

# Creativity and Critical Thinking as Predictors of Cognitive Learning Outcomes among Students in Technical Beauty Education

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**Abstract**—The impact of creativity and critical thinking on students' cognitive learning outcomes in technical beauty education is investigated in this study. Partial Least Squares Structural Equation Modelling (PLS-SEM) was used in a quantitative ex post facto design. The study involved undergraduate students from a Cosmetology Education program who had finished classes on hair maintenance and colouring. Further analysis of the structural correlations is supported by the measuring model's sufficient validity and reliability. Both creativity and critical thinking significantly and favourably affected cognitive learning outcomes, with critical thinking making a greater contribution. Additionally, the model demonstrated adequate explanatory and predictive power. Cognitive accomplishment in technical beauty education is linked to students' capacity for idea generation, information analysis, alternative evaluation, and reasoned decision-making in addition to practical competence. From the standpoint of technical education, the findings emphasise how crucial it is to incorporate critical thinking and creativity as complementary higher-order thinking abilities in learning activities that blend theoretical knowledge with real-world professional responsibilities.

**Keywords**—PLS-SEM, technical education, technical beauty education, critical thinking, creativity, and cognitive learning outcomes.

## I. INTRODUCTION

The development of higher-order thinking abilities, especially creativity and critical thinking, has replaced the passive acquisition of knowledge in 21st-century education. Through educational activities that include students in both critical evaluation and creative idea development, these two competences can be cultivated in tandem (Tiong & Bakar, 2022). These skills are becoming more and more crucial in technical education since students are required to adapt to technological change, solve real-world issues, weigh options, and create solutions that are applicable to professional practice. In his presidential speech at the American Psychological Association, Guilford first emphasised creativity as a psychological concept as an essential part of intelligence (Guilford, 1950). Since then, as scholars have started to investigate the multifaceted and multidisciplinary character of creativity, the notion of creativity has changed.

Graduates from technical higher education are supposed to possess a combination of transferable thinking abilities, practical competence, and disciplinary knowledge. Nonetheless, there can still be a disconnect between graduates' educational background and the changing skills needed in business and professional settings (Kapareliotis et al., 2019). Higher education should therefore emphasise cognitive skills like creativity, critical thinking, problem-solving, and decision-making in addition to technical proficiency.

After graduation, university graduates encounter difficulties, especially when it comes to finding work. After completing their education, graduates may continue to be unemployed for a variety of reasons. Cosmetology education is a type of technical higher education that integrates professional service skills, safety considerations, practical processes, theoretical knowledge, and aesthetic sense. The curriculum requires students to combine practical competence with cognitive understanding in areas including hair care, body and skin care, hairstyling, makeup application, and nail care. Hairstyling is one of the several beauty specializations offered by the Bachelor of Cosmetology Education program. A person's self-esteem is influenced by their hairstyle since it affects how they look. People use their hair and general look to portray a desired image, underscoring the significance of hairstyling in developing and preserving a positive self-image.

Additionally, services like hairstyling concentrate on the relationship between the client and the service provider, establishing a shared experience and establishing the calibre of service provided. The technically challenging discipline of hairstyling necessitates the blending of professional judgement, creativity, precision, and procedural expertise. When practicing hairstyling, people can come up with original ideas and create stunning hairstyles that fit particular face shapes (Lijun et al., 2014). Prior findings in the field of beauty education suggest that students may struggle to come up with original ideas, comprehend procedural requirements, and plan practical assignments. These challenges imply that mastering technical beauty demands not just psychomotor proficiency but also enhanced cognitive skills for understanding processes, weighing options, and coming to the right conclusions. Therefore, in order to improve

competencies and soft skills like creativity and critical thinking, it is necessary to apply suitable learning methodologies or models.

