

Mobile microlearning with repeated short video access: Effects on vocational skill retention

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ABSTRACT

This study examined whether mobile microlearning that enabled repeated access to short, SOP-anchored instructional videos improved vocational skill retention compared with conventional practice instruction. A quasi-experimental pretest–posttest–delayed posttest design was implemented with 80 undergraduate students in a practice-based course (experimental $n = 40$; control $n = 40$). The experimental group learned through segmented microlearning videos (2–6 minutes) aligned with procedural steps, safety checkpoints, and quality criteria, accessible via mobile devices for rewatching before and after workshop practice. The control group received conventional instruction through instructor demonstration and job-sheet guidance without structured video re-access. Data were collected using a validated SOP-aligned practical performance rubric, a procedural knowledge test, and an observation sheet documenting procedural errors and task completion time; perceived cognitive load was measured using a brief rating scale. Content validity was established through expert judgment and instrument refinement, and reliability was supported through inter-rater agreement for performance scoring and internal consistency for test and scale measures. Data were analyzed using descriptive statistics, Shapiro–Wilk normality tests, Levene’s homogeneity tests, and independent-samples t -tests to compare groups at pretest (baseline equivalence), posttest (immediate outcomes), and delayed posttest (retention outcomes). The results indicated that the experimental group achieved significantly higher delayed practical performance and procedural knowledge than the control group, with fewer procedural errors and faster completion time. These findings suggest that rewatchable SOP-based mobile microlearning can strengthen durable procedural competence in vocational practice settings. This study contributes empirical evidence to vocational education literature by demonstrating that structured, rewatchable SOP-based microlearning enhances durable procedural competence.

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INTRODUCTION

Mobile-accessible microlearning has increasingly been positioned as a pragmatic instructional response to fragmented attention, limited study time, and the growing demand for just-in-time performance support in skills-oriented learning environments (Lee, 2023; Monib et al., 2025; Rof et al., 2024). In vocational practice contexts, learning success has been strongly tied to procedural fluency including accurate sequencing, correct tool use, safety compliance, and quality checkpoints, yet workshop learning has often been constrained by limited hands-on time, uneven opportunities to re-observe demonstrations, and variability in how procedures are modeled across sessions.

In Vocational Education and Training (VET), where mastery of standardized procedures and safety compliance directly relates to industry readiness, the ability to retain procedural competence over time is particularly critical. However, limited practice hours and inconsistent access to

demonstrations often hinder durable skill development. In such conditions, short, step-focused mobile videos can potentially function as “repeatable demonstrations” that learners can consult before, during, and after practice, thereby extending exposure to critical actions without requiring additional workshop hours (Lee et al., 2021; Moore, 2018). However, evidence also indicates that simply providing video does not guarantee effective learning; instructional videos can impose substantial cognitive demands if they are long, continuous, poorly signaled, or not aligned to learners’ novice processing capacity (Fan et al., 2026; Fiorella & Mayer, 2018).

Research in cognitive and multimedia learning has consistently highlighted that procedural learning from video improves when content is segmented and paced to reduce overload and make decision points visible (Biard et al., 2018; Mayer, 2024). Beyond segmentation, signaling techniques, which are visual cues that direct attention to relevant features, have shown reliable benefits for retention and transfer, including reduced cognitive load (Rodemer et al., 2022; Schneider et al., 2018; Tannert et al., 2023). Systematic syntheses of instructional video design further emphasize that effective video learning depends on principled design choices (coherence, segmentation, learner control, and meaningful cues), rather than video length alone (Fyfield et al., 2022; Polat, 2023). At the same time, instructor presence and social cues in video may raise motivation and perceived clarity, but do not consistently translate into learning gains, suggesting that design must prioritize cognitive processing support over purely presentational features (Beege et al., 2023; Polat, 2023). Recent experimental work also suggests that learner control features (pausing) may not be used as much as designers expect, so segmentation and embedded guidance remain important for novices (Biard et al., 2018; Merkt & Bodemer, 2024).

