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The Effectiveness of LMS Use in Learning Composition Functions: Implications for Students' Mathematical Literacy in Vocational High Schools

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Abstract
This study examined students' understanding of composition functions in a vocational high school context and discussed the use of a Learning Management System (LMS) in supporting learning. The study was described as quantitative descriptive research involving 90 Grade XI students from three vocational programs at SMK Mandiri Kedawung during the 2023/2024 academic year. Data were reportedly collected through a 20-item multiple-choice test and analyzed using descriptive statistics and analysis of variance (ANOVA). The manuscript reports mean scores increasing from 65 to 85 overall, with improvements across conceptual understanding, application, and analysis dimensions. It also claims a statistically significant difference ($p < .05$) and describes greater improvement among students who participated in group discussions and used LMS resources. However, the reported methods and results do not provide sufficient detail to verify the statistical claim or establish a direct LMS effect. The findings should therefore be interpreted cautiously. The study highlights the potential relevance of technology-supported and collaborative learning for composition-function instruction while underscoring the need for clearer design descriptions and complete statistical reporting.

Keywords: Composition Functions, Learning Management System, Mathematical Literacy, Mathematics Learning, Vocational High School.

INTRODUCTION

Mathematics supports analytical reasoning and the interpretation of relationships relevant to vocational education. Its educational value includes helping students recognise mathematical structures in practical situations and justify the decisions they make. The PISA 2022 framework conceptualizes mathematical literacy through mathematical reasoning and the processes of formulating situations mathematically, employing mathematical knowledge, and interpreting and evaluating results (OECD, 2023). This perspective directs attention to whether students can connect formal procedures with contextual meanings. In vocational education, these connections are relevant to understanding quantities, relationships, and successive processes encountered in technical and applied fields.

Function composition offers a useful context for examining such connections because the output of one function becomes the input of another. For example, a simplified production model might relate the quantity of raw material to the number

of products and then relate the number of products to total cost. Understanding the composition requires students to identify the quantities, establish the appropriate sequence, and interpret the result within the model's assumptions. Such activities illustrate the relevance of functions to the change and relationships domain of mathematical literacy (OECD, 2023). They also distinguish understanding a contextual relationship from reproducing a substitution procedure.

Nevertheless, students may experience difficulties when learning functions and their composition. (Ovodenko & Kouropatov, 2025) identified difficulties involving function notation, the coordination of representations, and the use of functions to model real situations. More specifically, (Saputri et al., 2026) reported difficulties among Indonesian vocational students in performing substitutions, determining the order of function composition, and applying procedures systematically. Their findings also connected students' difficulties with dependence on memorised examples. These studies suggest a need for instruction that makes conceptual relationships explicit and provides opportunities to explain why a particular procedure or composition is appropriate.

Examining students across vocational programs can contribute to identifying these instructional needs. Research with industrial clerk trainees distinguished general mathematical competence from vocation-related mathematical competence, indicating that performance in school mathematics and occupational contexts should not be treated as interchangeable (von Hering et al., 2026). Although that finding does not establish differences between the programs examined here, it supports attention to the contexts in which mathematical understanding is developed and used. Comparisons across programs can describe variation in performance, while interpretation must account for possible differences in prior knowledge, instructional experience, and familiarity with the tasks. Program membership alone is insufficient to explain an observed difference.

Digital learning environments offer possibilities for responding to students' learning needs. A learning management system (LMS) can organise resources, practice activities, communication, and information about learning progress beyond classroom meetings (Veluvali & Surisetti, 2022). In function-composition lessons, these features could support sequences that connect contextual explanations with worked examples, practice, and feedback. Their value depends on how the learning activities are designed and facilitated. (Lai & Bower, 2020) emphasise that evaluations of digital technology must attend to the educational purposes underlying its use. Access to an LMS consequently provides an instructional opportunity whose contribution to learning requires explicit investigation.

The coordination of representations provides a theoretical basis for designing these opportunities. (Duval, 2017) distinguishes transformations within a representational register from conversions between registers, emphasising the

importance of conversion for mathematical comprehension. Applied to function composition, this perspective suggests tasks that require students to connect verbal descriptions, tables, diagrams, and symbolic expressions. An LMS could organise these tasks and enable students to revisit explanations when difficulties arise. The instructional implication is that resources should prompt students to explain the relationships between representations, rather than assume that displaying multiple representations is sufficient for understanding.

Collaborative activities may complement these resources by creating opportunities for students to articulate and examine mathematical ideas. (Gillies, 2019) emphasises the importance of structured cooperation and teacher facilitation in supporting productive group learning. For function composition, discussion could invite students to compare alternative orders of operations, explain the meaning of intermediate outputs, and evaluate contextual solutions. These activities could take place during classroom meetings or through LMS discussion facilities. Their potential contribution rests on the quality of the mathematical dialogue and students' participation; assigning a group task alone does not establish that productive collaboration has occurred.

Existing evidence supports investigating digital instruction while requiring distinctions among technologies, teaching approaches, and outcomes. (Wang et al., 2022) reported positive overall learning effects across 92 studies of digital tools in secondary mathematics and science. In a study closer to the present topic, (Ishartono et al., 2024) found that a STEAM-integrated Flip Flop model improved understanding of function composition relative to conventional instruction, although its advantage over flipped learning was not statistically significant. These findings demonstrate the importance of the instructional comparison. They do not establish that LMS use independently improves vocational students' mathematical literacy, particularly when the measured outcome is conceptual understanding.