Numerous academic disciplines, including philosophy, education, and psychology, are involved in the study of critical thinking. Due to attempts by academics to evaluate and quantify critical thinking as a study variable, the notion has evolved into a scientific construct (Lamont, 2020). A similar pattern can be seen in the critical thinking research map. In technical education, critical thinking has become an important transferable competency because graduates must interpret information, evaluate alternatives, solve practical problems, and make evidence-based decisions in professional contexts. Surprisingly, most previous studies have been busy testing various learning strategies that are effective in improving critical thinking, instead of empirically measuring the direct contribution of critical thinking skills themselves to cognitive learning outcomes (Korotaj & Buchberger, 2026). Although creativity and critical thinking are often conceptualized as different things, they both have a number of underlying cognitive and metacognitive components. Both involve processes of evaluation, assessment, and self-regulation that require flexible but goal-oriented reasoning (Park et al., 2025).

Students increasingly need to integrate creativity, logical reasoning, and problem-solving when responding to complex learning and professional tasks (Thornhill-Miller et al., 2023). Although the trend of research on creativity in the world of education has jumped sharply in recent years, there is an interesting pattern that is often overlooked. However, if you look more deeply, the majority of the literature still places creativity as limited to external outcomes or just the impact of the application of certain learning models. There are still very few studies that place creativity as the main predictor variable to explain the success of cognitive learning outcomes (Al Adawiyyah et al., 2026). This limitation is exacerbated by the tendency of previous researchers to examine creativity and critical thinking separately.

In fact, conceptually, these two constructs reinforce each other and explain that creativity plays a role in producing a variety of alternative solutions, while critical thinking acts to evaluate the quality of these solutions (Thornhill-Miller et al., 2023). Unfortunately, this theoretical understanding has not been balanced by the availability of empirical research that integrates the two into one complete model. More specifically, research in technical education has often associated creativity and critical thinking with project performance, practical problem-solving, or work readiness rather than examining their direct contribution to cognitive learning outcomes. Testing the direct relationship between these two variables on cognitive learning outcomes, especially those tested simultaneously using Structural Equation Modeling (SEM), is still very rare. Existing studies also more commonly examine creativity and critical thinking as outcomes of instructional interventions rather than positioning both constructs simultaneously as predictors of cognitive achievement.

## II. LITERATURE REVIEW

### A. Creativity

Creativity is essential for meeting the constant demands of ever-changing living and working conditions. It is the key to education in the true sense of the word, and to solving humanity's most serious problems. The goal of traditional education is to impart knowledge and skills to individuals and prepare them for integration into society; however, it is evident that traditional methods fail to cultivate individuals capable of making valuable contributions to the rapidly evolving fields of science and technology (Bakır & Öztekin, 2014; Chouseinoglou & Ateşkan, 2025).

The importance of creative thinking skills in contemporary technical education is undeniable. These skills are crucial for students to develop novel ideas, enhance efficiency, and devise solutions to complex problems (Suciati et al., 2024). Interdisciplinary approaches such as STEAM have also been associated with the development of students' technical abilities by integrating scientific, technological, creative, and practical learning components (Ernazarov et al., 2025). Creative thinking is a tangible competence grounded in knowledge and practice that enables individuals to achieve superior outcomes, often within constrained and challenging environments (Karunarathne & Calma, 2024). The thought processes associated with creativity enhance other skills and competencies, including metacognitive capacity, problem-solving abilities, academic achievement, future career success, and social engagement.

Fluency is defined as the number of ideas related to (and not repetitions of) the task. Flexibility is defined as the number of shifts in ideas related to the task; it can be interpreted as the ability to propose various solutions or approaches to a problem. Originality is defined as the uniqueness of an idea or the ability to generate ideas that differ from those of others. Elaboration is the ability to generate detailed ideas. It is also the ability to refine a concept by adding details that enhance its quality. Elaboration is further described as the ability to explain something in detail, clearly, and at length (Takeuchi et al., 2020). These indicators can be used to measure or identify an individual's creative thinking skills (Alabbasi et al., 2025). Based on the explanation above, the indicators of creative thinking are:

- (i) The ability to generate numerous ideas (Fluency).
- (ii) The ability to propose various solutions or approaches to a problem (Flexibility).
- (iii) The ability to generate ideas that differ from those of others (Originality).
- (iv) The ability to explain something clearly and in detail (Elaboration).

