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Dimensions of Students' Mathamatical Creative Thinking Ability in the Post-Covid-19 Pandemic

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Abstract: Mathematical Creative Thinking Ability is a means of finding solutions and solving problems universally. This study aims to analyze students' mathematical creative thinking skills after the covid-19 pandemic. The research subjects were 100 SMA/MA students in DIY. The research method used is descriptive quantitative assisted by the LISREL program. The analytical tool used is structural equation modeling to analyze the dimensions of mathematical creative thinking which consists of four indicators, namely flexible, fluent, elaborative, and evaluative thinking. The results showed that the students' mathematical creative thinking ability was at a moderate level above 80% with a loading factor value greater than 0.3 and a t-value above 1.96. Of the four dimensions, the indicator of elaborative thinking ability is the most dominant in contributing to and influencing the sub-indicator, namely developing students' ideas.

Keywords: mathematical creative thinking, structural equation modelling, Covid-19 pandemic.

Abstrak: *Kemampuan Berpikir Kreatif Matematis merupakan sarana untuk menemukan solusi dan memecahkan masalah secara universal. Penelitian ini bertujuan untuk menganalisis kemampuan berpikir kreatif matematis siswa pasca pandemi covid-19. Subjek penelitian ini adalah 100 siswa SMA/MA di DIY. Metode penelitian yang digunakan adalah deskriptif kuantitatif berbantuan program LISREL. Alat analisis yang digunakan adalah pemodelan persamaan struktural untuk menganalisis dimensi berpikir kreatif matematis yang terdiri dari empat indikator yaitu berpikir luwes, lancar, elaboratif, dan evaluatif. Hasil penelitian menunjukkan bahwa kemampuan berpikir kreatif matematis siswa berada pada taraf sedang di atas 80% dengan nilai loading factor lebih besar dari 0,3 dan nilai t-hitung di atas 1,96. Dari keempat dimensi tersebut, indikator kemampuan berpikir elaboratif paling dominan berkontribusi dan mempengaruhi sub indikator yaitu mengembangkan ide siswa.*

Kata kunci: *berpikir kreatif matematis, pemodelan persamaan struktur, pandemi Covid-19.*

▪ INTRODUCTION

The Covid-19 pandemic creates a new liestyle for interacting with society in realizing a healthy life (Atmadja et al. 2020). In realizing a healthy lifestyle, the world of education also changes and adapts in providing learning services to students (Herliandry et al. 2020). Learning that is usually in the classroom is transformed online using the learning media of WhatsApp, zoom, meet, and Instagram (Atsani 2020). This new habit of learning certainly causes various problems in conveying the content of the material to student (Wahyono, Husamah, and Budi 2020). The problem faced by students is the inhibition of mathematical cognitive abilities (Supriani and Hadi 2020), while the obstacle faced by teachers is the readiness to use technology in learning (Wahyono et al. 2020)

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Mathematical problem solving is one of the determining factors in achieving mathematics learning objectives (Hidayat and Sariningsih 2018), increasing students' mathematical understanding abilities (Kesumawati 2010), complete models, and interpreting models designed or obtained (Mawaddah and Anisah 2015), and closely related to self-efficacy and problem-solving abilities (Jatisunda 2017). Mathematical problem solving is closely related to cognitive load, the higher cognitive load will affect students' mathematical problem-solving abilities (Kolfschoten, French, and Brazier 2014), so it is necessary to integrate concept maps in the student learning process not to be burdened with extra cognitive loads so that they can improve mathematical abilities students (Hwang et al. 2014). Cognitive load is closely related to the creative thinking ability test, the achievement of which is increasing students' mathematical creative abilities (Susanto and Munandar 2017).

Mathematical creative thinking is the ability to find solutions and ideas in mathematical problems (Prasetyo, Zulela, and Fahrurrozi 2021), create or find different and original renewable ideas (Andiyana, Maya, and Hidayat 2018), think straightforwardly, be flexible, and describe mathematical problems (Marliani 2015), elaboration thinking (Hanipah, Yuliani, and Maya 2018), evaluative thinking (Sukarjita 2020; Tambunan 2016), thus the ability to think creatively is very important in the era of global competition because problems are increasingly complex in various modern aspects (Maharani 2014).