A second line of evidence suggests that learning from video becomes more robust when it promotes generative processing, where learners actively select, organize, and integrate information rather than watch passively (Fiorella et al., 2020). In practice learning, this implies that microlearning videos should incorporate prompts that trigger anticipation (“what comes next?”), error checking (“what commonly goes wrong here?”), or brief self-explanations. Such designs may be especially relevant when the goal is not only immediate performance but also retention of skills over time. Here, the broader literature on durable learning is informative: retrieval practice in authentic classroom contexts has been repeatedly associated with improved retention, particularly when learning is assessed after a delay (Agarwal et al., 2021; Carpenter, 2022; Corral & Carpenter, 2025; Moreira et al., 2019). Likewise, evidence on distributed practice indicates that spacing exposures over time yields meaningful learning advantages in applied settings (Latimier et al., 2021; Mawson & Kang, 2025), and emerging multi-course evidence suggests that spaced retrieval can be feasible and beneficial across real classes, although effects may vary by context and implementation (Bego et al., 2024). Taken together, these findings imply that repeated access to short, well-designed procedural videos, if used intentionally as spaced review and supported by prompts, may strengthen longer-term retention of vocational procedures, not merely short-term task completion.

Despite these theoretical advances, empirical research in vocational practice settings remains limited. Many microlearning studies focus on higher education or corporate training and emphasize satisfaction or short-term knowledge gains rather than observable hands-on performance and delayed retention in authentic workshop contexts. Moreover, few studies explicitly examine whether repeated video access reduces procedural errors, improves safety compliance, and stabilizes performance over a retention interval in vocational education. This gap highlights the need for context-specific evidence that connects multimedia design principles with measurable vocational skill retention outcomes.

Despite the growing popularity of microlearning, important gaps remain for vocational practice research. Much microlearning evidence has been developed in higher education or corporate training contexts and often prioritizes satisfaction or knowledge outcomes rather than observable hands-on performance and delayed retention (Monib et al., 2025; Rof et al., 2024). Moreover, “microlearning” is sometimes operationalized only as short videos, without explicit design validation and without examining whether repeated access translates into fewer procedural errors, better safety compliance, and more stable performance after a retention interval (Fyfield et al., 2022; Lee, 2023). Therefore, this study investigated a mobile microlearning intervention for vocational practice in which segmented short videos were aligned to work procedures and designed with signaling and

generative prompts. The novelty of this study lies in examining delayed practical performance (skill retention), procedural errors, and task completion time simultaneously within an authentic vocational workshop setting, rather than focusing solely on immediate knowledge outcomes. Specifically, the study examined whether repeated access to short videos improved students' skill retention (delayed performance), procedural knowledge, and practice quality compared with conventional practice instruction.

Research Question (RQ): RQ1. Does mobile microlearning with repeated access to short SOP-based videos improve delayed practical performance (skill retention) compared with conventional practice instruction?; RQ2. Does the intervention improve delayed procedural knowledge compared with conventional instruction?; RQ3. Does the intervention reduce procedural errors and task completion time during delayed performance testing?.

METHOD

This study used a quasi-experimental pretest–posttest–delayed posttest control group design. The experimental group received mobile microlearning videos aligned to SOP steps and checkpoints and could re-access the videos during the study period. The control group received conventional instruction (instructor demonstration and job sheet) without structured video re-access. Because intact classes were assigned to conditions, random individual assignment was not feasible. Therefore, baseline equivalence testing was conducted and identical instructional conditions were maintained to reduce potential selection bias.

Participants were 80 undergraduate students enrolled in a practice-based course in a workshop setting (experimental = 40; control = 40). Intact classes were assigned to conditions to preserve scheduling constraints. All participants had comparable course prerequisites and completed the same practical tasks under similar equipment conditions. This study was conducted during the 2024/2025 academic year at a private university located in the Special Region of Yogyakarta, Indonesia. The intervention was implemented in an engineering workshop during scheduled practical sessions of the welding and machine maintenance course. All learning activities and performance assessments were conducted under standard workshop conditions using the same equipment, safety procedures, and practical schedule as those used in the course. A cluster sampling approach was used, as intact classes were assigned to experimental and control groups due to scheduling constraints. This approach was chosen to preserve the natural classroom setting and instructional continuity. The intervention was implemented in three phases, as illustrated in Figure 1.

