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Research Article

Elaboration–Fluency Cognitive Activation Theory of Creative Thinking in Mathematics Performance: Evidence from Structural Equation Modeling

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ABSTRACT

Creative thinking is widely recognized as essential for mathematics learning; however, the structural mechanisms linking its domains to mathematics performance remain insufficiently understood. This theory-building study investigated the relationship between the domains of creative thinking and mathematics performance among junior high school learners. Using a quantitative, non-experimental design, data were collected from 300 Grade 9 learners in the Tugbok District, Division of Davao City, Philippines. Creative thinking was operationalized using a researcher-developed 16-item instrument that assessed four domains: fluency, flexibility, originality, and elaboration. The instrument is an open-ended questionnaire requiring respondents to generate varied responses, which were evaluated using teacher-scored rubrics. Fluency was measured by relevant ideas produced to solve the problems; flexibility by the diverse of solution of strategies used; originality by the uniqueness with valid reasoning of responses; and elaboration by the level of explanation, clarity of ideas, and completeness of mathematical steps used. Mathematics performance was obtained from official academic records. Structural Equation Modeling (SEM) was fit to utilize for testing multiple hypothesized models and identify which among the models is the best-fitting structural representation of these relationships. Results showed that elaboration do not significantly predict mathematics performance but indirectly significant when both the elaboration and mathematics performance is linked with fluency. That is, elaboration significantly predicted fluency ($\beta = .617, p < .001$), and fluency, in turn, significantly predicted mathematics performance ($\beta = .276, p = .033$). Among five models, Structural Model 5 best fit the data (CMIN/DF = 1.986, RMSEA = .049, CFI = .981), supporting

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the core idea that elaboration strengthens fluency, which then translates into higher mathematics achievement. This theory emphasizes that with elaboration strengthen by fluency, mathematical success follows.

Keywords: *Creative thinking, Elaboration, Fluency, Mathematics performance, Mediation, Structural equation modeling*

Introduction

Mathematics is essential for learners to develop logical and creative thinking skills, which are necessary for doing well in school and helping nation building. However, many learners in the Philippines are still struggling when it comes to dealing with mathematics at school. In fact, the Philippines got a score of 355 in mathematics in the Programme for International Student Assessment or PISA in 2022 which's much lower than the average score of 472 from other countries. This is also a problem in Region XI especially in Davao City where junior high school learners are not doing well in mathematics based from the National Achievement Test or NAT 2024 results. Specifically, when compared to other subjects, learners gained a mean percentage score of 52.08 in mathematics which obviously lags behind other subjects like Makabayan and language subjects.

The National Achievement Test results in mathematics have remained below the Department of Education's desired proficiency level. This suggests that the region's low performance in mathematics reflects not learning disruption but also broader curricular, instructional, attitudinal and socio-environmental challenges. The COVID-19 pandemic made things even worse for mathematics education. It hampers learners from learning and understanding mathematics. This made the gaps in their knowledge even bigger.

The COVID-19 pandemic made it hard for learners to acquire deeper learning in mathematics. This situation shows that there is a need to do studies that examines how learners learn mathematics in their schools. While most studies in the Philippines have looked at how teachers teach and the socioeconomic status of families affects studies, they have not looked much at how learners think creatively and process learning in a mathematics classroom.

Mathematics is a subject that needs logical reasoning while creative thinking is coming up with ideas on thinking of multiple ways to solve problems with novel solutions. However, there is much to understand more on how creative thinking relates with how well learners perform in mathematics.

This study aims to examine how creative thinking is associated with the mathematics performance of Grade 9 learners in the Tugbok District of Davao City. It sought to find out which parts of thinking are most important for doing well in mathematics. This study also looked at how these domains of creative thinking are related to each other.

Given these gaps, this study adopts the theory-building approach to gain better understanding of how creative thinking affects mathematics performance. By using a Structural Equation Modeling this study hopes to create a model that can help us better understand the relationship of creative thinking and learner's mathematics performance. Also, this model can identify which creative thinking domains such as fluency, flexibility, originality and elaboration are most predictive of mathematics performance. Mathematics education, in the Philippines can benefit from this study. This model can inform future researchers on how mathematics should be taught in class. We are trying to improve thinking, creativity and learning skills since mathematics a subject which we need to make sure our learners are learning well.

