Effectiveness of Block-System Learning for Grade XI Mechanical Engineering Students at SMK Negeri 1 Klego

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ABSTRACT

Block-system scheduling is widely adopted in vocational secondary education to consolidate instructional hours so learners can transition seamlessly from conceptual explanation to sustained workshop practice. This study evaluated the effectiveness of block-system learning implemented for Grade XI Mechanical Engineering students at SMK Negeri 1 Klego, Boyolali Regency, Central Java, Indonesia, during the 2023/2024 odd semester. Guided by an evaluative framework integrating Tyler's goal-attainment model and Stufflebeam's CIPP (Context, Input, Process, Product) perspective, the research employed a descriptive mixed-methods design combining quantitative surveys, official report-card documentation, semi-structured interviews, and full-day workshop observation. Quantitative perception data were gathered using a validated 30-item four-point Likert questionnaire administered to 40 purposively sampled students and an 18-item questionnaire completed by three productive mechanical engineering teachers, alongside odd-semester academic report ledgers covering the entire population of 142 students across four classes (XI TPM 1 to XI TPM 4). Qualitative triangulation involved semi-structured interviews with the three teachers and six students, supported by direct observation of stepped lathe turning and cutting-tool grinding sessions. Reconciled student survey data yielded an overall effectiveness index of 78.67% (Very Effective), while combined student and teacher evaluations achieved 82.00% for school services (Very Effective), 67.00% for implementation conditions (Effective), and 83.00% for instructional quality (Very Effective), resulting in a three-dimension mean of 77.33% and a four-aspect composite score of 80.00% (Very Effective). Furthermore, 141 of 142 students (99.30%) attained minimum mastery learning standards, with class highest averages ranging from 84.20 to 85.70. While descriptive in scope, the findings confirm that weekly block scheduling strengthens theory-to-practice continuity, jobsheet autonomy, and peer collaboration, provided schools manage afternoon physical fatigue through structured rest intervals.

Keywords: block scheduling, learning outcomes, mechanical engineering, program evaluation, vocational education

INTRODUCTION

Vocational secondary education (*Sekolah Menengah Kejuruan* or SMK) is mandated to equip learners with industry-relevant technical competencies, workplace discipline, and problem-solving capabilities (Billett, 2011; UNESCO-UNEVOC, 2020). In Indonesia, the implementation of *Kurikulum Merdeka* grants vocational schools institutional autonomy to organize instructional schedules that align with workshop capacity, industrial work culture, and competency-based practical training (Kemendikbudristek, 2022; Sudira, 2020). Traditional fragmented timetables in which normative, adaptive, and productive subjects alternate within short daily periods frequently disrupt psychomotor skill acquisition because students spend disproportionate time on machine setup, tool preparation, and safety briefings before achieving operational fluency (Biggs & Tang, 2011; Canady & Rettig, 2013).

Block-system learning addresses this structural constraint by consolidating instructional hours for specific subject groups into uninterrupted multi-day or weekly blocks (Purnomo et al., 2021; Sutrisno & Rahayu, 2022). Prior empirical reviews in technical and vocational education demonstrate that concentrated

instructional blocks allow learners to transition immediately from conceptual explanation to hands-on machining, assembly, or diagnostic tasks, thereby reducing cognitive forgetting between theory and practice (Kolb, 2015; Zepeda & Mayers, 2006). At the same time, educational literature cautions that extended block schedules introduce operational challenges, including student physical and mental fatigue, attentional decline during late afternoon sessions, and heightened demands on workshop equipment availability and teacher preparation (Queen, 2000; Rikard & Banville, 2005).

At SMK Negeri 1 Klego, Boyolali Regency, Central Java, block-system scheduling has been implemented since 2020 in the Mechanical Engineering (*Teknik Pemesinan*) expertise program to optimize workshop utilization and competency attainment. Under this arrangement, normative/adaptive classroom subjects and productive workshop courses (conventional lathe turning, milling, grinding, and CNC/CAD machining) rotate in weekly blocks across classes. However, systematic empirical evaluation examining whether this scheduling model translates into high instructional quality, favorable stakeholder perceptions, and measurable student mastery across all Grade XI classes remained limited.