Holmes et al. (2021) explain that competence refers to an individual's state when performing a task. Competence development occurs through actions and interactions—whether in formal or informal educational or professional contexts and requires more than just the knowledge acquired. At the highest level, this conceptualization of competence implies the ability to select and adapt from one's acquired repertoire to solve complex, unfamiliar tasks or problems.

In technical education, competence refers to the integration of measurable knowledge, skills, and attitudes required to perform professional tasks effectively. Competence is a combination of skills, attitudes, and knowledge developed over a long period, enabling one to act appropriately in various situations depending on the circumstances. The foundation of Miller's pyramid is knowledge, or the ability to gather and comprehend information. Miller's hierarchy of competence is illustrated in Figure 1.



Fig. 1. Miller's Pyramid of Competence

### B. Critical Thinking

The greatest challenge in 21st-century education is the ability of the educational system to prepare a generation equipped with the skills to navigate rapid, massive, and continuous change. Learning is not merely about the transfer of knowledge but also about maturing students' minds so they can solve problems and think creatively. Critical Technology cannot replace the ability to think. For students to become knowledgeable consumers of scientific information and to make wise decisions in response to varied scientific breakthroughs, critical thinking is essential (Amin et al., 2023).

The act of reasoning to arrive at a logical conclusion is known as critical thinking. It is essential to human growth. Critical thinkers are able to create relevant questions, incorporate pertinent information, show productivity and effectiveness, be creative, build strong arguments, and

provide logical, convincing results. When students use these abilities to collect, process, evaluate, and react to information, critical thinking skills grow (Wale & Bishaw, 2020). Critical thinking is crucial for improving student learning results. It improves the coherence and rationale of the language created while also facilitating the assimilation of knowledge through written and oral communication (Anjaniputra, 2020).

### C. Research Gap

The current state of the literature leaves three fundamental research gaps. First, there have not been many studies that position creativity and critical thinking as determinants of cognitive achievement, but only as the impact of learning. Second, research that integrates these two constructs within a single structural model in technical education remains limited. Third, simultaneous empirical testing using the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach in this context is still not widely carried out. In order to fill this academic gap, this study aims to analyze the simultaneous influence of creativity and critical thinking on students' cognitive learning outcomes by utilizing the reliability of the PLS-SEM approach. The findings of this study are expected not only to enrich the discourse on competency development in the 21st century but also to contribute to the design of technical learning models, particularly in beauty education, that can support students' cognitive learning outcomes.

As shown in Table I, previous studies have examined critical thinking, instructional models, self-confidence, and academic achievement from different perspectives. However, these studies have not simultaneously positioned creativity and critical thinking as predictors of cognitive learning outcomes in technical beauty education.

## III. METHOD

### A. Research Design

In this study, an ex post facto quantitative approach was used with a survey method. The study examined the relationships among creativity, critical thinking, and cognitive learning outcomes according to the research framework presented in Figure 2.

TABLE I  
SUMMARY OF PREVIOUS RESEARCH AREAS AND IDENTIFIED RESEARCH GAPS.

| Research area                                                      | Main contribution                                                                                          | Limitation identified                                                                        | Gap addressed in this study                                                                                           |
|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
| Students' critical thinking skills                                 | Exploring students' critical thinking skills through content analysis.                                     | Data on critical thinking skills and learning motivation were analyzed using ANCOVA.         | Creativity and critical thinking as determinants of cognitive achievement, but rather merely as outcomes of learning. |
| The discovery learning model on students' critical thinking skills | The Effect of the Discovery Learning Model on Students' Critical Thinking Skills                           | uses a quasi-experiment conducted in the Department of Geography, Faculty of Social Sciences | Not focused on students in technical beauty education                                                                 |
| Critical thinking skills and self-confidence                       | The Effectiveness of the Clinical Learning Model on Students' Critical Thinking Skills and Self-Confidence | Enhancing students' critical thinking skills and confidence is no easy task.                 | It does not measure critical and creative thinking skills, but rather self-confidence.                                |

|                      |                                                                  |                                                                                                                                    |                                                                                                             |
|----------------------|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Academic achievement | Critical thinking and its relationship with academic achievement | As a measure of academic performance, GPA is a variable that is positively and linearly related to the level of critical thinking. | It is not only GPA that serves as proof of academic performance, but also the students' creative abilities. |
|----------------------|------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|

