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YouTube-Based Instructional for Quality and Inclusive CAD Patternmaking Learning: Effects on Student Engagement, Cognitive Load, and Learning Achievement

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Abstract: The use of YouTube-based learning has become increasingly relevant in vocational education, particularly in technical and procedural courses such as CAD Patternmaking. This study aims to analyze the contribution of YouTube-based learning to student engagement, cognitive load, and learning achievement in a CAD Patternmaking course. A quantitative approach with an ex post facto design was employed. The sample consisted of 107 Fashion Design students selected through purposive sampling. Data were collected using a Likert-scale questionnaire and analyzed using simple linear regression and stepwise multiple regression with SPSS. The results show that YouTube-based learning contributes positively and significantly to student engagement and negatively and significantly to cognitive load. In addition, YouTube-based learning and student engagement simultaneously contribute significantly to learning achievement, while cognitive load does not have a significant partial contribution. These findings indicate that learning achievement in YouTube-based CAD Patternmaking learning is more strongly influenced by student engagement than by perceived cognitive load. In conclusion, YouTube-based learning can effectively support vocational learning outcomes when designed to enhance student engagement. This study provides practical implications for developing structured video-based learning strategies in vocational education.

Keywords: Cognitive load; Learning achievement; Student engagement; Video YouTube

Introduction

Digital transformation in higher education has fundamentally reshaped learning strategies, particularly through the integration of online platform–based instructional media such as YouTube (Arifa et al., 2023). The increasing reliance on video-based learning resources has positioned YouTube as a global learning ecosystem, especially within vocational and skills-oriented education, where procedural visualization and repeated access to learning materials are essential (Alzoubi et al., 2022; Fajri et al., 2024; Guo et al., 2014; Hanif et al., 2023). Empirical studies consistently indicate that more than 80% of university students regularly utilize online instructional videos, with YouTube being the most frequently accessed platform due to its accessibility, flexibility, and replay functionality that supports self-paced learning (Caella & Yulianto, 2024; Khanagar et al., 2022; Moghavvemi et al., 2018; Muyassaroh & Suyono, 2023; Sweeney, 2024).

In the context of Fashion Design education, particularly CAD Patternmaking instruction, the demand for visual learning media is even more critical. CAD Patternmaking requires students to simultaneously process abstract design concepts, procedural software operations, and spatial-visual representations of garment construction, resulting in high intrinsic cognitive load (Kay, 2012; Sweller et al.,

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2011). CAD Patternmaking is a core professional course undertaken by second-semester students in the Diploma (D3) Fashion Design Program, the Bachelor's Program in Vocational Education of Fashion Design, and the Bachelor's Program in Family Welfare Education at Universitas Negeri Padang. In this course, students are expected not only to understand theoretical pattern-making principles but also to master digital pattern modification, tool functions, and step-by-step operational procedures using specialized software (Hastuti et al., 2025). Consequently, instructional media that can clearly visualize procedural sequences while supporting independent and repeated learning become pedagogically indispensable.

Although YouTube provides abundant instructional video content, the pedagogical effectiveness of such materials cannot be assumed solely based on availability. Prior studies emphasize that the effectiveness of instructional videos is determined by their instructional design quality and alignment with course learning outcomes, particularly their impact on student engagement, cognitive load, and learning achievement (Deng, 2023; Fathurohman et al., 2023; Kuhlmann et al., 2024; Lackmann et al., 2021). In this study, the YouTube videos used as learning media were systematically developed in alignment with the CAD Patternmaking curriculum and learning outcomes, but the primary focus of this research is not the development process itself. Instead, the study adopts an impact-analysis perspective to examine how the use of YouTube-based instructional videos influences students' learning experiences and outcomes.

