Cooperative Learning Model on Group Work Ability of Vocational High School Students: Learning Basic Electronics

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Article Info	ABSTRACT
	The ability to work together in groups is a crucial soft skill for vocational high school students, but conventional learning methods are often less effective in honing this collaborative competence in complex technical subjects. This study aims to test the effectiveness of the Cooperative Learning (CL) learning model on improving students' group work skills in Basic Electronics. This study used a quasi-experimental method with a nonequivalent control group pretest-posttest design. The sample consisted of 50 students of grade XI TAV Vocational High School 4 Gowa who were divided into an experimental group (CL implementation) and a control group (conventional learning). The research instruments included a validated learning outcome test and a group work ability questionnaire. Data were analyzed using Normalized Gain Score (N-Gain) and Analysis of Covariance (ANCOVA). The findings showed that the N-Gain value of the experimental group reached 61.77%, higher than the control group, which was only 44.06%. The effectiveness difference of 17.71% indicates an increase in group skills in the moderate category but significantly outperformed the control class. The ANCOVA test results confirmed this finding with a significant value of 0.001 ($p < 0.05$), proving a significant influence of the CL model on students' collaboration skills. This study confirms that cooperative learning is an effective strategy for strengthening collaboration soft skills in vocational education environments while also providing practical recommendations for educators on integrating teamwork into technical curricula.

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1. INTRODUCTION

Improving the quality of human resources (HR) is an absolute prerequisite for facing current developments in science and technology (Hitka et al., 2019; Turulja & Bajgoric, 2018). Education, as mandated by Law No. 20 of 2003 on Teachers and Lecturers, aims to develop students' potential to become knowledgeable, capable, creative, independent, and responsible individuals (Maulana, 2023). Within the national education system, vocational high schools play a crucial role as institutions explicitly tasked with

preparing students to compete productively and professionally in the workforce (Indrawati & Kuncoro, 2021; Rahmadhani & Suryati, 2022). Since 1993, the "link and match" concept has realized this goal by aligning competencies with market needs (Kautsar et al., 2018; Pohan et al., 2023).

Although vocational technical competencies are the primary focus, the demands of the industrial world now increasingly emphasize soft skills, particularly the ability to work in teams (collaboration) (Munir, 2022). In engineering and industry, strong collaboration skills are a prerequisite for project success (Barutha et al., 2021). The learning process must be directed so that students are given opportunities to work collaboratively in groups during specific lessons so that group work skills can be developed as a competitive asset in the workplace (Thapa et al., 2024; Wolfinbarger et al., 2021).

The Basics of Electronics course is the most important foundation in electrical engineering majors at vocational high schools (Curiel-Ramirez et al., 2022; Danković et al., 2022), as it equips students with basic knowledge and skills regarding electronic components and circuits. However, observations indicate a serious challenge; many students have not achieved the minimum competency standards, primarily due to low student engagement in the learning process.

Most teachers still use traditional methods, namely conveying information through oral and written lectures (Gumartifa et al., 2023; Nugroho, 2022). This method tends to create one-way communication, where students become passive, simply listening, observing, and taking notes. This monotonous, teacher-dominated learning environment not only leads to boredom but also fundamentally hinders the development of much-needed collaboration skills (Masnawati et al., 2024). Students' inadequate group work skills significantly impede the attainment of vocational education's teamwork-focused objectives.

The Cooperative Learning (CL) model is suggested as an effective educational method to combat student passivity and promote collaborative soft skills (Talkhan et al., 2025; Yang, 2023). CL is a structured learning model that organizes students into small, heterogeneous groups to work together to achieve shared learning goals (Baloche & Brody, 2017; Johnson & Johnson, 2018). CL was developed with the assumption that the learning process will be much more meaningful if students can teach each other (peer teaching).

CL is supported by a strong theoretical framework, particularly Constructivist Learning Theory, which emphasizes that knowledge must be actively constructed by students through social interaction (Erbil, 2020; Lenkauskaitė et al., 2020). In CL, this interaction is facilitated through five essential elements (Baker & Clark, 2010; Putri et al., 2024). (1) Positive Interdependence: Each member's contribution determines the group's success. (2) Individual Accountability: Each member is responsible for mastering the material and completing tasks. (3) Face-to-Face Interaction: Group members interact with each other, share ideas, and solve problems together. (4) Social Skills: Learning explicitly develops communication and conflict resolution skills. (5) Processing: Reflection on the effectiveness of collaboration. With this deliberately

designed structure, CL offers advantages over ordinary group work, making it a prospective strategy to be applied in Electronics Fundamentals courses that demand technical precision and collaborative problem solving (Nugroho, 2022; Satria, 2021).