### B. Participants and Sample Characteristics

516 undergraduate students from the Cosmetology Education program made up the study population. Sampling was done to make the study and data collection procedures easier given the size of the population. The sample size for this study was determined to be 225 students using Slovin's algorithm with a 5% margin of error. Those who have finished hair care and hair colouring courses made up the student sample.

### C. Research Components and Indicators

The study's variables are critical thinking, creativity, and cognitive learning outcomes. Fluency, adaptability, originality, and elaboration are the metrics used to assess creativity. Interpretation, analysis, appraisal, inference, explanation, and self-control are examples of critical

thinking. Occupational health and safety, kinds, anomalies, and diseases of the scalp and hair, colour theory, hair colouring procedures, and post-coloring hair care are indicators for cognitive learning outcomes.

### D. Data Analysis

The main method of data analysis used in the study is partial least squares structural equation modelling (PLS-SEM). Evaluation of the measurement model (outer model) and evaluation of the structural model (inner model) were the two successive phases of the PLS-SEM analysis.

Before testing the proposed associations between variables, the initial step is to evaluate the measurement model's quality to make sure that each construct is assessed precisely and consistently. Outer loadings are used to assess indicator reliability; an indicator that explains more than 50% of the variance in its linked construct is said to have a standardised loading value of 0.708 or higher.

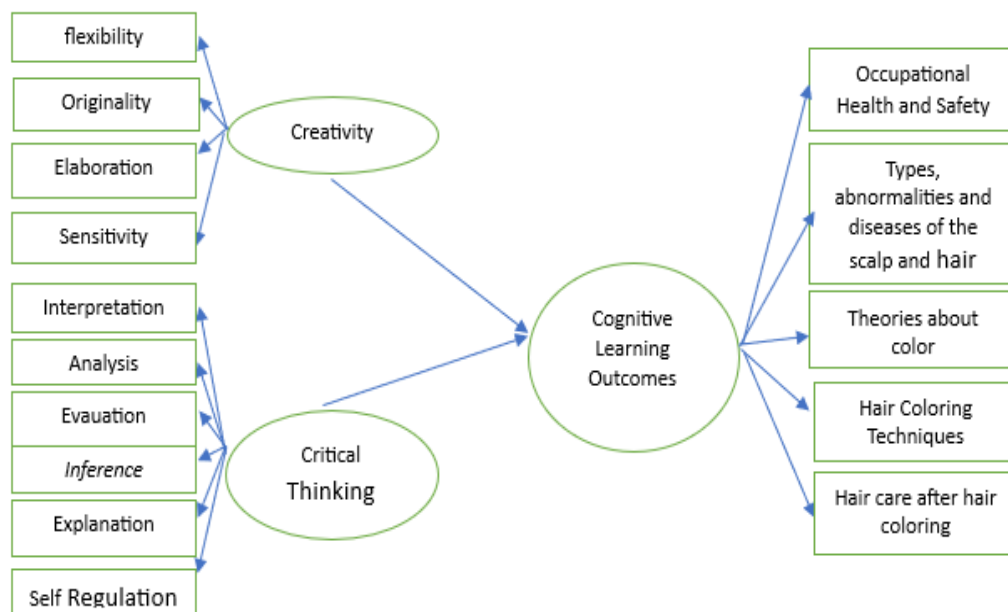


Fig. 2. Research Framework

Composite Reliability (CR) is then used to assess each construct's internal consistency; values greater than 0.70 indicate adequate reliability. Average Variance Extracted (AVE) is used to evaluate convergent validity; a value larger than 0.50 means that a concept absorbs more variance from its indicators than variance due to measurement error. Discriminant validity was assessed using the Fornell–Larcker criterion and cross-loadings to further guarantee that each latent construct reflects a unique concept. The square root of the Average Variance Extracted (AVE) for each construct was compared with its correlations with other