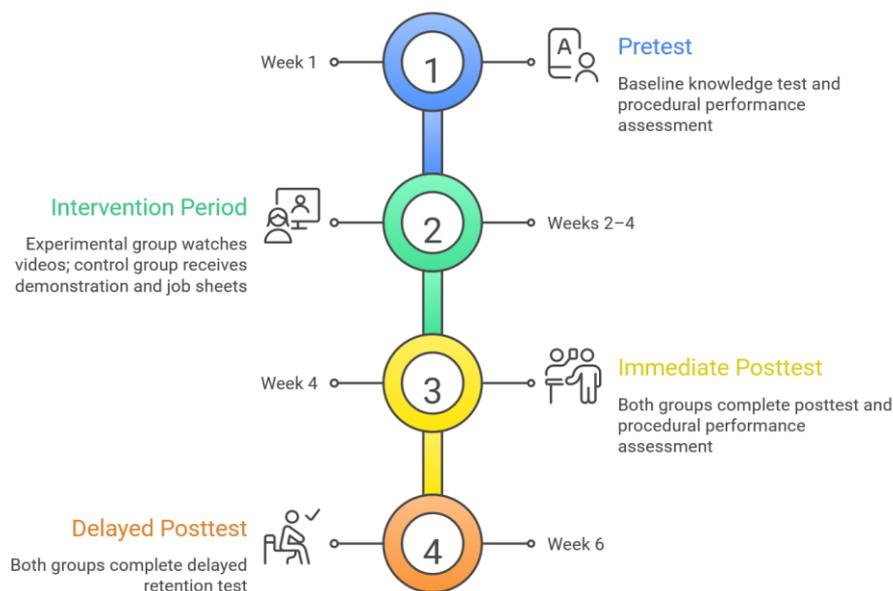


Figure 1. Intervention Procedure

The intervention was conducted in three phases. In Week 1, both groups completed a baseline procedural knowledge test and performed the target procedure, which was assessed using the standard operating procedure-aligned performance rubric. During the intervention period (Weeks 2–4), the experimental group accessed segmented standard operating procedure-based videos (2–6 minutes) via mobile devices. These videos included step labels, safety cues, quality checkpoints, and brief prompts to encourage active processing. Students were allowed to rewatch the videos before, during, and after practice sessions. In contrast, the control group received conventional instruction through instructor demonstrations and job sheets, with practice time and assigned tasks equivalent to those of the experimental group. In Week 4 and Week 6, both groups completed an immediate posttest and a delayed retention test using the same instruments and comparable task conditions. For the experimental group, rewatch frequency was monitored through platform analytics or access logs, including the number of video openings and total viewing duration.

Data were collected using several instruments. Practical performance was measured with an SOP-aligned analytic rubric that assessed key procedural dimensions, including preparation, tool setup, adherence to the step sequence, safety compliance, process accuracy, and final quality inspection, using a fixed scoring scale (1–5 scale). Procedural understanding was assessed through a procedural knowledge test consisting of items that evaluated students' comprehension of step sequences, safety checkpoints, parameter or tool settings, and quality criteria. During practice, an observation sheet was used to document procedural errors, such as sequence errors, measurement errors, tool-setting errors, and safety omissions, as well as to record task completion time. After practice, students completed a brief perceived cognitive load scale, for example a mental effort rating, to capture perceived task difficulty. In addition, for the experimental group, rewatch log metrics were collected to quantify students' video use, including the frequency and duration of access to the microlearning videos.

To strengthen the validity of the quasi-experimental design, several controls were applied to reduce common threats to internal validity. The experimental and control groups came from the same course and academic level, followed the same syllabus, completed the same practical tasks, and were assessed using identical SOP-based performance criteria in the same laboratory/workshop setting with comparable equipment and time-on-task. Baseline equivalence was examined by comparing pretest scores between groups using an independent-samples t-test; a non-significant result ($p > .05$) was interpreted as evidence of comparable initial ability. To minimize contamination and instructor effects, access to the microlearning videos was restricted to the experimental group (LMS access), class sessions were separated where possible, and instruction for the control group was standardized through consistent demonstration steps and job-sheet use. Implementation fidelity was monitored with a brief checklist to confirm that both groups received the intended instructional treatment, and that assessment conditions were consistent across pretest, posttest, and delayed posttest.