Previous research demonstrates that well-designed instructional videos can enhance student engagement by fostering active participation, sustained attention, and meaningful cognitive processing (Deng, 2023; Guo et al., 2014; Karim et al., 2025; Kay, 2012; Moghavvemi et al., 2018; Zhang et al., 2006). Student engagement is widely conceptualized as a multidimensional construct consisting of behavioral engagement (observable participation and on-task behavior), emotional engagement (interest, enjoyment, and motivation), and cognitive engagement (investment in deep learning strategies and self-regulation). However, many empirical studies in technology-enhanced learning contexts still treat engagement as a single undifferentiated variable, limiting deeper understanding of how different engagement dimensions interact with instructional media. Several studies report that CAD tutorial videos assist students in independently and repeatedly understanding pattern-making processes, thereby supporting self-regulated learning (Syamsul & Kharnolis, 2022; Putri & Ernawati, 2022). Nevertheless, some research has yielded inconsistent findings, particularly regarding increased cognitive load resulting from long video durations, information overload, or insufficient instructional structure (Aini & Nelmira, 2025; Fitria et al., 2025; Nelmira et al., 2022, 2023; Utami et al., 2025). Moreover, empirical studies that integrate the three key variables; student engagement, cognitive load, and learning achievement—within a single analytical framework in CAD Patternmaking instruction remain limited, indicating that this area is underexplored and warrants further investigation.

At the same time, research findings regarding cognitive load in video-based learning remain inconsistent. While instructional videos can support comprehension and procedural mastery, poorly designed videos such as those with excessive duration, dense information, or lack of signaling may increase extraneous cognitive load and hinder learning effectiveness (Caella & Yulianto, 2024; Sweller, 2020). Despite the growing body of literature on instructional videos, empirical studies that simultaneously analyze student engagement (across behavioral, emotional, and cognitive dimensions), cognitive load, and learning achievement within a single analytical framework particularly in CAD Patternmaking and Fashion Design education remain limited. Most existing studies focus on general technology enhanced learning or other disciplinary contexts, leaving a gap in vocational fashion education research.

Therefore, this study aims to comprehensively analyze the effects of YouTube video usage in CAD Patternmaking learning on student engagement, cognitive load, and learning achievement among Fashion Design students. Specifically, it examines how YouTube-based instructional videos influence students' behavioral, emotional, and cognitive engagement; how they affect perceived cognitive load during the learning process; and how these factors relate to students' learning achievement. By integrating multimedia learning theory and student engagement theory, this research offers novel insights into the pedagogical mechanisms underlying video-based learning in vocational Fashion Design education. The findings are expected to contribute theoretically by clarifying the interrelationships among engagement, cognitive load, and achievement, and practically by providing evidence-based guidance for lecturers and curriculum developers in designing effective and sustainable CAD Patternmaking learning strategies.

Method

Research Design

This study employed a quantitative research approach using an ex post facto design to examine the effects of YouTube-based instructional video usage on

student engagement, cognitive load, and perceived learning achievement among Fashion Design students who had completed CAD Patternmaking instruction using YouTube videos. The ex post facto design was considered appropriate because the independent variable had already occurred naturally and could not be manipulated by the researcher. This design enables the empirical examination of relationships among variables within authentic technology-enhanced learning contexts.

Participants

Participants were selected using purposive sampling, with the primary inclusion criterion being prior experience in learning Computer-Aided Design (CAD) Patternmaking through YouTube-based instructional videos. A total of 107 undergraduate students participated in the study, consisting of 19 students from the Diploma (D3) in Fashion Design program, 24 students from the Bachelor's Program in Vocational Education of Fashion Design, and 64 students from the Bachelor's Program in Family Welfare Education with a concentration in Fashion Education.

All participants had completed the same CAD Patternmaking course, used the same instructional videos, and followed identical learning objectives and assessment standards. Therefore, sample homogeneity was ensured based on academic background, learning experience, and instructional tools rather than demographic characteristics.

Instrument for Data Collection

Data were collected using a self-administered questionnaire distributed via Google Forms, employing a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The research variables were operationalized as follows:

- YouTube-based instructional video usage (X): measured using items 1–9
- Student engagement (M1 / Predictor Variable 1): measured using items 10–15
- Cognitive load (M2 / Predictor Variable 2): measured using items 16–23
- Perceived learning achievement (Y): measured using items 24–28

It is important to note that learning achievement in this study refers to perceived learning achievement, as measured through students' self-reported understanding, confidence, and perceived mastery of CAD Patternmaking concepts, rather than objective exam or project scores.

The instrument underwent content validation by three experts in educational measurement and evaluation. The experts reviewed the clarity, relevance, and alignment of each item with the research objectives and provided feedback regarding language use and construct representation. Revisions were made based on their recommendations prior to data collection.