Methods and Materials

Research Design

This study employed a quantitative research approach using a non-experimental, correlational predictive design to examine the relationships between the domains of creative thinking such as fluency, flexibility, originality,

and elaboration, and mathematics performance among Grade 9 learners. A quantitative design was appropriate to use because it enabled the development and testing of possible models and structural relationships among variables of the study and their latent variables using empirical data (Kline, 2016). The study was grounded in the post-positivist paradigm, which assumes that objective knowledge can be approximated through systematic observation and statistical analysis. The theoretical foundation of this study was anchored in three theories such as the Theory of Divergent Thinking by Guilford (1950), Associative Theory of Creativity by Mednick (1962), and Theory of Cognitive Development by Piaget (1936), which collectively explains how creative cognitive processes activates mathematical reasoning and problem-solving of the learners. Structural Equation Modeling (SEM) was employed as the primary analytical technique to simultaneously examine direct and indirect relationships among variables. SEM is essentially used since it allows rigorous testing of hypothesized pathways and identifying the best-fitting structural model explaining mathematics performance.

Research Locale

The study was conducted in the secondary and integrated schools belonging to Tugbok District, located in the 3rd Congressional District of Davao City, Philippines. Davao City is a major urban center located in South-eastern Mindanao. It has a population of 1,825,450 based on the 2020 census. Within it is one of the most populate, culturally diverse and geographically wide-ranging, that is, Tugbok District. It was purposively selected due to its diverse educational environment, which includes both urban and semi-urban secondary and integrated schools with diverse instructional practices from different schools and socio-economic conditions. This diversity provides opportunity and is an appropriate context for examining cognitive variables such as fluency, flexibility, originality, and elaboration in mathematics education, as this area is where the diverse cultures meet and varied teaching techniques are used due to its geographical location, which is both an urban and semi-urban

environments. Furthermore, previous studies and institutional observations have identified persistent gaps in learners' mathematical readiness and limitations in instructional strategies. This suggests the need to examine internal cognitive learner variables such as creative thinking domains as possible predictors of mathematics performance. Furthermore, this study focused only on a single district to ensure contextual specificity, localized, and to allow the study to have relevant insights for improving mathematics education and performance.

Participants of the Study and Sampling Process

The study involved learners from Grade 9 who are officially enrolled for the School Year 2024 – 2025 from to Cluster 6 and Cluster 7 secondary and integrated schools in Tugbok District who consented to participate in the study. Using a cluster sampling technique, from a total population of 2,856 learners, there were 300 targeted participants followed by random sampling to ensure equitable representation and minimize selection bias. Specifically, there were 222 learners selected from Cluster 6 and 78 learners from Cluster 7. According to Chomeya et al. (2022) and Denis (2021), a sample size of 300 was deemed fit and sufficient for Structural Equation Modeling (SEM).

Research Instrument

A researcher-developed instrument was used, consisting of a 16-item open-ended creative thinking questionnaire which were used by learners, and a rubric-based teacher rating sheet. The questionnaire measured the four domains of creative thinking, namely, fluency, flexibility, originality, and elaboration. Each domain contains four-item open-ended questions. The open-ended question format allowed learners to draw diverse problem-solving processes and provide reasonable strategies to solve mathematical problems.

Learners' responses were evaluated by mathematics teachers using the researcher-made rubric-based rating sheet aligned with DepEd curriculum standards and Divergent Thinking Theory of Guilford (1950). Responses from each domain were rated on a five-point scale which was scored by teachers through the

mentioned rubric, with scores 1 being the lowest and 5 as the highest. Fluency was measured by the relevant ideas generated, flexibility by the variety of solution strategies, originality by the uniqueness with valid reasoning, and elaboration by the depth in the level of explanation, clarity and completeness of steps. To ensure scoring consistency, teacher-raters were oriented on the scoring rubric with the help of sample responses. Inter-rater reliability was essentially established to have a subset of responses which were independently rated by multiple teachers, yielding acceptable agreement levels.

Content validity was established through expert evaluation having the mean of 4.48. The instrument was pilot-tested with 30 other Grade 9 learners to refine clarity and administration procedures. Internal consistency reliability was high with a Cronbach's $\alpha = .890$. With the use of Confirmatory Factor Analysis, it supported the Construct, with acceptable convergent validity of $AVE > .50$, composite reliability of $CR > .70$, and discriminant validity based on the Fornell–Larcker criterion.

