3.885	15.091	12	35
	Female	28	28	27	3.079	9.478	21	34
17-18 years	Male	27.02	28	25	4.701	22.102	7	35
	Female	27.98	28	27	3.826	14.638	11	35

Based on Table 9, the perception of COM skills in all groups was in the good category, because the average score was in the range of 27.02 to 28.00, which was included in the interval $23.80 < X \leq 29.40$. In general, female had a slightly higher average than male in both age groups, although all remained in the same category. This finding is consistent with previous studies showing that female students tend to demonstrate better communication skills than male students (Ralmugiz et al., 2025). The median value is in the range of 27 to 28, while the mode is in the range of 25 to 31. In terms of data distribution, the standard deviation of 3.079 to 4.701 and the variance of 9.478 to 22.102 indicate that the scores between students still vary. In addition, the minimum score ranged from 7 to 21, indicating that there were still students in the very low to fair categories, while the maximum score ranged from 34 to 35, which was in the very good category. Thus, although in general the students COM skills were considered good in all groups, their ability levels still showed differences. The results of this study reinforce previous studies that the COM skills of VHS students tend to be at a good level (Mulyono et al., 2025; Setyawan et al., 2024).

Of the three COM skill indicators studied, the indicator of conveying information with confidence is an aspect of COM skills that students still lack mastery of. Low self confidence is associated with suboptimal speaking performance (Permatasari et al., 2024; Wibisono & Aminin, 2025). This finding may be related to the teaching practices still commonly found in Kediri, which tend to be teacher centered. In such learning situations, students more often receive information from the teacher than actively express opinions, ask questions, or communicate ideas in front of the class. In addition, opportunities for serious classroom presentations and structured oral COM practice are still limited, which may hinder the development of students confidence in conveying information. Conversely, the indicators of respecting the other person and being a good listener are aspects that students have mastered better. Oral COM requires the ability to listen and respect other people's opinions (Mahmud et al., 2023). Thus, strengthening the COM skills of VHS students in the CNE program in Kediri City needs to focus on increasing self confidence and clarity in conveying ideas, even though in general, students COM skills are already in the good category. The description of VHS student perception of COL skills in the CNE program can be seen in Table 10.

Table 10. Description of COL Skills Perception

Variable	Mean	Median	Mode	Std. Dev	Var	Min	Max
COL Skills	52.75	53	56	7.166	51.351	16	65

Based on Table 10, the average COL skill of 52.75 is in the good category because it falls within the range of $44.20 < X \leq 54.60$. The median is 53 and the mode is 56. The standard deviation of 7.166 indicates that there is variation in scores between students, while the variance of 51.351 indicates that students COL skills still vary. Meanwhile, the minimum score of 16 is in the very low category, and the maximum score of 65 is in the very good category. In general, students COL skills are in the good category, although the level of ability among students still shows variation.

To obtain a more comprehensive picture of the perception of COL skills among VHS students CNE program in Kediri City, the data was further grouped based on age and gender. The description of the perception of COL skills based on this grouping is presented in Table 11.

Table 11. Grouping of COL Skills Perceptions

Group		Mean	Median	Mode	Std. Dev	Var	Min	Max
15-16 years	Male	51.95	52	50	7.068	49.951	29	65
	Female	54.23	54.50	58	6.068	36.817	39	65
17-18 years	Male	52.66	53	51	7.376	54.411	19	65
	Female	53.20	54	54	8.077	65.234	16	65

Based on table 11, the perception of COL skills in all groups is in the good category, because the average score is in the range of 51.95 to 54.23, which is included in the interval $44.20 < X \leq 54.60$. In general, female have a slightly higher average than male. The median value ranges from 52 to 54.50, while the mode ranges from 50 to 58. In terms of data distribution, the standard deviation of 6.068 to 8.077 and the variance of 36.817 to 65.234 indicate that the scores between students still vary. In addition, the minimum score ranges from 16 to 39, indicating that there are still students in the very low to fair categories, while the maximum score for the entire group reaches 65 and is in the very good category. Thus, although in general, students perception of COL skills is good in all groups, their skill levels still show differences. The results of this study reinforce previous research that the COL skills of vocational school students are in the good category (Mulyono et al., 2023).

Of the five indicators of COL skills studied, the indicators of teamwork, respect, and responsibility were the aspects that students mastered best. COL skills include the ability to work effectively with others, respect team members, take responsibility in joint work, and actively participate in achieving group goals (Khasanah et al., 2025; Mellyzar et al., 2025). Conversely, the indicators of contribution and work organization are aspects that still need to be strengthened. Unbalanced contributions, low active participation, and uneven task distribution can hinder the effectiveness of group work (Hairida et al., 2021; Hajar et al., 2025). Thus, strengthening students COL skills needs to be directed at increasing active contributions and the ability to organize group work in a more structured manner. This is important because in the context of vocational education, COM, negotiation, teamwork, responsibility, and commitment are integral parts of students work readiness (Sultoni et al., 2023).

The description of VHS student perception of CT skills in the CNE program can be seen in table 12.