While previous studies have focused more on measuring learning outcomes (cognitive), this study specifically examines parameters of group work capabilities (such as collective leadership, technical conflict resolution, and role distribution) in the context of an electronics laboratory. This study integrates the Cooperative Learning model with modern learning media (e.g., software simulations like Proteus or Tinkercad before actual practice), which are relevant to the current digital transformation in vocational schools. Furthermore, this study applies modified Cooperative Learning steps tailored to the characteristics of Basic Electronics, a subject with high risks and the need for precision measuring instruments, thus creating a safe yet collaborative learning environment.

Therefore, based on the analysis of the problem background and literature review, this study has two main objectives: (1) To determine the implementation of basic electronics learning using the cooperative learning approach at Vocational High School 4 Gowa. (2) To test the significant influence of basic electronics learning using the cooperative learning approach on students' abilities in group work at Vocational High School 4 Gowa. The proposed research hypothesis is: Alternative Hypothesis (H1): There is a significant influence of basic electronics learning using the cooperative learning approach on students' abilities in group work at Vocational High School 4 Gowa.

2.   METHOD

This research is classified as quantitative research, which aims to measure measurably and statistically the effect of learning the basics of electronics using the cooperative learning approach on students' group work abilities. The design applied is a quasi-experiment with a Nonequivalent Control Group Pretest-Posttest Design. This design was chosen because of the limitations of full random assignment of research subjects due to the natural conditions of the school environment. With this design, researchers can compare the results (posttest) between the experimental group (receiving CL treatment) and the control group (receiving conventional learning) after conducting an initial measurement (pretest). The location of the research is Vocational High School 4 Gowa, which is in Gowa Regency, South Sulawesi Province. Data collection was carried out over a three-month period, starting from July to September 2025. The population of this research was all grade XI TAV students at Vocational High School 4 Gowa, with a total of 72 students divided into three classes. The population of this study was all class XI TAV students at Vocational High School 4 Gowa, with a total of 72 students divided into three classes.
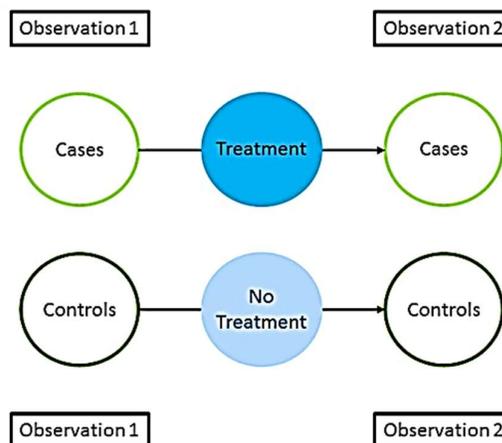
Figure 1. Nonequivalent Control Group Pretest-Posttest Design

Table 1. Details of the Research Population

No	Class XI TAV at State Vocational School 4 Gowa	Number of students
1	XI TAV 1	22 students
2	XI TAV 2	25 students
3	XI TAV 3	25 students
4	Total	72 students

This study used a sample of 50 students, drawn from two selected classes. The sampling technique used was Cluster Random Sampling, where classes were selected randomly. Class XI, Year 2 (n=25) was designated as the experimental group, and class XI, Year 3 (n=25) was designated as the control group. Group assignments were performed using a Random Number Generator (RNG) to ensure objectivity.

Independent Variable (X): Learning Basic Electronics using a Cooperative Learning approach. Dependent Variable (Y): Group work ability. This ability is measured based on a series of effective collaboration skills, including participation, communication skills, responsibility, and collaborative problem-solving.

The group work ability indicators measured are:
1. Active participation in group discussions.
2. Ability to listen to and respect the opinions of peers.
3. Ability to complete group assignments collaboratively.
4. Discipline and division of tasks within the group.
5. Initiative and contribution in solving group problems.

Instruments:
1. Questionnaire: Used to measure the dependent variables (group work skills) and the implementation of CL. The measurement scale used was a 4-point Likert scale (ordinal).

2. Learning Outcome Test: 25 multiple-choice questions were used for the pretest and posttest (ratio scale).

Data Quality Test

The validity of the instrument was tested through Expert Judgment, which resulted in an average score of 3.375 for the questionnaire (valid category) and 3.50 for the test instrument (valid category). A product-moment test further confirmed that all 16 questionnaire items and 25 test items had valid r values.

Reliability testing was conducted using Cronbach's Alpha. The questionnaire achieved a α of 0.814 and the test instrument a α of 0.862. Because both values exceeded the minimum reliability limit of 0.60, the instruments were deemed consistent and reliable.

The Cooperative Learning treatment was implemented in experimental class for five meetings. The treatment syntax included orientation, heterogeneous group formation, task and role assignments, collaborative discussions, presentations, individual and group evaluations, and reflection and rewards. The control class received the same material but used conventional learning methods. Furthermore, the data analysis in this study is described as follows.