Mathematical creative thinking ability in several previous studies is often associated with learning achievement (Eva and Kusrini 2016; Supardi 2015), various learning methods including cooperative learning (Florentina and Leonard 2017), eliciting activities models (Amalia, Duskri, and Ahmad 2015), Missouri Mathematics Project Learning (Amalia et al. 2015), Contextual approach (Dewi, Akbar, and Afrilianto 2019), discovery learning model (Mawaddah and Suyitno 2015), Open-Ended based mathematics learning (Noer 2011), Brain based learning (Nur 2016), STEM project-based learning (Ismayani 2016), so in this study, analyzing a different side from previous research, namely analyzing the dimensions of mathematical creative thinking, so that it can be seen the influence of each dimension on the variable construct.

Creativity includes fluency, flexibility, originality, and elaboration (Coleman and Hammen 1974; Cotton 1991).). The level of proficiency can be seen from the process of student activity observed through student interaction in the learning process (Lie 2002), the theory of cognitive flexibility in learning is focused on the ability to spontaneously compose knowledge, and provide adaptive responses to change situational demands (Kubzansky et al. 2007 ; Spiro, Feltovitch, and Coulson 2003; Trux and Jacobsan, 1989), Originality is the ability to express ideas in ways that are original and not clichéd (Berger 2011; Bissola and Imperatori 2011). Elaboration is the ability to describe and review a problem based on a different perspective from what is already known by many people (Norman and Schmidt 1992; Schmidt 1993).

▪ METHOD

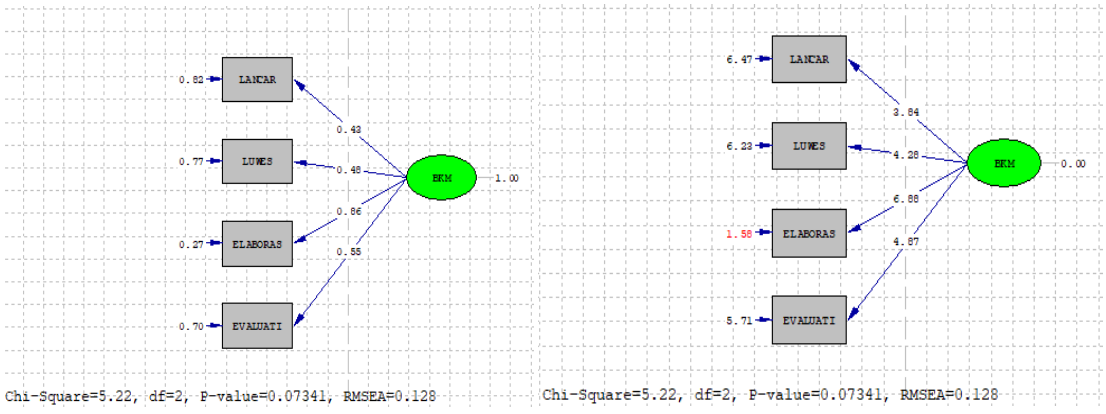
This study uses a quantitative descriptive approach. The design of this study analyzed the dimensions of students' mathematical creative thinking. The research was carried out in Yogyakarta, the subjects of this study amounted to 100 students from Madrasah Aliyah Province of the Special Region of Yogyakarta. Quantitative data

analysis techniques in analyzing the dimensions of mathematical creative thinking using lisrel 8.50 (Ghozali and Fuad 2008; Rumasoreng, Khuzaini, and Setiana 2021), this program was chosen because it has advantages in identifying relationships between complex variables (Ulya 2015), and can accommodate exogenous latent variables (Manaf and Christianti 2020). Collecting data using a google form-assisted questionnaire consisting of 29 Likert scale statements, the latent variable dimension of mathematical creative thinking consists of 4 observed variables: fluent thinking, flexible thinking, elaborating thinking, and evaluative thinking.

▪ RESULT AND DISSCUSSION

Description of mathematical creative thinking skills in general after the covid-19 pandemic is at a moderate level, in each dimension of smooth, flexible, elaborative and evaluative thinking respectively 89%, 92%, 90% and 91%, on the other hand flexible thinking, elaboration and evaluative at high level < 4%. Description analysis shows that at a high level of Evaluative and Elaborative thinking of 9%, fluent thinking is 8%, and flexible thinking is 5%. Descriptively the data shows that during the pandemic period students are still weak in mathematical creative thinking, while at the moderate level above 80%, it shows that almost most students have mathematical creative thinking skills but have not yet been optimized so that they are able to solve mathematical problems. This is in line with research (Payadnya & Suwija, 2021) which concludes that Covid-19 has had a major impact on students' thinking abilities.