constructs to evaluate the Fornell–Larcker criterion. Additionally, cross-loadings were analysed to verify that each indicator loaded more strongly on its intended construct than on the other constructs. The study moves on to the assessment of the structural model after verifying that the measurement model satisfies the necessary psychometric requirements. To find possible multicollinearity among predictor constructs, the first step is to look at Variance Inflation Factor (VIF) values. The coefficient of determination ( $R^2$ ), which shows the percentage of variance in the endogenous construct explained by the predictor

variables, is then used to evaluate the explanatory power of the suggested model. Stone-Geisser's predictive relevance ( $Q^2$ ), which is acquired during the blindfolding process, is used to assess the model's predictive capacity in addition to this assessment. The model has sufficient predictive relevance and can correctly predict the observed data if the  $Q^2$  value is positive. Additionally, each exogenous construct's practical contribution is evaluated using the effect size ( $f^2$ ), which goes beyond simple statistical significance to enable the understanding of the relative degree of each predictor's influence on the endogenous construct. The proposed hypotheses are tested using the bootstrapping resampling procedure, which is considered a standard inferential technique in PLS-SEM because it does not require data to be normally distributed. Through repeated resampling of the original dataset, bootstrapping generates an empirical sampling distribution that provides robust estimates of standard errors, t-statistics, p-values, and confidence intervals for each structural relationship. The significance of hypothesized relationships is determined based on path coefficient ( $\beta$ ) estimates, t-statistics, and p-values. This procedure enables more reliable statistical inference and is widely recognized as best practice for hypothesis testing in variance-based structural equation modeling.

#### IV. RESULTS AND DISCUSSION

##### A. Measurement Model Analysis

The results of the analysis showed that all indicators in the Creative, Critical Thinking, and Cognitive Learning Outcomes constructs had an outer loading value above 0.70, with a value range of 0.815–0.879; 0.800–0.840; and 0.777–0.819, respectively. The values have met the criteria recommended in PLS-SEM, so all indicators are declared valid and able to represent the construct well. The indicators with the highest loading values were found in CR2 (0.879) for the Creative construct, CT5 (0.840) for the Critical Thinking construct, and CLO3 (0.819) for the Cognitive Learning Outcomes construct. Finally, there are no indicators that need to be eliminated because all indicators have met the requirements for convergent validity. Thus, the measurement model in this study can be declared adequate to be used in the next stage of analysis.

##### B. Reliability and validity

The reliability and validity of the construct were evaluated using Cronbach's Alpha,  $\rho_A$ , Composite Reliability (CR), and Average Variance Extracted (AVE) values. The results of the analysis showed that the entire construct had a Cronbach's Alpha value between 0.858–0.903,  $\rho_A$  between 0.859–0.904, and a Composite Reliability between 0.898–0.928. All of these values have exceeded the minimum limit of 0.70, which indicates an excellent level of internal consistency.

In addition, the AVE scores for the Creative, Critical Thinking, and Cognitive Learning Outcomes constructs were 0.721, 0.670, and 0.638, respectively. The entire AVE value was above the minimum criterion of 0.50, which indicates that each construct was able to explain more than 50% of the variance of the indicators used. Thus, all constructs in this study meet the requirements of reliability and convergent validity, making them suitable for further structural model analysis. The measurement model and loading factors are presented in Figure 3.

The validity of the discriminator was evaluated using the Fornell-Larcker and Cross-Loadings criteria. Based on the results of the Fornell-Larcker Criterion, the square root value of AVE in each construct, namely Creative (0.849), Critical Thinking (0.819), and Cognitive Learning Outcomes (0.799), is higher than the correlation value between constructs. These results show that each construct has good discriminating abilities and can be empirically distinguished from other constructs.