Supplemental instrument used for the mathematics performance were the percentage scores obtained from the mathematics teachers' records during the second quarter of SY: 2024 – 2025, composed of written works, performance tasks, and quarterly examinations in accordance with DepEd Order No. 8, s. 2015.

Statistical Analysis of Data

This study employed several statistical techniques to analyse the data gathered from the conduct of this study. Prior to inferential analysis, the collected data underwent screening to ensure compliance with the assumptions for Structural Equation Modeling (SEM). To address the missing values and inconsistencies of the responses, data cleaning procedures were employed. On the other hand, outliers were identified using standardized scores and graphical methods such as histograms and Q-Q plots. To assess the normality of the data, skewness and kurtosis indices were examined, alongside with Shapiro-Wilk. Linearity was verified with the help of scatterplots, while multicollinearity were done through Variance Inflation Factor (VIF) and tolerance values,

confirming the assumptions for correlation, regression and Structural Equation Modeling.

Mean and standard deviation were used to describe and summarize results from the learners' mathematics performance and creative thinking. The Pearson Product–Moment Correlation Coefficient was used to determine the strength and direction of relationships between domains of creative thinking and mathematics performance, while multiple linear regressions identified significant predictors of mathematics performance.

SEM was essentially employed to examine direct and indirect relationships among variables and to identify the best-fitting structural model. Chi-square divided by degrees of freedom (CMIN/DF), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Normed Fit Index (NFI), Goodness-of-Fit Index (GFI), and p-value were used to evaluate the Best Model fit. Following established criteria, acceptable model fit was indicated by $CMIN/DF < 2.00$, $RMSEA < 0.05$, $p > 0.05$, and CFI, TLI, NFI, and $GFI \geq 0.95$ (Browne & Cudeck, 1993). The use of multiple fit indices was necessary because no single fit statistic is deemed sufficient to determine model adequacy, ensuring absolute fit, incremental fit, and model parsimony, thereby strengthening the validity of the structural analysis (Hu & Bentler, 1999; Kline, 2016).

Ethical Considerations

This study adhered to the ethical standards for research involving human participants. Ethical approval and permissions from schools and institutions such as Department of Education – Division of Davao City and Bukidnon State University Research and Ethics Committee were obtained prior to data collection. Since the respondents were minors, signed informed consent from parents or guardians were necessary to obtain together with the assent form from learners to ensure their voluntary participation. Confidentiality and anonymity of respondents were maintained throughout the study to secure data handling and coding procedures. All data were used solely for research purposes, and respondents were oriented of their rights, privacy, and well-being was protected throughout the study. They were also

reminded that they can withdraw as respondents if they wished to.

Results and Discussion

Level of Learners’ Mathematics Performance

Table 1 shows the **level of learners’ mathematics performance** with an overall **high performance** with the mean of 79.07 and standard deviation of 9.23 which is transmuted to a score of 87, that is, very satisfactory. Among the components, **performance tasks** obtained the highest mean of 86.56 with a standard deviation of 10.93, transmuted to a score of 91, that is described as outstanding, followed by **written works** with a mean of 79.25 with standard deviation of 13.84,

transmuted as 87, very satisfactory. However, **periodical examinations** recorded a lower mean of 63.70, with standard deviation of 17.37, transmuted as 77, fairly satisfactory, indicating variability in learners’ mastery during summative assessments. These findings support the results of the study of Flores (2019) that mathematics performance is multifaceted. It is influenced by engagement and problem-solving processes. It can also be observed in the results that lower examination outcomes reflect national trends reported in international large-scale assessments such as **TIMSS** (Mullis et al., 2019) and **PISA** (OECD, 2019; OECD, 2024), where Filipino learners consistently performed below global standards.

Table 1. Level of Mathematics Performance of Learners

Component	M	SD	Transmuted Score	Descriptive Level
Written Works	79.25	13.84	87	Very Satisfactory
Performance Tasks	86.56	10.93	91	Outstanding
Periodical Examination	63.70	17.37	77	Fairly Satisfactory
<i>Overall</i>	<i>79.07</i>	<i>9.23</i>	<i>87</i>	<i>Very Satisfactory</i>

Level of Creative Thinking of Learners

Shown in Table 2 is the level of creative thinking of learners in terms of fluency, flexibility, originality and elaboration. In terms of Fluency, learners demonstrated a high level with a mean of 3.81. Conceptual understanding scored the highest mean of 3.94, followed by strategic competence with a mean of 3.90. Adaptive reasoning, though slightly lower with a mean of 3.59, remained at a high level. These results align with the theory of Piaget (1936) on cognitive development and the theory of Mednick (1962) on divergent thinking, that abstract reasoning at a formal stage, in this study referring to the high school learners, link fluency to the activation of ideas and connecting these to process solutions needed in solving mathematical problems. Additionally, Rushton et al (2016) alongside with Stocker and Kubina

(2021) confirms this result that with a strong fluency, academic performances tend to enhance and reduces cognitive stress to learners.