The next analysis with CFA is to analyze the descriptive data above so that it is known which factors are more dominant in contributing and influencing the mathematical creative thinking variable. Qualitative analysis using CFA, with several indicators namely Elaborative Thinking, Evaluation, Flexible and fluent, > 0.3 indicates that each indicator can construct mathematical creative thinking variables. This can also be seen from the value of t > 1.96, indicating that the observed variable affects the latent variable, as shown in the figure below.



(a) (b)

Figure 2. Schematic diagram of (a) loading factor value of the test model, (b) t-value model test

In the Figure 2, it can be seen that the highest loading factor value is 0.86, which indicates that the elaboration indicator contributes to mathematical creative thinking by 86%, then sequentially evaluative thinking is 0.55, flexible thinking is 0.48, and fluent thinking is 0. 43. While the influence of each indicator on creative mathematical thinking is the most dominant is 6.88 elaboration thinking, then 4.87 evaluative thinking, 4.28 flexible thinking, and 3.04 fluent thinking. To determine the fit of the model using Absolute fit indices that fall into this category are the chi-squared test, GFI, AGFI, RMR, and SRMR (Hu & Bentler, 1999; Shevlin & Miles, 1998). table as follows.

Table 1. Absolute fit indices

No	Goodness of Fit	Hasil Analisis		
		Cut of Value	**Value**	**Decision**
1	Chi-Square	$\leq 2\ x\ df$ $\leq 2\ x\ 2$	5,22	Good
2	GFI	≥ 90	0.97	Good
3	NFI	≥ 90	0.92	Good
4	P Value	≥ 0.05	0.07	Good

The table above shows that the model has met the requirements for analysis of the results found.

The next stage is an analysis of elaborative thinking which is the most dominant indicator of its influence on mathematical creative thinking, to find out which sub-indicators contribute to and influence elaborative thinking so that they can map in more detail the state of mathematical creative thinking during the COVID-19 pandemic.

CFA analysis of Elaborative thinking based on the loading factor value in the image below

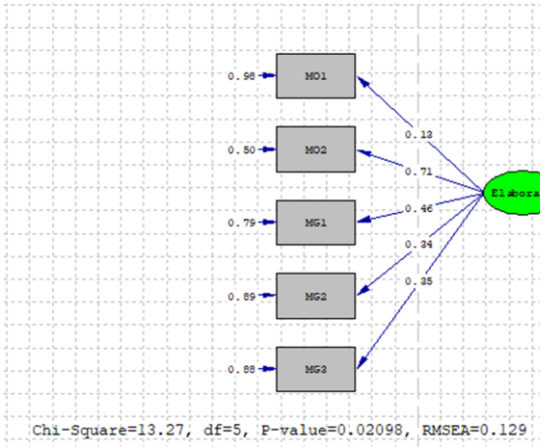


Figure 3a. of standard loading factor Model Test

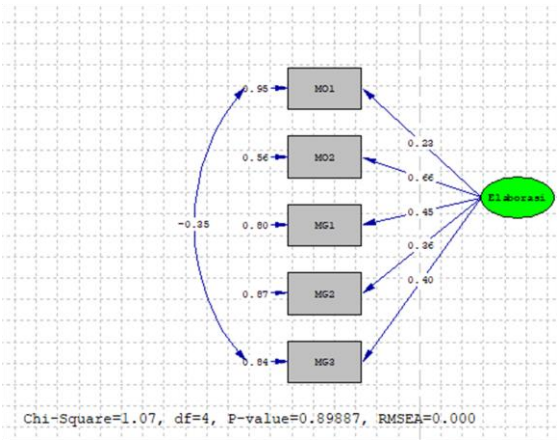
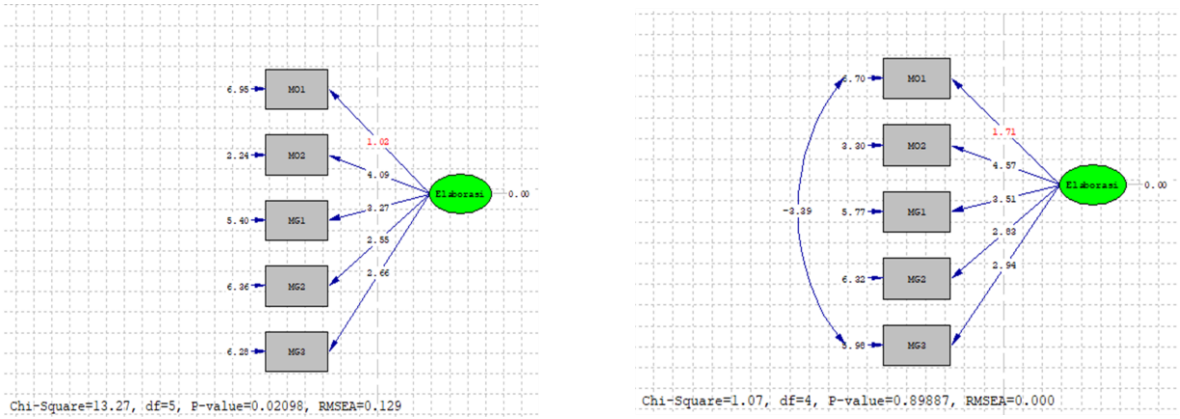


