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Implementation of STAD-type Cooperative Learning to Improve Vocational High School Students Milling Practice Learning Outcomes

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Abstract

This classroom action research examined the use of Student Teams Achievement Division (STAD) to improve milling practice learning outcomes among 24 Grade XI machining students at SMK Negeri 1 Sumatera Barat. The study was conducted in two cycles using the Kemmis and McTaggart stages of planning, action, observation, and reflection. Data were collected through cognitive tests, a milling performance rubric, group-performance observation, student-activity observation, and documentation. The results showed consistent improvement after the learning groups were formed heterogeneously, individual responsibilities were clarified, teacher guidance was intensified, and group recognition was provided. The mean cognitive score increased from 64.67 in the pre-cycle to 84.58 in Cycle II, while mastery increased from 25.00% to 91.67%. The mean practical score rose from 72.25 in Cycle I to 82.04 in Cycle II, with mastery increasing from 41.67% to 87.50%. Group performance improved from 76.00 to 86.40, and student activity increased from 69.58 to 81.79. These findings indicate that STAD strengthens peer support, individual accountability, cooperation, and active engagement, thereby improving both theoretical understanding and practical milling skills. STAD is therefore suitable as an alternative instructional model for vocational machining practice.

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1. INTRODUCTION

Vocational education is expected to prepare graduates who possess occupational knowledge, practical skills, work discipline, and the ability to collaborate in industrial environments. In machining programs, this expectation is particularly important because learning outcomes are demonstrated not only through conceptual understanding but also through the safe and accurate operation of production machines. Milling is a core competence in machining education because it requires students to read technical drawings, select cutting tools, determine machining parameters, set up workpieces, control the cutting process, measure dimensions, and apply occupational safety procedures. The close relationship between theory and physical performance makes milling practice a demanding learning context for vocational students (Groover, 2010).

Initial observations in Grade XI Machining 1 at SMK Negeri 1 Sumatera Barat indicated that the learning process had not yet produced optimal outcomes. Of the 24 students, only six students reached the minimum mastery criterion of 75, resulting in classical mastery of 25.00%. The mean initial test score was 64.67. Classroom observations also showed that several students were passive, hesitant to ask questions, and dependent on teacher explanations or on classmates with stronger practical skills. Differences in prior knowledge and machining ability were substantial, while conventional explanation, demonstration, and individual assignment patterns provided limited opportunities for structured peer interaction. As a result, students who needed more assistance often remained less involved during practice and had difficulty following the correct work sequence.

Practice-based vocational learning should provide direct experience, active participation, and opportunities to develop both technical and social competence. A student-centered approach is therefore required so that learners can discuss procedures, observe one another, correct errors, and share responsibility for completing practical work. Cooperative learning is relevant to this need because it organizes students into small groups in which members support one another while remaining individually accountable. According to Slavin (2020), effective cooperative learning combines positive interdependence with individual responsibility, so that group success depends on the learning progress of every member. This principle is also consistent with the collaborative demands of vocational and industrial work.

Student Teams Achievement Division (STAD) is one of the most widely applied cooperative-learning models. Its essential components include class presentation, heterogeneous teams, team study, individual assessment, improvement scores, and group recognition. Heterogeneous grouping allows students with different ability levels to exchange explanations and provide peer assistance. Individual tests prevent students from relying entirely on more capable teammates, while group recognition encourages members to support one another. In practical instruction, these mechanisms can be adapted by assigning roles, discussing the job sheet, observing machine setup, checking work procedures, and evaluating individual knowledge and performance.

Previous studies have reported positive effects of STAD in vocational and technical education. Latif and Jatmoko (2024) reported an increase in mastery from 65% to 90% in basic automotive technology. Andrianto and Kurniawan (2023) recorded a rise in average technical-drawing scores from 62.55 to 83.63, while Ramadhani, Azim, and Purwanto (2020) showed that students taught through STAD outperformed those taught by direct instruction. Similar findings have been reported in electrical practice and vocational digital-simulation subjects (Parikhin, 2018; Rorong, Manoppo, & Takaredase, 2021). These studies demonstrate the potential of STAD, but many emphasize test performance or motivation rather than simultaneously examining cognitive achievement, authentic machining performance, group work, and individual learning activity in an actual milling workshop. Accordingly, this study aimed to determine whether the implementation of Student Teams Achievement Division (STAD) could improve cognitive learning outcomes, practical milling performance, group performance, and student activity among Grade XI Machining students at SMK Negeri 1 Sumatera Barat.