The level of flexibility was found to be moderate overall mean of 3.03. Adaptation was described as high with a mean of 3.44, while identification of problem characteristics gained a mean of 3.34 and efficient use of strategies with a mean of 3.04, were both in moderate level. However, multiple strategies obtained a low mean of 2.31, indicating limited exploration of alternative methods. This result supports the theory of Guilford, which highlights flexibility as a core element of divergent thinking, and findings by Hickendorff (2022) and Santana et al. (2022), emphasizing the significant role that cognitive flexibility has in mathematics achievement.

Table 2. Level of Creative Thinking of Learners

Indicators	M	Descriptive Level
<i>Level of Fluency of Learners in Mathematics</i>		
Conceptual Understanding	3.94	High
Strategic Competence	3.90	High
Adaptive Reasoning	3.59	High

Indicators	M	Descriptive Level
<i>Overall</i>	3.81	High
<i>Level of Flexibility of Learners in Mathematics</i>		
Adaptation	3.44	High
Identification of Problem Characteristics	3.34	Moderate
Efficient Use of Strategies	3.04	Moderate
Multiple Strategies	2.31	Low
<i>Overall</i>	3.03	Moderate
<i>Level of Originality of Learners in Mathematics</i>		
Associative Remoteness	2.71	Moderate
Cleverness	2.47	Low
Uncommonness	2.28	Low
<i>Overall</i>	2.49	Low
<i>Level of Elaboration of Learners in Mathematics</i>		
Awareness	3.43	High
Interest	3.25	Moderate
Cognitive Engagement	3.18	Moderate
<i>Overall</i>	3.29	Moderate

The level of originality obtained the lowest mean among all the domains with an overall mean of 2.49. Latent variables such as associative remoteness only reached a moderate level with a mean of 2.71. Meanwhile, cleverness with a mean of 2.47 and uncommonness with a mean of 2.28, were both described as low. This suggests that learners tend to rely more on routinely practices and common approaches they previously used in solving mathematical problems rather than finding new and unique solutions. This finding reflects the limited utilization of divergent thinking skills among learners as described by Guilford (1950) and Mednick (1962), and aligns with several studies emphasizing that there is a need for idea generation from learners and enhancing divergent instruction in school (Creswell & Speelman, 2020; Ling & Mahmud, 2023).

Lastly, moderate levels of elaboration were observed with an overall mean of 3.29. Awareness was high which obtained a mean of 3.43, while interest with a mean of 3.25 and cognitive engagement with a mean of 3.18, were both moderate. These results indicate that learners may recognize essential problem characters such as given and what is asked but may not consistently demonstrate deep cognitive engagement as to what are other steps to do next and what reasoning will be used when getting such answer. Elaboration is strongly associated with critical thinking and problems

solving, as well as, mathematics literacy (Zohar & Dori, 2016; Magen-Nagar, 2016) and is recognized as a key learning strategy in assessments like used in the PISA frameworks (Lin & Tai, 2015).

Overall, the findings above revealed that while learners demonstrate creative thinking through fluency and a very satisfactory mathematics performance, domains such as flexibility, originality, elaboration, and as well as, summative assessment, requires targeted instructional support. Strengthening divergent thinking, adaptive reasoning, and elaborative learning strategies may enhance both classroom and large-scale assessment outcomes.

Relationship between Domains of Creative Thinking and Mathematics Performance

The results in the relationship between creative thinking and mathematics performance reflected in Table 3 indicates that among the domains of creative thinking, fluency, particularly the components such as strategic competence having $r = .138$ and $p < .05$, and conceptual understanding with $r = .127$ and $p < .05$, only showed significant positive relationships with mathematics performance. The result reveals that learners tend to succeed in mathematics when they demonstrate strong problem-solving strategies and deep conceptual foundations of the topic. These perspectives

aligns with the studies of Ay et al. (2016) and Edulsa (2022) which emphasized that strategic competence and conceptual understanding are critical in the prediction of mathematics performance. In the same manner, Hunter et al (2018) stressed that mathematics performance is strongly rooted to the conceptual foundations that supports strategic and adaptive reasoning in activating cognitive learning in mathematics.