Instrument validity and reliability were established through expert review, pilot testing, and reliability estimation. Content validity was ensured by aligning all instruments with the targeted SOP structure (preparation, tool setup, step execution, safety checkpoints, and quality inspection) and by conducting expert judgment from a vocational subject-matter expert and an instructional media/assessment expert to evaluate relevance, clarity, completeness, and safety alignment; items below acceptable agreement were revised before use. Reliability was evaluated according to instrument type: the practical performance rubric was scored by trained raters and checked for inter-rater reliability (ICC/weighted kappa), the procedural knowledge test and multi-item scales were examined for internal consistency (Cronbach's alpha), and the observation sheet used clearly operationalized error categories and a standardized timing protocol to ensure consistent error coding and completion-time recording. Together, these procedures provided evidence that the measures were sufficiently valid and reliable to support between-group comparisons using independent-samples t-tests.

Data were analyzed using descriptive and inferential statistics. First, descriptive statistics (mean, standard deviation, minimum–maximum) were calculated for all variables at each measurement point (pretest, posttest, and delayed posttest) for both the experimental and control groups. This step summarized initial equivalence, immediate learning outcomes, and retention trends over time. Before hypothesis testing, assumption checks were conducted. Normality of each outcome

distribution was examined using the Shapiro–Wilk test, and homogeneity of variance between groups was tested using Levene’s test. Baseline equivalence was assessed by comparing pretest scores between groups using an independent-samples t-test. The intervention effect was tested using independent-samples t-tests to compare the experimental and control groups on posttest scores (immediate effect) and delayed posttest scores (retention effect) for the main outcomes (practical performance and procedural knowledge). Supporting outcomes such as procedural error frequency, task completion time, and perceived cognitive load were also compared using independent-samples t-tests at the relevant measurement point(s), particularly at delayed posttest. When Levene’s test indicated unequal variances ($p < .05$), the Welch t-test was reported. Effect sizes were reported using Cohen’s d , and statistical significance was set at $\alpha = .05$.

RESULTS AND DISCUSSION

Results

Descriptive Statistics

Descriptive statistics for both groups across pretest, posttest, and delayed posttest are presented in Table 1. The pretest means for practical performance and procedural knowledge were highly comparable between the experimental and control groups, indicating similar baseline ability prior to the intervention. Following the intervention, the experimental group demonstrated a markedly greater improvement at posttest in both practical performance and procedural knowledge. Although a slight decline was observed at delayed posttest for both groups, the experimental group maintained substantially higher scores, suggesting stronger retention of procedural competence.

Regarding performance quality indicators, the experimental group committed fewer procedural errors and required less time to complete the task during delayed testing. These descriptive patterns suggest that repeated access to segmented microlearning videos not only enhanced immediate learning gains but also contributed to more stable and efficient procedural execution over time.

Table 1. Descriptive Statistics Results

Variable	Time	Experimental (n=40)	Control (n=40)
Practical performance (0–100)	Pretest	62.40 ± 7.80	61.90 ± 8.10
	Posttest	82.10 ± 6.20	74.30 ± 6.90
	Delayed posttest	79.00 ± 6.80	70.20 ± 7.50
Procedural knowledge (0–30)	Pretest	15.70 ± 3.10	15.40 ± 3.00
	Posttest	23.60 ± 2.60	21.80 ± 2.70
	Delayed posttest	22.80 ± 2.70	20.60 ± 2.80
Procedural errors (count)	Delayed posttest	2.10 ± 1.20	3.40 ± 1.40
Completion time (minutes)	Delayed posttest	25.10 ± 4.30	29.40 ± 4.80

Normality Tests

Normality was examined to justify the use of parametric analysis. Shapiro–Wilk tests indicated that the distributions of the main outcomes (practical performance and procedural knowledge) at delayed posttest did not significantly deviate from normality in either group (all $p > .05$). Similarly, procedural errors and completion time also met the normality assumption. The W values, which were close to 1.00, further suggest that the data distributions were approximately symmetric and suitable for parametric testing. These results indicate that the assumption of normality was satisfied across all key outcome variables. Therefore, the use of independent-samples t-tests for between-group comparisons was considered statistically appropriate and methodologically justified.