Figure 3b. of standard loading factor indicator MO1-MG3 Respecification

CFA analysis of Elaborative thinking based on the t-value in the image below



(a) (b)

Figure 4. Schematic diagram of (a) standard t-value model test, (b) standard t-value of MO1-MG3 indicator respecification

The following table shows the goodness of the fit Elaborative Thinking Variable, which shows the need for reanalysis to meet the standard fit model

Table 2. Goodness of fit variable

Size of GoF	Kriteria Fit	Analisis Awal	Reanalisis
Chi-Square	$\leq 2\ x\ df$	13,27 (df:5)	1,07 (df:4)
p	$p > 0{,}05$	0,02	0,89
RMSEA	$\leq 0{,}05$	0,13	0,000
NFI		0,64	0,97
NNFI		0,38	1,24
CFI	$\geq 0{,}90$	0,69	1,00
GFI		0,95	1,00
RFI		0,28	0,93
IFI		0,73	1,08

The table above shows that before the reanalysis, almost all the goodness of fit measures for the Elaborative Thinking Variable did not meet the standards for improving model fit by correlating between errors (Ghozali & Fuad, 2008). From the Figure 4, the MO1 loading factor value <0.3 and MO1 t-value <1.96 indicates that MO1 does not contribute to and influence elaborative thinking, while the loading factor value MO2, MG1-MG3> 0.3, and t value > 1.96 shows that these indicators contribute and affect elaborative thinking.

From the results of data analysis, it can be seen that mathematical creative thinking after the Covid-19 pandemic at a high level of < 4% needs to be improved, this is certainly inseparable from the impact of the Covid-19 pandemic so that it affects students' abilities and has an impact on learning completeness, as researches against the impact of the covid-19 pandemic, where mathematical literacy skills and learning achievement decline (Fahmy et al. 2021; Tambunan 2021), students' social interaction skills (Amri, Bahtiar, and Pratiwi 2020).

Further analysis using CFA can be seen that students' elaboration abilities in the dimension of mathematical creative thinking after the covid-19 pandemic still provide the largest contribution and influence on students' mathematical creative thinking abilities, it certainly cannot be separated from online learning during the covid-19 pandemic, where students asked to study independently by utilizing existing facilities so that some students' abilities increase during the pandemic, especially digital education (Amri et al. 2020; Hermawan 2020; Tambunan 2021).

▪ CONCLUSION

From the results of the analysis of creative thinking skills above, it shows that all indicators contribute to and influence, elaborative ability during the covid-19 pandemic, from the results of descriptive analysis, mathematical creative thinking ability > 80% in the medium category, of course, this is the impact of changes in learning during During the covid-19 pandemic (Rahayu et al., 2020), educational experiences have caused teachers' abilities to varying in online learning that demands mathematical creative thinking (Fakhrunisa & Prabawanto, 2020), learning methods that are able to foster mathematical creative thinking skills are still difficult to develop online. so it cannot provide feedback to students (Fakhrunisa & Prabawanto, 2020).

In all indicators, elaborative ability contributes the most dominant influence, this is due to several factors including a learning system that uses information systems so that management, efficiency and quality increase during the covid pandemic (Puangrimaggalatung, 2021), from the results of the analysis of elaborative abilities as well it can be seen that the ability to develop ideas during the pandemic has actually increased greatly, this is due to the demands of students to study independently (Sulistyowati & Amri, 2021; Akhdiyat & Hidayat, 2018), learning methods during the covid-19 pandemic tend to increase students' creativity In developing their ideas (Abdurrozak & Jayadinata, 2016; Ambarita, n.d.), on the other hand, detailing an object from student answers given to the teacher as an example does not affect students' elaborative thinking, one of the reasons is the inhibition of teacher and student interaction due to from weak p the use of information media and technology (Chusna & Utami, 2020).

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