Fluency, although it gained $r = .110$ and $p = .057$ that showed a positive correlation, it did not reach statistical significance. This suggests that fluency alone may not directly predict mathematical success in the absence of structured reasoning. Hence, conceptual understanding and strategic competence are very essential in developing fluency among learners (Kellman et al., 2020).

Table 3. Relationship between Domains of Creative Thinking and Mathematics Performance

Creative Thinking Domain	Correlation (r)	Significance (p)	Relationship to Mathematics Performance
Strategic Competence	0.138	< 0.05	Positive
Conceptual Understanding	0.127	< 0.05	Positive
Fluency	0.110	0.057	Positive (not significant)
Flexibility	—	—	Not significant
Originality	—	—	Not significant
Elaboration	—	—	Not significant

In contrast, some domains of creative thinking such as originality, flexibility, and elaboration demonstrated no significant relationships with mathematics performance. The domain on originality, including its latent variables such as cleverness and uncommonness, showed negative correlations. This suggests that divergent or unconventional thinking does not necessarily results into favourable outcomes in structured mathematical assessments. This finding is consistent with Walia and Walia (2017), who emphasized that originality alone, is not enough to influence the results of mathematics assessments; it must be supported by strong content knowledge to impact mathematics performance. Likewise, although elaboration remains relevant for long-term comprehension and reasoning development, it still did not significantly predict performance, (Van der Stel & Veenman, 2014; Leikin & Levav-Waynberg, 2020).

Theoretically, this finding is supported by the Cognitive Development Theory of Piaget (1936), in which he underscores the important role of logical reasoning and intellectual thinking in mathematical success. In contrast, as proposed by Guilford (1950) and Mednick (1962), the broader divergent thinking skills appear, the less it directly aligned with the structured and systematic nature of mathematics

performance. Meaning, the more that learners apply creative and free-flowing of ideas, the less it directly fits the naturally organized step-by-step nature of solving mathematical tasks.

Overall, the results of the study above revealed that the creative thinking domains are rooted in logical structure and conceptual depth. In particular, strategic competence and conceptual understanding, the latent variables of fluency, have a more direct and significant relationship with mathematics performance than domains of creative thinking itself such as fluency, flexibility, originality and elaboration.

Standard Fit of the Five Structural Models

The five hypothesized structural models were evaluated using SEM to examine the influence of creative thinking domains on mathematics performance. As shown in Table 4, Model 1 included all domains such as fluency, flexibility, originality, and elaboration as direct predictors of mathematics performance, but none showed significant direct effects despite strong internal relationships among the latent variables (Ay et al., 2016; Edulsa, 2022). Model 2 emphasized flexibility strongly predicted another observed variable, that is, fluency, with $\beta = .822$ and $p < .001$, however, it still does not directly influence performance (Kellman et al.,

2020). In Model 3, originality predicted an observed variable, that is again, fluency, with $\beta = .596$ and $p < .001$, which then positively influenced mathematics performance with $\beta = .271$ and $p = .037$, while direct effects on originality and mathematics performance remained non-significant (Ling & Mahmud, 2023). Model 4

demonstrated that fluency mediated the effects of other observed variables such as flexibility, originality, and elaboration, with flexibility significantly predicting fluency with $\beta = .838$ and $p < .001$ and that fluency positively affects performance with $\beta = .236$ and $p = .050$ (DeCaro, 2022).