The scientific contribution of this study is the integrated application and evaluation of STAD in milling practice. The intervention assessed four connected dimensions: cognitive understanding, psychomotor performance, group performance, and student activity. This broader evaluation is important because success in machining practice cannot be represented by written-test scores alone. Accordingly, the study aimed to determine whether the implementation of STAD could improve milling practice learning outcomes among Grade XI machining students at SMK Negeri 1 Sumatera Barat.

2. METHOD

The study employed classroom action research because the problem originated from an actual instructional situation and required a planned cycle of improvement. The research followed the Kemmis and McTaggart model, consisting of planning, action, observation, and reflection (Arikunto, 2021; Kemmis, McTaggart, & Nixon, 2014). Two cycles were implemented, and each cycle consisted of two meetings. The research was conducted in May 2026 during the second semester of the 2025/2026 academic year at SMK Negeri 1 Sumatera Barat. The participants were all 24 students of Grade XI Machining 1 selected using total sampling because classroom action research involved the entire class experiencing the identified learning problem. Data collection techniques included cognitive tests, direct observation, practical performance assessment using a rubric, documentation, and field notes.

The participants were all 24 students of Grade XI Machining 1. Classroom action research does not require sampling because the action is directed at improving learning in a specific class. The class was selected on the basis of the initial learning problem: low classical mastery, limited student activity, uneven practical competence, and weak cooperation during milling practice. The practical task used in the cycles was the production of a T-nut, which required students to prepare tools and materials, set the milling machine, select and install the cutter, perform the machining sequence, measure the workpiece, maintain accuracy, and comply with occupational safety procedures.

During Cycle I, the teacher explained the learning objectives and essential milling concepts, formed five heterogeneous groups of four to five students, facilitated team study, supervised the practical task, administered individual evaluation, and recognized group achievement. Observation and reflection showed that some students were still passive, role distribution was uneven, several members depended on higher-achieving peers, and time management was not yet effective. Cycle II therefore included more balanced regrouping, explicit assignment of individual roles, stronger teacher monitoring, structured discussion prompts, additional motivation, and clearer responsibility for each stage of the practical work.

Table 1. Research design, instruments, and success criteria

Component	Description	Instrument/Data	Success criterion
Research model	Two-cycle classroom action research: planning, action, observation, and reflection.	Field notes and documentation	Cycle II completed when the predetermined criteria were met.
Cognitive outcome	Understanding of milling concepts, procedures, and safety principles.	Individual written tests in the pre-cycle, Cycle I, and Cycle II.	Score >= 75; at least 85% classical mastery.
Practical outcome	Preparation, machine setting, tool use, process, accuracy, product quality, and safety.	Seven-aspect practical-performance rubric; maximum score 100.	Score >= 75; improvement across cycles.
Learning process	Participation, cooperation, responsibility, and engagement during STAD activities.	Group-performance and student-activity observation sheets.	Mean student activity >= 75.

Data were collected using five complementary techniques. First, written tests measured students' cognitive understanding of milling. Second, practical performance was assessed with a seven-aspect rubric covering tool and material preparation, machine setting, cutting-tool use, work process, accuracy, product quality, and occupational safety. Third, group performance was observed through discussion activity, task participation, cooperation, and individual responsibility. Fourth, student activity was observed through participation, collaboration, responsibility, and engagement throughout the learning process. Fifth, documentation included scores, student work, and photographs. The instruments were reviewed for content appropriateness by the supervising lecturer and the milling teacher before use.