A pilot test was conducted with 30 students outside the main study sample. Reliability analysis using Cronbach's Alpha yielded an overall coefficient of $\alpha = 0.68$. Although this value is slightly below the commonly recommended threshold of 0.70, previous methodological studies suggest that reliability coefficients in the range of 0.60–0.70 are acceptable for exploratory research, particularly in educational and social science contexts (Hinton et al., 2014; Taber, 2018). Therefore, the instrument was considered adequate for exploratory analysis in this study.

Method of Data Analysis

Data analysis was conducted using stepwise multiple regression analysis with the assistance of SPSS. This analytical method was employed to examine the extent to which YouTube-based instructional video usage, student engagement, and cognitive load functioned as predictor variables influencing perceived learning achievement.

Because multiple regression analysis does not directly test mediation effects, the variables of student engagement and cognitive load were treated as independent predictor variables, not mediating variables. The stepwise procedure enabled the identification of the most significant predictors contributing to perceived learning achievement, while simultaneously assessing their partial and combined effects within the proposed research framework.

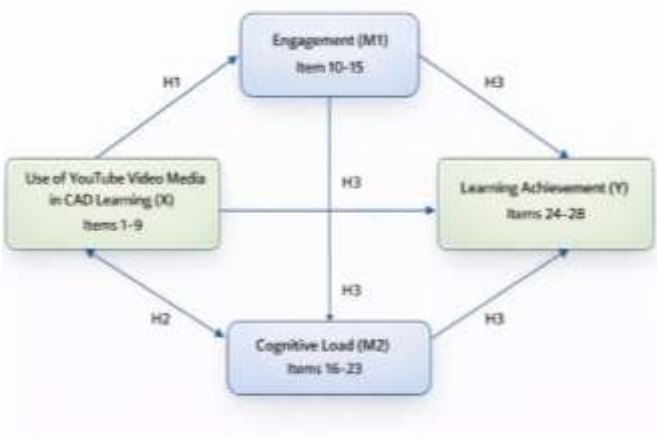

Figure 1. Design framework

Based on theoretical considerations and the revised analytical model, the hypotheses of this study were formulated as follows:

- H1: The use of YouTube-based instructional videos has a positive and significant effect on student engagement.

- H2: The use of YouTube-based instructional videos has a negative and significant effect on cognitive load.
- H3: The use of YouTube-based instructional videos, student engagement, and cognitive load simultaneously have a significant effect on perceived learning achievement.

Result and Discussion

Result

The results of this study were obtained from quantitative data analysis examining the effects of YouTube-based instructional video usage in CAD Patternmaking learning on student engagement, cognitive load, and perceived learning achievement among Fashion Design students.

Effect of YouTube Video Usage on Engagement in CAD Patternmaking Learning

Table 1. Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.858	0.735	0.733	0.332

Predictors: (Constant), VIDEO

Table 1 indicates a very strong relationship between YouTube video usage and student engagement (R = 0.858). The R Square value of 0.735 shows that 73.5% of the variance in student engagement can be explained by the use of instructional videos, while the remaining 26.5% is influenced by other factors not included in the model.

Table 2. Data of ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	32.145	1	32.145	291.747	p < 0.001
Residual	11.569	105	0.110		
Total	43.713	106			

Dependent Variable: ENGAGE
Predictors: (Constant), VIDEO

The ANOVA results confirm that the regression model is statistically significant (F = 291.747, p < 0.001), indicating that YouTube video usage significantly predicts student engagement in CAD Patternmaking learning.

Table 3. Data of coefficients[a]

Model	Unstandardized Coefficient		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
VIDEO	1.008	0.059	0.858	17.081	p < 0.001

Dependent Variable: ENGAGE

The regression analysis shows that YouTube video usage has a positive and significant effect on student engagement. The unstandardized coefficient (B = 1.008) indicates that increased effectiveness of video usage is associated with higher engagement levels. The standardized coefficient (Beta = 0.858) confirms a strong effect size, supporting H1.

Effect of YouTube Video Usage on Cognitive Load in CAD Patternmaking Learning

Table 4. Data of model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.271[a]	0.074	0.065	0.967

Predictors: (Constant), VIDEO

Table 4 shows a weak relationship between YouTube video usage and cognitive load (R = 0.271). The R Square value of 0.074 indicates that video usage explains 7.4% of the variance in cognitive load, suggesting that most variance is influenced by other factors.