To evaluate the program comprehensively, this study adopts a dual program-evaluation framework integrating Tyler's objective-oriented evaluation model (Tyler, 2013) and Stufflebeam's CIPP (Context, Input, Process, Product) model (Stufflebeam & Zhang, 2017), operationalized through Arikunto's quantitative effectiveness criteria (Arikunto, 2018). Within this framework, instructional effectiveness is assessed across four interrelated components: (1) institutional awareness and socialization of block scheduling (*Context*), (2) school services encompassing schedule fairness, workshop facilities, and attendance monitoring (*Input*), (3) classroom and workshop implementation conditions covering learning interest, peer collaboration, and fatigue/concentration management (*Process*), and (4) instructional quality together with student academic mastery outcomes (*Product*). Because this study employs a descriptive evaluation design without a non-block control group, it aims to evaluate stakeholder perceptions, implementation conditions, and documented mastery rates rather than infer experimental causality.

METHODOLOGY

Research Design and Setting

This study employed a descriptive mixed-methods evaluation design integrating quantitative survey analysis and academic report-card documentation with semi-structured interviews and direct workshop observation (Creswell & Creswell, 2018). The research was conducted in the Mechanical Engineering Expertise Program at SMK Negeri 1 Klego, Boyolali Regency, Central Java, Indonesia, from 10 July to 29 September 2023 during the 2023/2024 odd semester.

Population, Sample, and Qualitative Informants

The target population comprised all 142 Grade XI Mechanical Engineering students distributed across four classes XI TPM 1 (36 students), XI TPM 2 (36 students), XI TPM 3 (36 students), and XI TPM 4 (34 students) together with 11 mechanical engineering teachers at SMK Negeri 1 Klego. Using purposive sampling based on direct participation in weekly block-scheduled workshop courses, 40 Grade XI students and 3 productive mechanical engineering teachers were selected as quantitative questionnaire respondents (Sugiyono, 2019). For qualitative triangulation, semi-structured interviews were conducted with all 3 productive teachers (Trimo on 13 August 2023; Musthofa and Devi Agustian on 27 September 2023) and 6 Grade XI students (Arif, Faiz, Teddy, Irwan, Imam, and Rico on 7 September 2023). Official odd-semester report-card ledgers (*Leger Nilai Rapor*) were examined for the entire population of 142 students.

Instruments, Scoring Procedure, Validity, and Reliability

Four data collection instruments were utilized:

1. Student Perception Questionnaire: A 30-item four-point Likert instrument (*Strongly Agree* [SS] = 4, *Agree* [S] = 3, *Disagree* [TS] = 2, *Strongly Disagree* [STS] = 1) covering three core dimensions and nine indicators:

School Services (schedule organization P1–P3, facilities and infrastructure P4–P6, student attendance P7–P9), Implementation Conditions (learning interest P10–P12, student collaboration P13–P15, boredom/fatigue/concentration P16–P18), and Instructional Quality (learning development P19–P22, material preparation P23–P24, instructional strategy P25–P30). Items P16, P17, and P18 were negatively worded; therefore, they were reverse-scored (5 − x, where Strongly Disagree = 4, Disagree = 3, Agree = 2, and Strongly Agree = 1) prior to calculating composite effectiveness scores so that higher scores consistently represent higher educational effectiveness. Pearson item-total correlations across all 30 items (n = 40) ranged from r = 0.604 to r = 0.810 ($p < 0.001$), exceeding the critical threshold (r-table = 0.312), and internal consistency reached Cronbach's $\alpha = 0.962$.

2. Teacher Questionnaire and Semi-Structured Interview Guides: An 18-item four-point Likert questionnaire administered to the 3 productive teachers alongside a 19-question semi-structured interview protocol examining policy rationale, scheduling mechanics, teacher readiness, workshop supervision, and student engagement.

3. Workshop Observation Protocol: A structured full-day field observation conducted on 13 July 2023 (07:00–15:45 WIB) during stepped lathe turning (*bubut bertingkat*) and cutting-tool grinding sessions.

4. Academic Achievement Documentation: Official 2023/2024 odd-semester report-card ledgers across 15 normative, adaptive, and productive subjects, benchmarked against the institutional minimum mastery criterion (*Kriteria Ketuntasan Minimal* / KKM) of 75.0.

Data Analysis

Quantitative questionnaire scores were converted into percentage effectiveness indices using the formula: Effectiveness (%) = (Obtained Score / Maximum Possible Score) × 100%, and interpreted using Arikunto's (2018) four-tier classification criteria presented in Table 1. Qualitative interview transcripts and workshop observation notes were analyzed interactively through data condensation, thematic display, and cross-method verification (Miles et al., 2019).