Table 12. Description of CT Skills Perception

Variable	Mean	Median	Mode	Std. Dev	Var	Min	Max
CT Skills	40.89	41	39	6.691	44.765	13	55

Based on Table 12, the average CT skill of 40.89 is in the good category because it falls within the range of $37.40 < X \leq 46.20$. The median is 41 and the mode is 39. The standard deviation of 6.691 indicates that there is variation in scores among students, while the variance of 44.765 indicates that students CT skills still vary. Meanwhile, the minimum score of 13 is in the very low category and the maximum score of 55 is in the very good category. These results indicate that students CT skills tend to be in the good category, but the abilities of each student are not yet completely the same.

Furthermore, to obtain a more comprehensive picture of the perception of CT skills among VHS students CNE program in Kediri City, the data was grouped based on age and gender. The results of this grouping can be seen in Table 13.

Table 13. Grouping of CT Skills Perceptions

Group		Mean	Median	Mode	Std. Dev	Var	Min	Max
15-16 years	Male	40.49	40	40	6.809	46.358	24	55
	Female	41	42	42	6.070	36.841	28	52
17-18 years	Male	41.63	42	38	6.948	48.277	13	55
	Female	40.54	41	39	6.706	44.977	24	55

Based on table 13, the perception of CT skills in all groups was in the good category, because the average score was in the range of 40.49 to 41.63, which was included in the interval $37.40 < X \leq 46.20$. In general, the average difference between groups is relatively small, with the highest average being 41.63 and the lowest being 40.49, indicating that the CT skills of students in each group tend to be at the same level. The median value ranged from 40 to 42, while the mode ranged from 38 to 42. In terms of data distribution, the standard deviation of 6.070 to 6.948 and the variance of 36.841 to 48.277 indicate that the scores between students still varied. In addition, the minimum score ranges from 13 to 28, indicating that there are still students in the low to very low categories, while the maximum score ranges from 52 to 55, which is in the very good category. Thus, the CT skills of students in all groups are classified as good, even though the abilities of the students still vary.

Of the four CT skill indicators studied, the indicators of decomposition and algorithm development are aspects that, still need to be strengthened. Students CT skills are relatively good in terms of pattern recognition and abstraction, but in terms of decomposition and algorithms, students are still unable to solve problems systematically with the correct answers (Aidil Fitriyah & Mulyono, 2025; Pirzado et al., 2025; M. R. H. Putra et al., 2025). This condition may reflect teaching practices in Kediri that are still oriented toward memorizing standard procedures rather than encouraging students to construct their own problem solving steps. When classroom learning emphasizes following fixed instructions, students may become accustomed to reproducing known procedures instead of designing logical solution sequences independently. This may explain why algorithm development appears weaker than other CT indicators. Therefore, algorithm development requires more targeted

learning interventions so that students are better able to formulate structured and independent problem-solving procedures (Aroonsiwagool et al., 2025).

CONCLUSION

Fundamental Finding : Based on the research results, the COM, COL, and CT skills of VHS students CNE program in Kediri City are generally in the good category. COM skills scored an average of 27.55, COL skills 52.75, and CT skills 40.89, all of which are in the good category based on the scoring criteria used. The grouping results also show that all student groups tend to be in the same category, so there are no noticeable differences between groups. However, the analysis by indicator shows that several aspects still need to be strengthened. In COM skills, the main weakness lies in the ability to convey information confidently and explain ideas clearly. In COL skills, the aspects that still need to be improved are active contribution in discussions and group work organization. Meanwhile, in CT skills, the aspects of decomposition and algorithm development are relatively not yet optimally mastered. Overall, these findings indicate that although VHS students already demonstrate a generally adequate level of workplace-relevant soft skills, targeted improvement is still needed in specific indicators to ensure that graduates are not only academically prepared but also better equipped to respond to the practical demands of the evolving world of work. **Implication:** These findings have important implications for the development of learning strategies in VHS, particularly in the CNE program. This is important in preparing students for the world of work, which requires soft skills. Based on the findings, VHSs need to adopt a more structured policy to integrate soft-skill development into classroom learning, for example by requiring presentation-based tasks, collaborative project work, and problem-solving activities as regular components of instruction, rather than focusing predominantly on content delivery and technical mastery alone. **Limitation:** This study has limitations in the use of perception questionnaires, which only describe students self-assessments and do not measure actual performance in practice. In addition, the research sample was limited to three VHS in Kediri City, so generalization to other regions needs to be done with caution. **Future Research:** Further research is recommended to combine survey methods with direct performance assessments, such as observation, and to use comparative studies across vocational programs and regions. Further research could also examine the effectiveness of various learning approaches in improving VHS students communication, collaboration, and computational thinking skills.

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Nasyiwa Ega Palupi

Department of Information Technology Education,
Universitas Negeri Surabaya,
Building A10, Ketintang Wiyata Street, Surabaya, East Java 60231
Email: nasyiwa.22055@mhs.unesa.ac.id

Mohammad Wildan Habibi (Corresponding Author)

Department of Information Technology Education,
Universitas Negeri Surabaya,
Building A10, Ketintang Wiyata Street, Surabaya, East Java 60231
Email: mohammadhabibi@unesa.ac.id