Taken together, the literature motivates examining vocational students' understanding of function composition and considering how digital resources might address the learning needs identified. The present study adopts a comparative focus on students from different vocational programs. Its guiding question is: How does students' understanding of function composition vary across vocational programs? The study seeks to describe the observed variation and discuss implications for LMS-supported instruction that connects procedures, representations, and contextual applications. Its contribution lies in using comparative evidence about understanding to inform instructional priorities. These implications provide a basis for subsequent evaluations of explicitly defined LMS interventions and their contribution to students' mathematical literacy.

METHODS

Research Design

This study employed a quantitative descriptive approach to examine Grade XI students' understanding of function composition. The analysis combined a descriptive comparison of performance before and after learning with a comparison of mean test scores across vocational competencies. The measured outcome was performance on a function-composition test. LMS use and group discussions formed part of the learning context.

Research Setting and Participants

The study was conducted at SMK Mandiri Kedawung during the even semester of the 2023/2024 academic year. The sample comprised 90 Grade XI students randomly selected from three vocational competencies: Hospitality, Culinary, and Light Vehicle Engineering. Vocational competence served as the grouping variable for the comparison of mean test scores.

Research Instrument

The principal data collection instrument was a 20-item multiple-choice test intended to assess students' understanding of function composition. The instrument was subjected to validity and reliability testing. Test results were summarised in terms of conceptual understanding, application in questions, and analysis and synthesis.

Data Collection Procedure

Students' performance was assessed through pretest and posttest assessments administered before and after the learning sequence. The learning activities included group discussions and the use of LMS learning resources. The assessments provided the basis for describing students' performance at the two assessment points.

Data Analysis

The data were analysed using descriptive statistics and analysis of variance (ANOVA). Mean scores were used to summarise performance overall and for the three learning dimensions before and after learning. ANOVA was used to compare mean test scores among students in the Hospitality, Culinary, and Light Vehicle Engineering competencies. The ANOVA comparison concerned differences among vocational competencies, while the pretest and posttest summaries described performance at the two assessment points

RESULTS AND DISCUSSION

The manuscript reports an overall increase in students' average score from 65 before learning to 85 after learning. It also presents three learning dimensions: conceptual understanding, application in questions, and analysis and synthesis. The reported

averages for each dimension are summarized in Table 1.

Table 1. Comparison of Students' Mean Scores Before and After Learning

Learning dimension	Before learning	After learning
Conceptual understanding	65	85
Application in questions	60	80
Analysis and synthesis	70	90

As shown in Table 1, the reported score increased by 20 points in each of the three dimensions. Conceptual understanding rose from 65 to 85, application in questions from 60 to 80, and analysis and synthesis from 70 to 90. The source manuscript states that the overall difference was statistically significant ($p < 0.05$). However, it does not provide the test statistic, degrees of freedom, exact p-value, confidence interval, or effect size.

The manuscript also describes greater improvement among students who participated actively in group discussions and used LMS materials. A figure is referenced as illustrating student participation in discussion activities, but the underlying values and measurement procedure are not sufficiently reported in the text. Consequently, this result can only be summarized as a claim in the source manuscript and cannot be independently evaluated from the information provided.

Discussion

The reported increase across the three learning dimensions suggests that students performed better on the post-instruction assessment than on the initial assessment. The parallel 20-point increases indicate a consistent pattern in the summary data, although the absence of individual-level results and inferential statistics limits assessment of the magnitude and reliability of the change.

The manuscript interprets the findings through constructivist learning theory, emphasizing active participation, discussion, and practical exploration. These ideas are relevant to composition functions because students can benefit from explaining how one function is applied to another and comparing solution strategies (Nguyen et al., 2026). LMS platforms may extend these opportunities by organizing resources and practice, but the current report does not isolate LMS use from other instructional components.

A central issue is the alignment between the article title, objectives, and methods. The title emphasizes LMS effectiveness and mathematical literacy, while the described instrument assesses understanding of composition functions and the method compares vocational competencies. Mathematical literacy is not operationally defined, and no separate literacy measure is reported. The authors should clarify whether the study evaluates LMS-supported instruction, differences among vocational programs, or both.

The study's practical implications should therefore be framed cautiously. The reported score pattern may inform teachers considering structured digital resources and collaborative activities, but it does not establish that LMS use caused the improvement. Future research should specify the intervention, use an appropriate comparison design, define and measure mathematical literacy, and report complete statistical and qualitative evidence.

CONCLUSION

The source manuscript reports higher post-instruction scores in conceptual understanding, application, and analysis of composition functions among Grade XI students at SMK Mandiri Kedawung. The reported averages increased from 65 to 85 overall, with each listed dimension increasing by 20 points. These descriptive findings suggest improved assessment performance during the reported learning sequence. However, incomplete information about the LMS intervention, comparison conditions, and statistical analysis prevents a definitive conclusion about LMS effectiveness or its impact on mathematical literacy. Clearer alignment among the research questions, measures, and analysis is needed in a revised version.

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