Table 4. Summary of Standard Fit of the Five Structural Models

Model	CMIN/DF	P-value	NFI	TLI	CFI	GFI	RMSEA
1	2.242	.000	.947	.961	.970	.921	.064
2	2.918	.000	.950	.953	.966	.943	.080
3	3.626	.000	.948	.931	.961	.950	.094
4	2.177	.000	.949	.963	.972	.924	.063
5	1.986	.065	.969	.968	.981	.965	.049
Standard	<2.00	>0.05	>0.95	>0.95	>0.95	>0.95	<0.05

Model 5, as seen in the table above, is deemed fitted in all the standard indices, and is identified as the best-fitting model. This final model achieved the most robust fit indices such as a CMIN/DF of 1.986, a RMSEA of 0.049, a NFI of 0.969, a CFI of 0.981, a TLI of 0.968, and a GFI of 0.965, exceeding standard thresholds according to Browne and Cudeck (1993). Furthermore, this result highlighted that elaboration significantly predicted fluency, with $\beta = .617$ and $p < .001$, and that fluency significantly predicted mathematics performance, with $\beta = .276$ and $p = .033$, confirming the **indirect effect of elaboration to mathematics performance via fluency**. In contrast, direct effects remained to be not significant (Spencer et al., 2022; Handayani et al., 2021; Sari, 2019). These results supports the studies of Lince, (2016), Maharani (2014), and Walia and Walia, (2017) emphasizing the mediating role of fluency in translating creative thinking skills into measurable academic achievement.

Structural Equation Modeling Results

Structural Equation Modeling (SEM) was employed to examine the relationships among the domains of creative thinking such as fluency, flexibility, originality, and elaboration, and mathematics performance and come up with a model that best fit the goal of this study. Furthermore, Sem also is essential in determin-

ing the direct and indirect effects of the observed and latent variables of the study. The final structural model, shown in Figure 1. This Model 5 as results of the SEM, demonstrated acceptable goodness-of-fit indices, indicating that the hypothesized relationships adequately represented the observed data. The results revealed that **fluency plays an important role in establishing the relationship between elaboration and mathematics performance** and that is relationship highlights the indirect contribution of elaboration to mathematics performance.

Table 5 shows that elaboration does not directly significant with math performance ($\beta = -.13, p = .259$). This means that relying on elaborating on ideas alone does not directly improve learners’ math performance. However, elaboration is significant with fluency ($\beta = .617, p < .001$). Fluency in turn helps with math performance ($\beta = .276, p = .033$). This result shows an indirect relationship that elaboration is essential to learners as the explain ideas in detail organize thoughts and connect math concepts, which in turn, strengthens fluency. Fluency then helps improve performance by letting learners solve problems accurately and efficiently. Therefore, elaboration helps with math performance indirectly by improving cognitive processes.

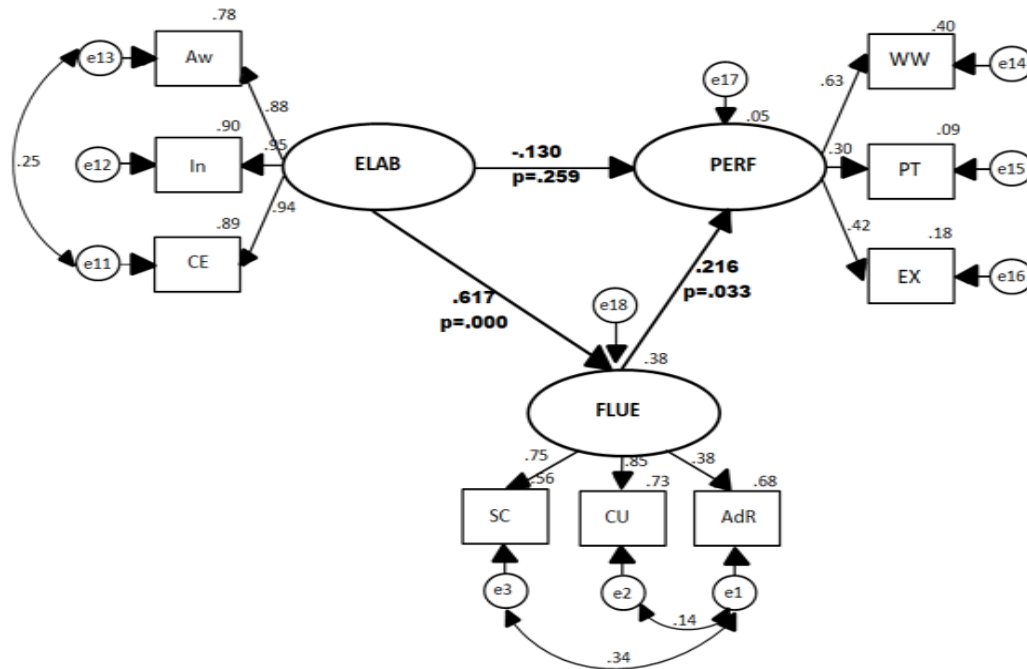


Figure 1. A Hypothesized Structural Model 5 of Mathematics Performance

Legend:

ELAB	-Elaboration	Aw	-Awareness	AdR	-Adaptive Reasoning
FLUE	-Fluency	In	-Interest	WW	-Written Works
PERF	-Math Performance	CE	-Cognitive Engagement	PT	-Performance Tasks
		SC	-Strategic Competence	EX	-Periodical Exam
		CU	-Conceptual Understanding		

Table 5. Standardized Regression Weights of Structural Model

Variables		B	S.E.	C.R.	Beta	P-value
FLUE	<--- ELAB	.385	.040	9.641	.617	.000
PERF	<--- FLUE	3.731	1.751	2,131	.276	.033
PERF	<--- ELAB	-1.108	.981	-1.129	-.130	.259
AdR	<--- FLUE	1.000			.827	
CU	<--- FLUE	1.037	.083	12.534	.854	.000
SC	<--- FLUE	.874	.075	11.602	.750	.000
CE	<--- ELAB	1.000			.942	
In	<--- ELAB	1.065	.051	20.765	.951	.000
Aw	<--- ELAB	.950	.032	29.332	.883	.000
WW	<--- PERF	1.000			.630	
PT	<--- PERF	.371	.155	2.393	.296	.017
EX	<--- PERF	.846	.345	2.453	.425	.014

Legend:

ELAB	-Elaboration	Aw	-Awareness	AdR	-Adaptive Reasoning
FLUE	-Fluency	In	-Interest	WW	-Written Works
PERF	-Math Performance	CE	-Cognitive Engagement	PT	-Performance Tasks
		SC	-Strategic Competence	EX	-Periodical Exam
		CU	-Conceptual Understanding		

Interestingly, regression and structural results consistently show that creative thinking domains do not directly affect math performance. However, indirect effects through fluency are consistently observed. This can be seen in Table 6. The results in the direct, indirect and total effects suggests that math

performance is not directly influenced by isolated creative thinking domains, rather its influenced by how these skills are activated and turned into fluent cognitive processes. In this sense, fluency is the mechanism that activates creative thinking into measurable academic outcomes.

Table 6. Standardized Direct, Indirect and Total Effect Estimates of Structural Model 5

Latent Variables	Outcome	Direct Effect	Indirect Effect	Total Effect
ELAB	FLUE	0.617	0	0.617
FLUE	PERF	0.276	0	0.276
ELAB	PERF	-0.130	0.170	0.040

Legend:

ELAB -Elaboration

FLUE -Fluency

PERF-Math Performance

From this perspective, teaching practices should focus on how creative thinking's used in learning and that instructional strategies should emphasize reasoning. This can be done by encouraging students to explain justify and expand their solutions. Reinforced by fluency, learning is developed through structured practice, pattern recognition and strategic problem-solving. With these practices in the classroom which generate learners' depth of explanation, representation and application are particularly effective in turning elaborated knowledge into positive mathematical outcomes.

These findings are consistent with the Divergent Thinking Theory of Guilford (1950) in which he identifies elaboration as a component of creative thinking that enhances the depth and refinement of ideas. It was further discussed by Guilford that elaboration supports the expansion and development of ideas and its influence on performance may occur through processes like fluency. Similarly, Mednick (1962) posits that elaboration strengthens association of mathematical ideas. This enables learners to form connections among mathematical concepts improving fluency and cognitive efficiency.

Additionally, this perspective is supported by the theory of Piaget (1936). It was explained in the theory that learners in the operational stage, such as adolescents, develop abstract reasoning and systematic problem-solving skills. It means that elaboration supports this development by integrating knowledge with existing cognitive structures. At the same time,

fluency enables the retrieval and application of this knowledge during mathematical tasks in the classroom. In short, elaboration strengthens the foundation necessary for fluency, which directly supports math performance.

The indirect effect observed in this study is not different from the empirical findings of Van der Stel and Veenman (2014) that strategies such as elaboration enhance comprehension and retention of learning, demonstrating long-term effects. Similarly, as emphasized by Kellman et al (2020) that fluency strengthens learners' ability for pattern recognition and drawing abstract reasoning that leads to mathematical success. These perspectives highlight that elaboration contributes to the development and fluency, indicating a pathway in which creative thinking enhances mathematical performance of learners.