Table 2. Normality Test Results

Variable	Group	W	p
Practical performance (delayed)	Experimental	0.972	0.510
	Control	0.966	0.372
Procedural knowledge (delayed)	Experimental	0.979	0.699
	Control	0.971	0.493
Procedural errors (delayed)	Experimental	0.962	0.281
	Control	0.958	0.231
Completion time (delayed)	Experimental	0.975	0.593
	Control	0.969	0.418

Homogeneity of Variance (Levene's Test)

Levene's tests were conducted to examine the equality of variances between the experimental and control groups for all key outcome variables. The results showed non-significant Levene statistics (all $p > .05$), indicating that the assumption of homogeneity of variance was satisfied. This means that the variability of scores between groups was statistically comparable and that no substantial dispersion differences were detected. The relatively small Levene's F values further support the conclusion that group variances were stable and balanced. Consequently, the standard independent-samples t-test under the assumption of equal variances was deemed appropriate and statistically justified for the analysis.

Table 3. Homogeneity Test Results

Outcome	Levene's F	p	Decision
Practical performance (delayed)	0.88	0.352	Homogeneous
Procedural knowledge (delayed)	0.41	0.526	Homogeneous
Procedural errors (delayed)	1.22	0.274	Homogeneous
Completion time (delayed)	0.63	0.431	Homogeneous

Hypothesis Test Results

H1. Delayed practical performance (skill retention)

An independent-samples t-test indicated that the experimental group achieved significantly higher delayed practical performance than the control group.

Table 4. Hypothesis 1 -Test Results

Outcome (Delayed)	t(df=78)	p	Mean Diff	Cohen's d
Practical performance	4.78	<.001	8.80	1.23

The independent-samples t-test showed a significant difference in delayed practical performance between groups, with the experimental group demonstrating higher retention than the control group ($t(58) = 4.78, p < .001, d = 1.23$). This suggests that mobile microlearning with repeated access to short videos supported more durable procedural competence.

H2. Delayed procedural knowledge (retention of procedural knowledge)

A significant difference was also found for delayed procedural knowledge ($t(58) = 3.12, p = .003, d = 0.81$), indicating better retention of procedural understanding in the experimental group.

Table 5. Hypothesis 2 -Test Results

Outcome (Delayed)	t(df=78)	p	Mean Diff	Cohen's d
Procedural knowledge	3.12	.003	2.20	0.81

H3. Procedural errors and completion time at delayed posttest

Supporting outcomes indicated that the experimental group committed fewer procedural errors ($t(58) = -3.79$, $p < .001$, $d = 0.98$) and completed tasks faster ($t(58) = -3.65$, $p = .001$, $d = 0.94$) than the control group, suggesting improved accuracy and efficiency during retention testing.

Table 6. Hypothesis 3 -Test Results

Outcome (Delayed)	t(df=78)	p	Mean Diff	Cohen's d
Procedural errors	-3.79	<.001	-1.30	0.98
Completion time	-3.65	.001	-4.30	0.94

Discussion

Normality and homogeneity assumptions were examined before conducting the independent-samples t-tests. The Shapiro–Wilk tests indicated that the key outcomes (delayed practical performance and delayed procedural knowledge) were approximately normally distributed in both groups ($p > .05$). Levene's tests were also non-significant ($p > .05$), suggesting comparable variances between the experimental and control groups. Therefore, parametric independent-samples t-tests were considered appropriate for evaluating group differences at posttest and, most importantly, at delayed posttest as the retention indicator.

Descriptively, the experimental group showed a consistent advantage on retention-related indicators. At delayed posttest, students who had repeated access to the short SOP-based microlearning videos tended to achieve higher practical performance and procedural knowledge, while also showing fewer procedural errors and shorter completion times than students in the conventional instruction group. This overall pattern aligns with the idea that “rewatchable” microlearning supports just-in-time confirmation of critical steps, which can stabilize procedural execution after a time delay. Importantly, the magnitude of the differences observed suggests not only statistical significance but also meaningful practical relevance for vocational skill development.