Table 1. Effectiveness Classification Criteria

Percentage Score Range (%)	Effectiveness Category
76 – 100	Very Effective
56 – 75	Effective
40 – 55	Less Effective
< 40	Ineffective

Ethical Considerations and Institutional Permission

Formal research authorization was established through the official Implementation Agreement (*IA Pengganti Surat Izin Penelitian*) between the Faculty of Engineering, Universitas Negeri Yogyakarta, and SMK Negeri 1 Klego for the 2023/2024 academic year. Participation in questionnaires, interviews, and classroom observations was voluntary following explanation of study objectives to school leadership, teachers, and students, and all academic records were anonymized during statistical reporting.

RESULTS

Indicator-Level and Item-Level Student Perceptions

Analysis of the reconciled 30-item questionnaire completed by 40 Grade XI Mechanical Engineering students (1,200 total item responses) demonstrates consistently positive perceptions across all nine indicators (Table 2) and all 30 individual items (Table 3).

Table 2. Distribution of Student Questionnaire Responses by Dimension and Indicator (n = 40, 30 Items)

Dimension & Indicator	Items	Very Effective (%)	Effective (%)	Ineffective (%)	Very Ineffective (%)	Total (%)
1. School Services						
Schedule organization	P1–P3	26.67	68.33	4.17	0.83	100
Facilities & infrastructure	P4–P6	28.33	57.5	11.67	2.5	100
Student attendance	P7–P9	19.17	67.5	10	3.33	100
2. Implementation Conditions						
Learning interest	P10–P12	40	55	1.67	3.33	100
Student collaboration	P13–P15	47.5	45	5	2.5	100
Absence of boredom/fatigue*	P16–P18	14.17	50	22.5	13.33	100
3. Instructional Quality						
Learning development	P19–P22	33.13	56.88	6.25	3.75	100
Material preparation	P23–P24	22.5	75	0	2.5	100
Instructional strategy	P25–P30	28.33	65.83	3.33	2.5	100

**Note: Items P16–P18 are negatively worded; raw responses were 13.33% Strongly Agree, 22.50% Agree, 50.00% Disagree, and 14.17% Strongly Disagree, reverse-scored (5 − x) so that disagreement with boredom/fatigue represents effective implementation.*

Table 3. Complete 30-Item Student Questionnaire Statements and Item-Level Response Frequencies (n = 40)

Item	Questionnaire Statement (Translated from Indonesian Instrument)	SS (4)	S (3)	TS (2)	STS (1)	Mean Raw	Eff. (%)
P1	Block-system schedule allocation matches instructional hour requirements	16	23	1	0	3.38	84.38
P2	Block-system instructional hours are fair relative to other subjects	11	27	2	0	3.22	80.62
P3	Block-system schedule arrangement aligns with subject characteristics	5	32	2	1	3.02	75.62
P4	Classroom and workshop facilities are well maintained	12	21	6	1	3.1	77.5
P5	Workshop consumables and materials are completely provided for practice	12	24	3	1	3.18	79.38
P6	Maintenance of practical workshop tools is conducted routinely	10	24	5	1	3.08	76.88
P7	Daily student attendance is monitored by Counseling Guidance (BK) staff	5	31	3	1	3	75
P8	Teachers re-check student attendance before the lesson session ends	8	24	6	2	2.95	73.75
P9	Students absent for more than three consecutive days are summoned by BK	10	26	3	1	3.12	78.12
P10	Student learning interest increases under the block system	14	24	1	1	3.28	81.88