Building from these interpretations, the study introduces the Elaboration-Fluency Cognitive Activation Theory, which framework is shown in Figure 2. This theory conceptualizes that the foundation for mathematical success is driven by elaboration that enriches interest, awareness, and engagement. Furthermore, fluency, as a cognitive mechanism, activates this elaborated knowledge through strategic competence, conceptual understanding, and adaptive reasoning. This interaction explains that fluency, as the direct and strongest predictor of mathematics performance, translates elaboration into idea generation, ultimately resulting to measurable mathematics achievement.

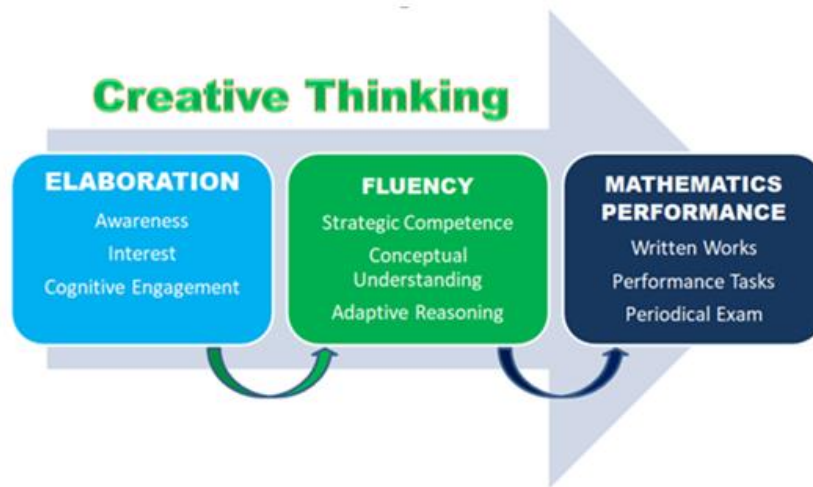


Figure 2. A Model Elaboration–Fluency Cognitive Activation Theory of Creative Thinking and Mathematics Performance

Flexibility and originality, on the other hand, do not have direct effects on mathematics performance, suggesting that these domains of creative thinking contribute indirectly to learners’ mathematical development. Flexibility may support strategy use and cognitive shifting, while originality may support long-term innovations and plays a critical to the specific improvements in enhancing tests construction that promotes open-ended questions.

Conclusions

The SEM results leads to the introduction of this new theory that posits the elaboration as a cognitive process is activated by fluency which in turn directly impacts mathematics performance. This highlights the perspective that creative thinking is multifaceted; some domains exert effects directly while others operate as mediating mechanisms. Although the overall domains ore creative thinking do not significantly predict mathematics performance, there were specific latent variables emerged to have a critical role in the mathematical success of learners such as strategic competence and conceptual understanding.

In terms of regression results which reveal that the no significant relationship was seen in the domains of creative thinking and mathematics performance, it suggests that when examined independently, they do not immediately translate into academic success. However,

the results of the SEM revealed the critical role of fluency in the elaboration and mathematics performance. While elaboration significantly predicts fluency, in turn, fluency significantly predicts mathematics performance, suggesting that fluency is an activation mechanism that transforms elaborated knowledge into effective and observable achievement. Therefore, the regression and SEM results do not contradict each other, instead, they reflects the limitations capturing the indirect effects of the variables of the study.

Recommendations

The findings of the study, specifically on the results of the SEM leading to the generation of the Elaboration-Fluency Activation Theory, are critical in improving classroom mathematical practices in school.

Therefore, classroom teachers are encouraged to give opportunities for learners to demonstrate elaboration by reinforcing activities that promote accuracy, logical reasoning, and efficient problem-solving, as fluency directly enhances mathematics achievement. More importantly, teachers should cultivate elaborative thinking to learners by encouraging them to justify their answers on class, articulate their reasoning verbally and in writing, and evaluate different solution approaches.

Furthermore, the results of the study emphasize that promoting elaboration indirectly

improves mathematics performance by strengthening fluency, confirming the elaboration-fluency cognitive activation theory. Classroom instructions should be integrated with structured learning experiences that allow learners to connect ideas, encourage explanation, and support deeper cognitive engagement to enhance fluency development. However, this development on elaboration and fluency as domains of creative thinking may require consistent instructional support from curriculum designers and implementers, and is still needing further research to explore additional factors influencing mathematics performance.

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