Table 5. Data of ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig
Regression	7.796	1	7.796	8.330	0.005
Residual	98.273	105	0.936		
Total	106.069	106			

Dependent Variable: COGLOAD
Predictors: (Constant), VIDEO

The F-test indicates that the regression model is statistically significant (F = 8.330, p = 0.005), meaning that YouTube video usage has a measurable effect on students' cognitive load.

Table 6. Data of coefficients[a]

Model	Unstandardized Coefficient		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
VIDEO	0.496	0.172	-0.271	0.000	0.005

Dependent Variable: COGLOAD

The results show that YouTube video usage has a negative and significant effect on cognitive load. The unstandardized coefficient (B = −0.496) indicates that improved video usage is associated with lower perceived cognitive load. The standardized coefficient (Beta = −0.271) confirms the direction and relative strength of this effect. Thus, H2 is supported.

Effect of YouTube Video Usage, Engagement, and Cognitive Load on Learning Achievement

Model 1 indicates that YouTube video usage alone explains 59% of the variance in perceived learning achievement. When student engagement and cognitive

load are added (Model 2), the explained variance increases to 64%, indicating an improved model fit.

The ANOVA results confirm that the regression model including all predictors is statistically significant. The results indicate that: YouTube video usage has a positive and significant effect on perceived learning achievement; Student engagement also has a positive and significant effect; and Cognitive load does not have a significant direct effect on learning achievement (p = 0.217).

All Variance Inflation Factor (VIF) values are below 5, indicating that multicollinearity is not a serious concern and that the regression model satisfies classical assumption requirements.

Table 7. Data of model summary

Model	R	R Square	Adjusted R Square	Adjusted R Square R Square Change	F Change	df1	df2	Sig. F Change
1	0.768[a]	0.590	0.596	0.590	151.235	1	105	0.000
2	0.800[b]	0.640	0.629	0.49	7.069	2	103	0.001

Predictors: (Constant), VIDEO
Predictors: (Constant), VIDEO, COGLOAD, ENGAGE
Dependent Variable: ACHIEVE

Table 8. Data of ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	26.391	1	26.391	151.235	p < 0.001
Residual	18.323	105	0.175		
Total	44.714	106			
Regression	28.602	3	9.534	60.952	p < 0.001
Residual	16.111	103	0.156		
Total	44.714	106			

Dependent Variable: ACHIEVE
Predictors: (Constant), VIDEO
Predictors: (Constant), VIDEO, COGLOAD, ENGAGE

Table 9. Data of coefficients[a]

Model	Unstandardized Coefficient		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	0.302	0.336	0.768	0.898	0.371	1.000	1.000
VIDEO	0.913	0.74		12.298	0.000		
(Constant)	0.571	0.373	0.396	1.529	0.129	0.258	3.872
VIDEO	0.470	0.138		3.401	0.001		
ENGAGE	0.415	0.116	0.410	3.567	0.001	0.265	3.779
COGLOAD	-0.050	0.040	-0.076	-1.241	0.217	0.926	1.080

Dependent Variable: ACHIEVE

Discussion

The analysis shows that YouTube video usage in CAD learning strongly contributes to student learning achievement. The first regression model yielded R = 0.768 and R Square = 0.590, meaning video usage explains 59% of the variation in students' learning achievement. The significance value of 0.000 indicates that this effect is statistically highly significant, confirming that instructional videos are an important factor in CAD learning.

In the second model, when engagement and cognitive load were included alongside video usage, R Square increased to 0.640, with an Adjusted R Square of 0.629. This indicates that the three variables together explain 64% of the variation in learning achievement. ANOVA results reinforce this finding, with F = 60.952 and significance = 0.000, showing that the regression model with these three predictors is significant and appropriate for use.

Regarding individual contributions, coefficient tests indicate that video usage has a positive and significant effect (B = 0.470; Sig. = 0.001), demonstrating that better use of YouTube videos correlates with higher student learning achievement. Engagement also has a positive and significant effect (B = 0.415; Sig. = 0.001), showing that active student involvement during the learning process is an important factor supporting optimal learning outcomes. Conversely, cognitive load does not significantly affect learning achievement (B = −0.050; Sig. = 0.217).