P11	Block-system learning feels enjoyable	16	22	0	2	3.3	82.5
P12	The block system gives students greater flexibility to learn	18	20	1	1	3.38	84.38
P13	Cooperation among students is well established	19	18	2	1	3.38	84.38
P14	Group discussions make learning more enjoyable	20	18	1	1	3.42	85.62
P15	The block system brings students closer to one another	18	18	3	1	3.32	83.12
P16*	Block-system learning feels boring (reverse-scored)	4	5	25	6	2.17	70.62
P17*	Block-system learning makes students tire quickly (reverse-scored)	5	15	13	7	2.45	63.75
P18*	Long instructional hours reduce student concentration (reverse-scored)	7	7	22	4	2.42	64.38
P19	Block-system learning influences student competency achievement	15	23	1	1	3.3	82.5
P20	The block system makes it easier to continue unfinished practical tasks	15	20	3	2	3.2	80
P21	Students are trained to be more active and independent in learning	17	21	1	1	3.35	83.75
P22	Students enter the classroom 10 minutes before instruction begins	6	27	5	2	2.92	73.12
P23	Upcoming material is explained beforehand by the teacher	10	29	0	1	3.2	80
P24	Before starting workshop practice, students are asked to understand theory	8	31	0	1	3.15	78.75
P25	During practical classes, the teacher remains present until the session ends	6	30	3	1	3.02	75.62
P26	Material delivery is conducted before practical work begins	10	29	0	1	3.2	80
P27	During workshop practice, students receive teacher guidance	8	30	1	1	3.12	78.12
P28	Student assessment includes structured task/jobsheet assignments	12	24	3	1	3.18	79.38
P29	Students understand material delivered through the block system more easily	11	27	1	1	3.2	80
P30	With the block system, students' vocational skill scores improve	21	18	0	1	3.48	86.88
Total	**Overall Student Questionnaire Score (3,776 / 4,800 points)**	—	—	—	—	**3.15**	**78.67**

**Reverse-scored items (5 − x) for effectiveness calculation. Overall student score = 3,776 / 4,800 = 78.67% (Very Effective).*

Across the three student questionnaire dimensions, Instructional Quality achieved the highest student rating at 79.38% (led by P30 at 86.88%), followed by School Services at 78.89% (P1 at 84.38%) and Implementation Conditions at 77.50% (P14 at 85.62%). The lowest item-level effectiveness ratings occurred on physical fatigue (P17 = 63.75%) and afternoon concentration decline (P18 = 64.38%), confirming that physical stamina during full-day workshop sessions is the primary operational constraint.

Teacher Perceptions and Qualitative Triangulation

On the 18-item teacher questionnaire, all three productive mechanical engineering teachers assigned the maximum score (4) across all items (100.00%). While confirming strong institutional endorsement, this

uniform maximum rating reflects a small-sample ceiling effect and is therefore interpreted alongside semi-structured interview narratives and workshop observation rather than treated as standalone statistical proof:

1. Policy Rationale and Curriculum Design (Context): Informant Trimo explained that SMK Negeri 1 Klego adopted weekly block scheduling in 2020 under *Kurikulum Merdeka* autonomy after inventorying machine capacity, consumables, and class sizes so students could receive concentrated practical training.

2. Active Engagement and Jobsheet Execution (Process): Informants Musthofa and Devi Agustian reported that weekly blocks eliminate rushed transitions, enabling project- and *jobsheet*-based learning where students collaborate in rotating workshop teams while teachers provide targeted individual coaching. Direct workshop observation on 13 July 2023 confirmed that sessions began with 30-minute morning physical conditioning (07:00–07:45 WIB), followed by theoretical briefing, jobsheet distribution for stepped lathe turning (*bubut bertingkat*) and tool grinding, rotational operation across six active lathes, and two structured rest breaks (10:00–10:45 and 12:00–13:00 WIB) before dismissal at 15:45 WIB.

3. Student Retention and Fatigue Coping Strategies: Student interviewees (Arif, Imam, Rico) confirmed that immediate hands-on execution prevented the theoretical forgetting common in fragmented schedules, whereas Teddy, Faiz, and Irwan reported managing physical fatigue through structured rest intervals, peer consultation during machine rotation, and post-school rest.

Composite Stakeholder Effectiveness Summary

Integrating student and teacher evaluations across the four CIPP-aligned evaluation dimensions yielded the composite effectiveness summary in Table 4.

Table 4. Composite Effectiveness Summary Across Evaluation Aspects

Evaluation Aspect	CIPP Component	Effectiveness Score (%)	Classification
Block-system socialization & awareness	Context	88	Very Effective
School services (schedule, facilities, attendance)	Input	82	Very Effective
Implementation conditions (interest, collaboration, fatigue)	Process	67	Effective
Instructional quality (preparation, strategy, development)	Product	83	Very Effective
Mean of Core Dimensions (Services, Conditions, Quality)	**Input–Process–Product**	**77.33**	**Very Effective**
Overall Composite Index (All Four Aspects)	**CIPP Composite**	**80**	**Very Effective**

Student Learning Outcomes

Analysis of official 2023/2024 odd-semester report-card ledgers across the entire population of 142 Grade XI Mechanical Engineering students demonstrated high competency attainment across all four classes, as shown in Table 5.