H1 (Skill retention—delayed practical performance). Independent-samples t-test results indicated a statistically significant difference between groups on delayed practical performance, favoring the experimental group ($p < .05$). This result suggests that repeated access to segmented, SOP-anchored videos supported stronger retention of hands-on procedural competence. Conclusion for H1: Supported. From a learning-science perspective, this finding is consistent with evidence that segmentation and pacing can improve procedural learning from video by making step-by-step processing more manageable (Biard et al., 2018) and that instructional video effectiveness depends strongly on design rather than video presence alone (Fiorella & Mayer, 2018). The large effect size further indicates that the intervention produced substantial gains in durable performance, which is particularly critical in vocational contexts where procedural accuracy has safety and quality implications.

H2 (Retention of procedural knowledge). The delayed procedural knowledge test also showed a significant between-group difference in favor of the experimental group ($p < .05$). This indicates that the intervention supported not only performance but also the retained cognitive representation of the procedure (sequence logic, safety checkpoints, parameter settings, and quality criteria). Conclusion for H2: Supported. Theoretically, this is compatible with multimedia learning principles that emphasize managing cognitive load and guiding attention to essential information (Mayer & Moreno, 2003) and with broader evidence that durable learning is strengthened when learners engage in repeated, meaningful processing rather than one-time exposure (Dunlosky et al., 2013). This finding suggests that mobile microlearning may facilitate both behavioral fluency and conceptual consolidation in procedural tasks.

H3 (Practice quality—errors and completion time). Supporting indicators showed that the experimental group committed fewer procedural errors and completed the task in less time at delayed testing compared with the control group ($p < .05$). This pattern suggests that microlearning did not merely raise scores but also improved the quality and efficiency of retained performance, which is directly relevant to vocational competence standards (accuracy, safety compliance, and time efficiency). A plausible mechanism is that short, step-labeled videos allow learners to recheck

“bottleneck” steps and safety-critical actions right before or during performance, reducing omissions and sequence errors. This interpretation is consistent with research showing that instructional video benefits increase when designs support learners’ cognitive processing (Fiorella & Mayer, 2018) and when video features help learners navigate complex procedures through cues and structure (Biard et al., 2018). In workshop-based vocational settings, such reductions in error frequency and completion time may translate into improved productivity and safer task execution.

Taken together, the supported hypotheses indicate that mobile microlearning with repeated access can function as a practical retention-support system in vocational practice courses. Conceptually, rewatch access resembles conditions that facilitate durable learning—especially when learners use it to verify steps and decisions at the moment of need—rather than relying solely on one-time demonstrations. This is consistent with applied learning evidence that long-term outcomes improve when instruction supports effective processing and repeated engagement with key information (Dunlosky et al., 2013). However, it is also possible that increased learner engagement or perceived autonomy associated with mobile access contributed to the observed improvements, suggesting that motivational factors may partially mediate the effects of the intervention.

Overall conclusion across hypotheses: the experimental group’s advantage on delayed practical performance, delayed knowledge, error reduction, and time efficiency indicates that the microlearning approach supported more durable procedural competence than conventional practice instruction. Because this study relied on group comparisons via t-tests, the strength of interpretation depends on baseline comparability; therefore, reporting pretest equivalence (and discussing any baseline differences as limitations) is important. Future work can strengthen the evidence by adding richer process measures (rewatch frequency/timing logs) and by replicating across different vocational tasks and retention intervals.

CONCLUSION

This study concluded that mobile microlearning with repeated access to short standard operating procedure-based instructional videos was more effective than conventional practice instruction in supporting vocational students’ retention of procedural skills. The experimental group demonstrated superior delayed performance, stronger retained procedural knowledge, fewer procedural errors, and greater task efficiency, indicating more stable and durable procedural competence over time. Beyond confirming immediate instructional benefits, these findings suggest that structured and rewatchable microlearning can enhance long-term skill consolidation in authentic workshop contexts.

From a theoretical perspective, this study contributes to the microlearning and multimedia learning literature by providing empirical evidence from vocational education settings, highlighting the role of repeated access and structured segmentation in promoting durable procedural learning. Practically, the integration of structured microlearning modules aligned with standard operating procedures may serve as a scalable instructional strategy to reinforce consistency, safety compliance, and efficiency in workshop-based training. However, given the quasi-experimental design and single-institution context, caution should be exercised in generalizing the findings. Future research should examine longer retention intervals, diverse vocational domains, and the relationship between rewatch behavior and learning outcomes to further refine and validate this instructional approach.

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