All indicators have the highest loading values in the measured constructs compared to other constructs. For example, the CR2 indicator has a loading of 0.879 on the Creative construct, which is higher than the loading for Cognitive Learning Outcomes (0.588) and Critical Thinking (0.440). Similarly, the CT5 indicator has the highest loading in the Critical Thinking construct (0.840), while the CLO3 indicator has the highest loading in the Cognitive Learning Outcomes construct (0.819). These findings indicate that each indicator is better able to represent its own construct than the other.

The results of the Fornell-Larcker and cross-loadings tests show that the model has met the requirements for discriminant validity. Thus, the constructs of Creative, Critical Thinking, and Cognitive Learning Outcomes can be declared to have an adequate level of differentiation and are suitable for use in structural model analysis.

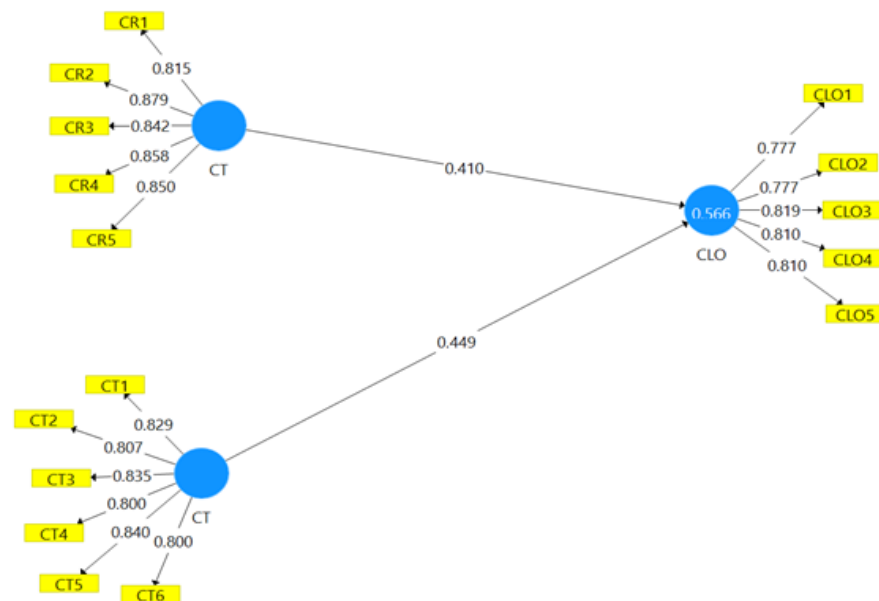


Fig. 3. Model the relationship between variables with each loading factor.

### C. Inner Model: Variance Inflation Factor (VIF)

The evaluation was carried out using the Variance Inflation Factor (VIF) value, with the criterion that the VIF value must be less than 5, or more conservatively less than 3. The results of the analysis showed that all indicators had VIF values ranging from 1.762 to 2.759. The highest VIF value is found in the CR2 indicator (2.759), while the lowest value is found in the CLO1 indicator (1.762). All of these values are below the maximum recommended limit, so there is no multicollinearity problem in the model. These findings indicate that each indicator is able to provide unique information in explaining the constructed construct and that there is no excessive redundancy between indicators.

The results of the analysis showed that the VIF value for the Creative and Critical Thinking variables was 1.394. This value is well below the maximum recommended limit, which is 5, and is even below the conservative limit of 3. Therefore, it can be concluded that the research model does not experience multicollinearity problems. These findings show that the Creative and Critical Thinking variables are two different constructs and do not overlap excessively in explaining Cognitive Learning Outcomes. Thus, the resulting path coefficient estimates can be considered stable. The VIF values for the predictor constructs are summarized in Table II.