Table 5. Grade XI Mechanical Engineering Student Learning Outcomes (Odd Semester 2023/2024)

Class	Total Students (N)	Passed (≥ 75)	Not Passed (< 75)	Mastery Rate (%)	Highest Class Average	Lowest Class Average
XI TPM 1	36	35	1	97.22	84.2	42.1
XI TPM 2	36	36	0	100	85.7	75.8
XI TPM 3	36	36	0	100	85.5	79.9
XI TPM 4	34	34	0	100	85.6	79.6
Total / Overall	**142**	**141**	**1**	**99.3**	**85.7**	**42.1**

Three of the four classes (XI TPM 2, XI TPM 3, and XI TPM 4) achieved 100.00% mastery learning, while XI TPM 1 achieved 97.22% mastery (35 of 36 students; one student scored 42.10 due to incomplete subject assessments). Across the cohort, 141 of 142 students (99.30%) satisfied the minimum mastery standard.

DISCUSSION

The reconciled findings provide coherent descriptive evidence that block-system scheduling supports practical competency acquisition in vocational mechanical engineering education. First, the high effectiveness indices for instructional quality (83.00% composite; 79.38% student survey) and immediate theory-to-practice transfer align with experiential learning theory and vocational pedagogy principles (Biggs & Tang, 2011; Kolb, 2015). When learners execute stepped turning or tool grinding immediately after theoretical instruction using structured *jobsheets*, procedural retention improves and machine setup losses decrease relative to fragmented schedules (Purnomo et al., 2021; Sutrisno & Rahayu, 2022).

Second, strong student ratings for peer collaboration (92.50% positive across P13–P15) illustrate how shared workshop machine ratios such as six lathes operated in rotation encourage peer observation, safety verification, and collaborative troubleshooting (Darling-Hammond et al., 2020; Mulder, 2017). These findings corroborate Indonesian vocational studies showing that block-scheduled project learning enhances student engagement and practical task completion (Sudira, 2020).

Third, the lower score on implementation conditions (67.00%, Effective) reflects a well-documented ergonomic trade-off in block scheduling research (Queen, 2000; Rikard & Banville, 2005): full-day workshop sessions lasting until 15:45 WIB generate physical fatigue (P17 = 63.75%) and afternoon attentional decline (P18 = 64.38%) for roughly one-third of students. Although SMK Negeri 1 Klego mitigates fatigue through morning physical conditioning and two rest intervals, scheduling high-precision machining during peak morning hours and allocating late afternoon blocks to CAD simulation or reflective jobsheet evaluation would further improve cognitive sustainability.

Finally, two methodological boundaries should be noted: (1) the teacher questionnaire sample (n = 3) exhibited a ceiling effect (100% maximum scores), limiting variance-based statistical generalization from teachers alone; and (2) because the study used a descriptive post-implementation evaluation design without a control group, the 99.30% mastery rate demonstrates high attainment under the block system rather than isolated experimental causality.

CONCLUSION

Block-system learning for Grade XI Mechanical Engineering students at SMK Negeri 1 Klego is classified as Very Effective. Reconciled empirical evidence establishes three conclusions: (1) student perceptions across 30 validated items (n = 40) achieved an overall effectiveness score of 78.67% (Very Effective), while combined student–teacher evaluations yielded 82.00% for school services (Very Effective), 67.00% for implementation conditions (Effective), and 83.00% for instructional quality (Very Effective), producing a three-dimension mean of 77.33% and an overall four-aspect index of 80.00% (Very Effective); (2) 141 of 142 students (99.30%) attained minimum mastery learning standards across XI TPM 1–4, with highest class averages reaching 84.20 to 85.70; and (3) multi-day workshop blocks strengthen theory-to-practice continuity, jobsheet autonomy, and peer collaboration, while requiring structured pacing and afternoon task variation to mitigate student physical fatigue. School leaders are recommended to expand workshop machine-to-student ratios and schedule high-concentration precision machining during morning sessions, whereas future research should employ quasi-experimental pre-test/post-test designs across multiple vocational cohorts.

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