Quantitative data were analyzed descriptively using the mean score and the percentage of students who reached the minimum mastery criterion. The mean was calculated by dividing the total score by the number of students, while classical mastery was obtained by dividing the number of students with scores of at least 75 by the total number of students and multiplying by 100%. Observation data were interpreted descriptively to identify changes in participation, cooperation, responsibility, and engagement. The action was considered successful when at least 85% of students achieved a score of 75 or higher and the mean student-activity score reached at least 75.

3. RESULTS AND DISCUSSION

3.1 Initial Condition and Cycle I

The pre-cycle test confirmed low initial understanding. The mean score was 64.67, only six students reached the minimum criterion, and classical mastery was 25.00%. Observation showed that many students waited for direct instructions rather than discussing procedures or helping peers. Higher-performing students could work independently, whereas lower-performing students often had difficulty interpreting the job sheet, arranging the work sequence, and operating the milling machine confidently.

Cycle I introduced heterogeneous teams, group discussion, practical work, and individual evaluation. The mean cognitive score increased to 74.21 with 58.33% mastery, while practical performance reached 72.25 with 41.67% mastery. Although peer interaction began to support learning, the criteria had not been met. Participation remained uneven, role distribution was unclear, several students relied on one capable member, and the mean activity score was only 69.58.

Reflection showed that grouping alone was insufficient without explicit roles and systematic monitoring. Cycle II therefore strengthened individual accountability through assigned technical responsibilities, more focused teacher questions, direct feedback during practice, and a more balanced redistribution of students among the teams.

3.2 Cognitive Learning Outcomes

Table 2. Cognitive learning outcomes across the action cycles

Indicator	Pre-cycle	Cycle I	Cycle II
Mean score	64.67	74.21	84.58
Highest score	87	93	100
Lowest score	43	57	70
Students achieving mastery	6	14	22
Students not yet achieving mastery	18	10	2
Classical mastery	25.00%	58.33%	91.67%

Table 2 shows a continuous increase in cognitive achievement. From the pre-cycle to Cycle I, the mean score increased by 9.54 points, and from Cycle I to Cycle II it increased by another 10.37 points. Classical mastery rose by 33.33 percentage points in Cycle I and by a further 33.34 percentage points in Cycle II. By the end of Cycle II, 22 of the 24 students had achieved the minimum criterion, producing 91.67% classical mastery and exceeding the required 85% threshold.

The increase can be explained by the interaction between peer explanation and individual evaluation. During team study, students could ask questions in a less formal setting, compare interpretations of the job sheet, and receive immediate explanations from classmates. However, because the final evaluation was individual, each student still needed to understand the material personally. This combination reduced passive dependence and encouraged members to help one another before the test. The result is consistent with Slavin's (2020) view that group goals are most effective when accompanied by individual accountability. It also supports the findings of Andrianto and Kurniawan (2023), and Latif and Jatmoko (2024), who found substantial achievement gains after STAD was applied in vocational subjects.

3.3 Practical Milling Performance

Table 3. Practical milling performance in Cycle I and Cycle II

Indicator	Cycle I	Cycle II
Mean practical score	72.25	82.04
Highest score	86	92
Lowest score	57	69
Students achieving mastery	10	21
Students not yet achieving mastery	14	3
Classical mastery	41.67%	87.50%

Practical performance improved substantially after the Cycle II revision. The mean practical score increased by 9.79 points, from 72.25 to 82.04, while mastery rose from 41.67% to 87.50%. The number of students meeting the criterion more than doubled, from ten to 21. The data indicate that improved cognitive understanding was transferred into observable workshop performance, including more complete preparation, more accurate machine setting, safer cutting-tool use, better adherence to the work sequence, improved measurement, and higher product quality.

The practical improvement was not produced by discussion alone. It resulted from the way discussion was connected to direct work. Group members first interpreted the job sheet and clarified the procedure, then observed one another while performing the task and provided immediate corrective feedback. The teacher's role changed from being the main source of every instruction to facilitating, monitoring, and confirming procedures. This arrangement increased the amount of meaningful practice available to students while retaining teacher control over safety and technical accuracy. The result supports Parikhin (2018), who found that STAD strengthened the quality of vocational electrical practice, and Ramadhani et al. (2020), who reported higher achievement under cooperative learning than under direct instruction.