The findings provide a deeper understanding of the effect of YouTube video usage in CAD Patternmaking learning on student engagement, cognitive load, and learning achievement. Theoretically, the results showing

a significant effect of video usage on engagement align with multimedia learning theory, which states that presenting information through a combination of visual and audio channels enhances students' attention, comprehension, and engagement (Agisni et al., 2023). Instructional videos facilitate the presentation of learning content in a contextual, engaging, and comprehensible manner, enabling students to actively engage in cognitive, affective, and psychomotor learning processes (Amorin & Orbino, 2025; Haerawan et al., 2024). High engagement, in turn, contributes to a more effective learning process.

These results also support previous studies indicating that video usage increases learning engagement (Sastramiharja et al., 2021). Videos facilitate interactive and flexible learning, particularly in digital contexts, enhancing students' interest and motivation (Rongbutsri et al., 2023). Thus, instructional videos are an effective medium to boost student engagement. Educators and instructional designers are encouraged to optimize pedagogically designed videos that match student characteristics to maximize engagement.

The significant negative effect of video usage on cognitive load demonstrates that instructional videos help reduce students' mental effort. This aligns with Cognitive Load Theory, which asserts that well-designed learning media can reduce extraneous cognitive load, allowing working memory to process relevant information more effectively (Abadi et al., 2025; Sweller et al., 2011). Effective videos, for example, with clear visualization, structured presentation, and proper audio-visual integration, facilitate understanding without excessive cognitive burden (Trenholm & Marmolejo-Ramos, 2024). However, the low R^2 value indicates that video usage is not the sole determinant of cognitive load. Its effectiveness depends on instructional design, content difficulty, and individual learner characteristics (Fyfield et al., 2022). Hence, videos should be integrated with other pedagogical strategies for optimal cognitive load management. Regression results further indicate that video usage and engagement significantly affect learning achievement, contributing 64% of the variance when combined, while cognitive load has no significant direct effect. This demonstrates that YouTube video usage and active engagement are key factors in improving CAD learning outcomes, whereas cognitive load does not serve as a decisive factor in this study.

Theoretically, this study contributes to the literature by integrating student engagement and cognitive load theories in technology-based learning within the CAD Patternmaking context. Engagement and cognitive load interactively influence learning achievement (Zhang et al., 2023), reinforcing that effective video-based learning should balance engagement stimulation and cognitive load management (Fyfield et al., 2019). Engagement can be influenced by culture, language, and the relevance of the material (Gaylo, 2025; Karim et al., 2025).

Practically, these findings provide implications for educators and curriculum developers in Fashion Design and vocational education. Instructors are advised to integrate YouTube videos into structured learning strategies, considering video duration, content segmentation, and visual clarity. Institutions may use these findings to formulate sustainable, evidence-based digital learning policies. Therefore, YouTube videos function not only as alternative learning resources but also as strategic pedagogical tools to enhance CAD learning quality and achievement.

Despite these findings, the study has limitations. First, the scope is limited to one institution and three programs of study, which may constrain generalizability. Second, self-report instruments may introduce perception bias in measuring engagement and cognitive load. Third, variations in video design (e.g., presentation style, interactivity) were not fully explored. Future research should involve multi-institutional samples, experimental or longitudinal designs, and incorporate learning analytics for objective behavioral data. Such research can deepen understanding of YouTube videos' role in the evolving digital learning ecosystem.

Conclusion

This study investigated the effects of YouTube-based instructional video usage in CAD Patternmaking learning on student engagement, cognitive load, and perceived learning achievement among Fashion Design students. The findings indicate that the use of YouTube instructional videos significantly increases student engagement and contributes positively to perceived learning achievement. Video usage also shows a significant negative relationship with cognitive load, indicating that well-structured instructional videos can help reduce students' mental effort during the learning process. When engagement and cognitive load were analyzed together with video usage, the model explained 64% of the variance in learning achievement, demonstrating that these variables collectively play an important role in supporting learning outcomes. Among the predictors, student engagement emerged as a strong factor influencing learning achievement, while cognitive load did not show a significant direct effect. Overall, the results highlight that YouTube-based instructional videos are an effective pedagogical tool in CAD Patternmaking learning because they facilitate clearer visualization of procedural skills, encourage active student engagement, and support improved learning achievement in vocational education contexts.

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Author Contributions
W.N: Conceptualization; methodology; formal analysis; investigation; data curation; writing—original draft preparation; project administration; R.A.U: Conceptualization; validation; resources; supervision; writing—review and editing; funding acquisition; Software; investigation; data curation; visualization; validation; R.F: Validation; resources; writing—review and editing.

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