1. Effectiveness Test: The Normalized Gain Score (N-Gain) was used to measure relative improvement.
2. Prerequisite Test: Normality (Kolmogorov-Smirnov) and Homogeneity of Variance (Levene's Test) were tested. A homogeneity test for regression coefficients was also conducted to verify the ANCOVA assumptions.
3. Hypothesis Test: Analysis of Covariance (ANCOVA) was used. ANCOVA was chosen because it allows researchers to compare the posttest means of the two groups while controlling for and eliminating bias caused by differences in students' initial abilities (pretest scores). This choice is particularly strategic for Nonequivalent Control Group designs, where initial inequality often poses a threat to the internal validity of the study.

3. RESULTS AND DISCUSSION

Results

Description of Group Work Performance (Experimental Group)

Descriptive data analysis from the group work ability questionnaire in the experimental class (11th grade, grade 2) aimed to assess the extent to which CL was effectively implemented.

Table 2. Statistical Description of the Total Group Work Ability Score (Experimental Class)

Descriptive Statistics	Total Variable Score
N	25
Minimum	38.00
Maximum	60.00
Mean	47.44

Descriptive Statistics	Total Variable Score
Std. Deviation	5.931
Overall Mean (scale 4)	2.965
Category Interpretation	Positive

The average total questionnaire score was 47.44, which, after being normalized to a 4-point scale, yielded an overall mean of 2.965. Based on the interpretation criteria, students' groupwork skills were in the Positive category. This finding provides initial confirmation that the implementation of CL has successfully fostered collaboration skills among students.

Analysis based on indicators revealed specific strengths and weaknesses:
1. The highest indicator was Initiative and Contribution in Solving Group Problems (mean 10.56).
2. The lowest indicator was Discipline and Task Division within the Group (mean 9.76).

High levels of initiative and contribution can be linked to the principle of self-efficacy in Bandura's Social Cognitive Theory. The supportive CL environment, where students witnessed their groupmates succeed, increased their confidence to proactively contribute ideas and solutions to Basic Electronics technical assignments. Conversely, the lowest scores on Discipline and Task Division indicate that the Individual Accountability aspect of group practice has not been fully internalized by students. This indicates that although motivation to participate is high, a stronger emphasis on task and time management is needed in the context of vocational learning.

Improvement Effectiveness Analysis (N-Gain Score)

To measure the effectiveness of the treatment, an N-Gain Score was calculated for both groups. The N-Gain calculation is a method that accurately measures the extent of potential improvement achieved, regardless of the student's initial score.

Table 3. Summary of Average N-Gain

Group	Average N-Gain	Effectiveness Category
Experimental (CL)	61.77%	Moderate ($0.3 \leq g \leq 0.7$)
Control (Conventional)	44.06%	Moderate ($0.3 \leq g \leq 0.7$)
Effectiveness Difference	17.71%	Supports Experiment

Both groups demonstrated improvements categorized as Moderate. However, there was a 17.71% difference in effectiveness, which descriptively favored the experimental class using CL. Although both groups were in the same category, this percentage difference strongly indicates that the CL intervention resulted in better optimization of improvements compared to conventional methods. To determine whether this 17.71% difference in effectiveness was statistically significant, the analysis continued with an ANCOVA inferential test.

ANCOVA Hypothesis Testing

ANCOVA was chosen because the pretest means of the two groups differed substantially (experimental 58.12 vs. 38.56). ANCOVA allows researchers to purify the effect of the Cooperative Learning treatment from biases that may arise from differences in students' initial abilities.

Prerequisite tests confirmed normality of residuals (p=0.081), homogeneity of variance (p=0.375), linearity of covariates, and homogeneity of regression coefficients (p=0.648). Meeting these assumptions validates the use of the ANCOVA model.

Table 4. Results of ANCOVA Significance Test

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	8519.863	2	4259.932	18.067	0.000	0.472
Pretest (Covariate)	485.454	1	485.454	2.059	0.164	0.042
Group (Treatment)	3206.669	1	3206.669	13.603	0.001	0.224
Error	10831.657	46	235.471			
Total	344669.000	50				

The results of the ANCOVA test (table 4) show that the group variable (treatment) has a significant value of p = 0.001. Because this significance value is smaller than the specified significance level (α = 0.05), the Alternative Hypothesis (Ha) is accepted. It is concluded that there is a significant influence of Cooperative Learning on students' group work abilities. The Partial Eta Squared value of 0.224 indicates that the variation in the increase in group work abilities is caused by the Cooperative Learning treatment by 22.4%. This contribution is classified as a medium to large effect size in the context of educational research.