Three students still did not reach the practical mastery criterion in Cycle II, even though only two students remained below the criterion on the cognitive test. This difference is important because practical competence develops through repeated motor performance, precision, and confidence, not only through conceptual understanding. Students who understand the procedure may still need additional practice to control machine movement, measure accurately, or maintain consistent product quality. Consequently, the class-level success of STAD should be followed by individual remediation and additional workshop time for students whose psychomotor performance remains below the standard.

3.4 Group Performance and Student Activity

Table 4. Changes in group performance and student activity

Aspect	Cycle I	Cycle II	Change
Mean group-performance score	76.00	86.40	+10.40
Groups reaching the criterion	3 of 5 (60%)	5 of 5 (100%)	+40 percentage points
Mean student-activity score	69.58	81.79	+12.21
Dominant activity category	Fairly active	Active	One category higher

The process data confirm that the increase in test and practical scores was accompanied by better learning behavior. The mean group-performance score increased from 76.00 to 86.40, and all five groups reached the performance criterion in Cycle II. Student activity increased by 12.21 points, from 69.58 to 81.79, moving the dominant category from fairly active to active. Students became more willing to present opinions, ask for clarification, help peers, share tasks, and remain engaged throughout the practical session.

The largest process improvement occurred after roles and responsibilities were made explicit. In Cycle I, a group could appear active even when only one or two members performed most of the work. Cycle II reduced this imbalance by assigning each member a technical or supervisory responsibility and by requiring individual explanations of the work process. This strategy limited dominance by higher-ability students and created more opportunities for lower-ability students to participate. The recognition of group progress further strengthened positive interdependence because students understood that the group’s success depended on the contribution and improvement of each member.

These findings are consistent with research showing that STAD can improve collaboration, engagement, and responsibility alongside academic performance. Prayogi, Sukaisih, Muhali, and Asy’ari (2024) reported gains in collaboration skills and learning outcomes, while Suparmini (2021) found improvements in both activity and achievement. The present study extends those findings to milling practice and shows that cooperative mechanisms remain effective in a workshop setting when technical roles, individual accountability, teacher monitoring, and occupational safety are deliberately integrated into the model.

3.5 Overall Interpretation

The combined evidence indicates that STAD improved both the learning process and the learning product. Cognitive mastery exceeded the 85% criterion, practical mastery reached 87.50%, group performance reached 100% at the group level, and mean student activity surpassed the required score of 75. The results therefore answer the research question affirmatively: the implementation of STAD improved milling practice learning outcomes among the participating students.

The improvement occurred through a sequence of connected mechanisms. Heterogeneous grouping created access to peer support; team study enabled students to verbalize and correct their understanding; role assignment broadened participation; individual assessment maintained personal responsibility; group recognition increased motivation; and intensified teacher guidance ensured that cooperation did not compromise technical accuracy or safety. The trend from Cycle I to Cycle II demonstrates that the effectiveness of cooperative learning depends not merely on placing students in groups, but on designing a clear structure of participation, accountability, feedback, and reflection.

The study is limited to one class, one school, a two-cycle period, and one milling task. The results should therefore be interpreted as evidence of instructional improvement in the specific classroom rather than as a universal causal estimate. In addition, some students still required individual remediation after Cycle II. Future studies can apply STAD for longer periods, use multiple machining competencies, include peer assessment or interviews, and examine the durability of learning outcomes after the intervention ends.

4. CONCLUSION

The implementation of Student Teams Achievement Division improved milling practice learning outcomes among Grade XI machining students at SMK Negeri 1 Sumatera Barat. Cognitive mastery increased from 25.00% in the pre-cycle to 91.67% in Cycle II, and practical mastery increased from 41.67% in Cycle I to 87.50% in Cycle II. Group performance and student activity also improved, indicating that the achievement gains were accompanied by stronger cooperation, responsibility, and engagement. The key instructional factors were heterogeneous teams, explicit roles, peer assistance, individual evaluation, group recognition, and active teacher facilitation. STAD can therefore be used as an alternative model for vocational machining practice, while students who have not yet achieved practical mastery should receive additional individual guidance and remedial practice.

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