In this study, the Cognitive Learning Outcomes (CLO) variable had an  $R^2$  value of 0.566 and an Adjusted  $R^2$  of 0.562. The score showed that 56.6% of the variation in Cognitive Learning Outcomes could be explained by the Creative and Critical Thinking variables, while the remaining 43.4% was influenced by other factors outside the research model that were not analyzed in this study. The very small difference between the  $R^2$  and Adjusted  $R^2$  values also indicates that the model built has a good level of stability and does not experience inflation due to the number of predictors used. The  $R^2$  value of 0.566 is included in the moderate category, which shows that the model has a strong enough

explanatory ability in predicting Cognitive Learning Outcomes. Thus, Creative and Critical Thinking can be considered important factors that contribute to the achievement of students' cognitive learning outcomes. The developed structural model has adequate predictive power and is able to explain more than half of the variation in Cognitive Learning Outcomes. Therefore, the model is feasible for use in hypothesis testing and interpreting relationships between research variables. Table III provides a summary of the  $R^2$  and modified  $R^2$  values.

TABLE II  
VIF VALUES FOR THE CREATIVE AND CRITICAL THINKING VARIABLES.

| Creative | Cognitive Learning Outcomes | Critical Thinking |
|----------|-----------------------------|-------------------|
|          | 1.394                       | 1.394             |

TABLE III  
R-SQUARE VALUE

|                            | R Square | R Square Adjusted |
|----------------------------|----------|-------------------|
| Cognitive Learning Outcome | 0.566    | 0.562             |

### D. Effect Size ( $f^2$ )

According to the analysis, the Critical Thinking variable has an  $f^2$  value of 0.334 for Cognitive Learning Outcomes, whereas the Creative variable has an  $f^2$  value of 0.278. A minor effect is indicated by a  $f^2$  value of 0.02, a moderate effect by 0.15, and a large effect by 0.35. As a result, the  $f^2$  values for Critical Thinking (0.334) and Creative (0.278) are in the medium to large range.

These results show that both variables make a substantive contribution in explaining the variation in Cognitive Learning Outcomes. However, Critical Thinking has a larger effect size than Creative, which indicates that critical thinking skills make a relatively stronger contribution to improving students' cognitive learning outcomes. The

predictive ability of the model was evaluated using the Predictive Relevance ( $Q^2$ ) value obtained through the blindfolding procedure. The  $Q^2$  value is used to assess the extent to which the model has the ability to predict observational data on endogenous variables. The model is declared to have predictive relevance if the value of  $Q^2$  is greater than zero. Based on the results of the Construct Cross-validated Redundancy analysis, the Cognitive Learning Outcomes variable obtained a  $Q^2$  value of 0.355. The value is above zero and belongs to the large predictive relevance category, which indicates that the model has a strong predictive ability in explaining the Cognitive Learning Outcomes variable. These results indicate that the combination of Creative and Critical Thinking variables has a good ability to predict students' cognitive learning outcomes. Thus, the developed structural model is not only able to explain the relationship between variables through an  $R^2$  value of 0.566, but also has strong predictive relevance based on the obtained  $Q^2$  value. The main inner-model evaluation criteria, including  $R^2$ ,  $Q^2$ , effect sizes, and VIF, are summarized in Table IV.

TABLE IV  
VIF CRITERIA VALUE

| Criteria                                  | Value | Interpretation       |
|-------------------------------------------|-------|----------------------|
| $R^2$ CLO                                 | 0.566 | Moderate             |
| $Q^2$ CLO                                 | 0.355 | Large                |
| $f^2$ Creative $\rightarrow$ CLO          | 0.278 | Medium               |
| $f^2$ Critical Thinking $\rightarrow$ CLO | 0.334 | Medium               |
| Inner VIF                                 | 1.394 | No multicollinearity |

### E. Discussion

These findings show that creativity helps students develop ideas, connect concepts, and build new understandings, thereby improving cognitive learning outcomes. On the other hand, critical thinking has a greater influence because it encourages analysis, evaluation, and decision-making, which is at the core of high-level learning. These results support the importance of Higher-Order Thinking Skills (HOTS) in technical education and indicate that technical beauty learning should provide opportunities for idea exploration, authentic problem-solving, analytical evaluation, and critical reflection.