Discussion

Justification of the Influence of Cooperative Learning through Covariate Control

The key finding of the study, the significant effect of CL (p=0.001), was confirmed by the ANCOVA's role in neutralizing prior ability bias. Despite the large pretest difference, the ANCOVA eliminated its effect, as indicated by the non-significant value of the pretest covariate (p=0.164).

This condition implies that the learning mechanism in CL successfully facilitated equalization of abilities among students. This process aligns with Vygotsky's Zone of Proximal Development (ZPD) theory (Abtahi, 2018; Eun, 2019; Lambright, 2024; Xi & Lantolf, 2021). Intensive interaction within the CL group triggered strong scaffolding. Students with lower prior cognitive abilities, who would otherwise have struggled with the Basics of Electronics material, were able to achieve higher understanding with temporary assistance from more capable peers (more knowledgeable others or MKOs). Practical assistance within the group (e.g., verifying resistor values or interpreting circuit diagrams) directly activated students' collaborative potential and elevated their

groupwork abilities to a higher level than if they were working alone. Thus, the observed improvements are a genuine result of the pedagogical intervention (CL), not due to innate talent or unequal initial abilities.

Integration of Social Interdependence Theory

The success of CL in fostering group work skills at vocational high school 4 Gowa is rooted in Johnson & Johnson's Social Interdependence Theory. The CL approach is inherently designed to foster collaborative skills through positive interdependence, meaning the success of each member is tied to the success of the entire group. In the Fundamentals of Electronics lab assignment, each student has a complementary role (positive role interdependence) to achieve engineering goals, such as assembling and testing a functioning circuit. The need to rely on each other for task success facilitates communication, discussion, and peer teaching, which directly trains students in negotiation, sharing responsibility, and resolving conflicts—all important indicators of group work skills.

Performance Indicator Review and Procedural Challenges

A thorough analysis of the questionnaire indicators revealed complex group performance dynamics. High scores on initiative and contribution, as well as listening skills, are evidence of CL's success in affective and social-cognitive aspects. This increased initiative is theoretically supported by increased self-efficacy (Bandura's Social Cognitive Theory), where success in solving a series of problems increases their motivation to participate actively and proactively (Akbari et al., 2021; Schunk & DiBenedetto, 2020; Yin et al., 2022).

However, low scores on the discipline and task allocation indicators indicate structural barriers to CL practice. Although students are motivated to contribute ideas, they may not be accustomed to strict role allocation and disciplined time management, which poses a weakness in the implementation of the Individual Accountability principle. In a vocational environment that relies heavily on procedural efficiency, this weakness must be addressed. Future CL implementations need to include a more explicit emphasis and rigorous assessment of each member's specific role (e.g., timekeeper or quality control) to ensure each individual contributes equitably, thereby preventing the phenomenon of social loafing or domination by a few more skilled members.

Relevance to the Demands of the Vocational Workplace

Overall, this research strengthens the argument that the Cooperative Learning model is a superior pedagogical strategy for vocational education. By developing skills such as effective communication, initiative, and problem-solving (21st-century skills), CL prepares vocational high school graduates to be better prepared to face industry challenges, in line with the link and match policy. These results are also consistent with previous studies that have shown the effectiveness of CL in improving students' academic and collaborative learning outcomes at various levels of education (Geletu, 2022; Mendo-Lázaro et al., 2022; Rafique et al., 2021; Yang, 2023).

4. CONCLUSION

The study found that the implementation of basic electronics learning using the cooperative learning approach at Vocational High School 4 Gowa was effective. This was demonstrated by the results of the group work ability questionnaire, which was in the positive category with an average score of 47.44 (scale 4). The highest indicator was initiative and contribution (10.56), while the lowest indicator was discipline and task division (9.76). This indicates that students demonstrated active involvement and good responsibility in group work during learning using this approach. Additionally, the data analysis showed a significant effect of the implementation of basic electronics learning using the cooperative learning approach on students' group work abilities at vocational high school 4 Gowa. This significance was supported by the test results for the group variable, which obtained an F value (1.47) = 13.603 with a significance level of p = 0.001. Because the significance value of 0.001 is less than 0.05, the Alternative Hypothesis (Ha) was accepted. Thus, it can be concluded that the cooperative learning approach has proven effective in improving students' group work abilities, where the partial eta squared value of 0.224 indicates that 22.4% of the variation in the increase in group work abilities is caused by this learning treatment.

As a suggestion, teachers are advised to be more strict in monitoring the role-sharing structure in each group to ensure the workload is evenly distributed (not dominated by a single student). For further researchers, conduct experimental research with a control group to compare the effectiveness of this model in more contrast. In addition, integrate this model with Virtual Laboratory media to see whether group work capabilities remain consistent both in digital simulation environments and physical practice.

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