The results showed that creativity had a positive and significant influence on cognitive learning outcomes ( $\beta = 0.410$ ;  $t = 8.711$ ;  $p < 0.001$ ). These findings prove that the higher the level of students' creativity, the higher their ability to achieve cognitive learning outcomes. These findings directly answer the research gap that has been identified in the introduction, namely that creativity is not only a learning output, but also an important determinant that explains the success of cognitive learning. The large path coefficient showed that creativity contributed substantially to the variation in cognitive learning outcomes, which was also strengthened by the effect size value of 0.278 (medium category) and the model's ability to explain 56.6% of the variation in cognitive learning outcomes ( $R^2 = 0.566$ ).

Theoretically, the results of this study are in line with the Constructivist Learning Theory developed by Piaget and Vygotsky, which emphasizes that knowledge is actively

built through learning experiences. Creativity allows students to develop various alternative solutions, connect existing concepts with new experiences, and restructure knowledge through the process of exploration. This perspective is also strengthened by the theory of creativity, which explains that creativity is the ability to produce ideas that are new and useful so that they can improve the quality of the learning process. In technical beauty education, creative students are expected not only to remember information but also to transform knowledge into applicable solutions for authentic technical and professional problems (Runco and Jaeger, 2012). The findings of this study are also consistent with the results of Thornhill-Miller et al. (2023) research, which states that creativity is one of the core competencies of the 21st century that contributes to improving the quality of learning, innovation, and work readiness. Similarly, Al Adawiyyah et al. (2026), through a bibliometric study, showed that research on creativity in technical education continues to increase because creativity has a close relationship with high-level thinking skills and academic performance. However, in contrast to previous studies that evaluated creativity more as a result of the implementation of learning models, this study shows that creativity functions as a direct predictor of cognitive learning outcomes. Thus, this study expands the conceptual understanding of the role of creativity in technical learning and provides new empirical evidence through the PLS-SEM approach.

The results of this study also strengthen the research of Korotaj and Buchberger (2026), who stated that critical thinking is a central competency in technical education because it supports analytical decision-making and practical problem-solving in professional environments. In addition, research by Thornhill-Miller et al. (2023) shows that creativity and critical thinking are two complementary competencies in supporting the success of 21st-century learning. However, this study makes a new contribution because it shows that, in the context of technical beauty education, the influence of critical thinking on cognitive learning outcomes is stronger than creativity. These findings enrich previous literature that generally only discussed these two competencies as outputs of learning models, rather than as the main predictors of cognitive learning outcomes.

Creativity and critical thinking are two constructs that complement each other in improving cognitive learning outcomes. However, critical thinking skills make a more dominant contribution, so the development of technical learning should not only focus on creativity, but also systematically train students' abilities to analyze, evaluate, formulate arguments, and make decisions based on evidence. Thus, this study succeeds in answering the research gaps that have been identified in the introduction while making an empirical contribution to the development of 21st-century learning theories through evidence obtained using the PLS-SEM approach. The results of this study indicate that improving students' cognitive learning outcomes is not enough through conventional material delivery, but needs to be supported by learning strategies that provide opportunities for students to generate new ideas, explore

various alternative problem-solving approaches, and develop innovations in the context of learning. Therefore, technical beauty education can integrate approaches such as Project-Based Learning, Design Thinking, and Challenge-Based Learning to provide students with structured opportunities to develop creativity, critical evaluation, and problem-solving skills.

#### CONCLUSION

Creativity and critical thinking were significant predictors of cognitive learning outcomes among students in technical beauty education, with critical thinking showing a stronger contribution. These findings indicate that cognitive achievement in technical beauty education is influenced not only by practical competence but also by students' abilities to generate ideas, analyze information, evaluate alternatives, and make reasoned decisions. The study therefore supports the integration of creativity and critical thinking into learning strategies that combine theoretical understanding with practical professional tasks. From a technical education perspective, strengthening these higher-order thinking skills can help students respond more effectively to complex learning situations and professional challenges in beauty-related fields.

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