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Mathematics education in the digital age: How to foster higher-order thinking skills?

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ABSTRACT

How technology and industrial change affect how well students do in school for the 4.0 level to be met, students must be able to use higher-order thinking and technological pedagogical content knowledge (TPACK). Students have difficulty using advanced technological tools when they need to think critically and artistically. So, students will only be able to learn higher-order thinking skills if they have TPACK. It is a common reason why people need to learn mathematics better in the current world. The purpose of this research was to help complete a structural model of TPACK and higher-order thinking skills for distance math learners. In a cross-sectional quantitative study, the data were looked at with structural equation modelling (SEM). For this study, 279 people from Universitas Muhammadiyah Purwokerto and Universitas Riau were chosen to participate. The study's structure model shows a powerful link between higher-order thinking skills and TPACK. As a result, secondary school mathematics educators can benefit from this study's findings by adopting fresh perspectives on TPACK and higher-order thinking.

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1. INTRODUCTION

In the past few years, the phrase "industrial revolution 4.0" has been used a lot. The internet, the creation of artificial intelligence, and the study of machines were all significant parts of the fourth industrial revolution [1]. Internet of things (IoT) means everything is done through the internet. The IoT networks are currently utilized in online travel, shopping, and education [2]. The IoT comprises many different networks [3]. When the IoT and data processing are used together, a new way of learning is created [4]. The new paradigm in question is how technology can help education.

Warner and Kaur [5] stated that to succeed in the information age and the fourth industrial revolution, today's students must be prepared to think critically and imaginatively. Genkin, Valenta, and Yarom [6] also stated that mastery of thought is essential for understanding to grow and for taking care of current responsibilities. This gives students a chance to improve their ability to think critically and creatively within the setting of higher-order thinking. Analyzing, evaluating, and creating are all examples of higher-order thinking demonstrating a student's ability to combine facts and ideas. Whether judging a fact they are learning about or using what they have learned to make something new. According to Maker, Jo, and

Muammar [7], when higher-order thinking skills are developed, students apply previously acquired knowledge and concepts in novel contexts to generate novel insights and perspectives.

According to previous studies, higher-order thinking skills are based on three main ideas about how people learn and think [8]–[10]. First, the different stages of thought and schooling are linked and depend on each other [11]. Second, you can improve your higher-order thinking skills and abilities by connecting what you learn in class and the natural world [8]. Third, higher-order thinking skills involve mental tasks in demanding and unsure situations [9].

Several researchers [12], [13] stated that the three steps of the thinking process could be used to identify students with higher-order thinking abilities in the educational setting. Since the quality of student thought is correlated with the quality of questions posed [12], [14], it is crucial to devise a method of education that propels pupils to greater heights. So, it is essential to choose learning activities that allow students to practice critical thought, analysis, filtering, learning improvement, feedback, and evaluation of their progress [15].

During the COVID-19 pandemic, one thing that can make it hard for students to learn mathematics is when they are expected to engage in analytical and imaginative thought, but need help using high levels of technology [16], [17]. When learning online, paying close attention to technological pedagogical content knowledge (TPACK) and higher-order thought skills is essential. Students need TPACK to know to think in more complex ways. In a "mathematics for industry" course, 11.35% of students dropped out, and the study could not explain the abstract thinking they had learned in class [18]. They need to know about ideas and TPACK to do well. Saedah [19] also found that 16.33% of students in the Faculty of Education at the University of North Sumatra needed help recognizing the value of higher-order thinking skills because their own developed critical and creative faculties could have been better. Other researchers [12], [14] found that between 15% and 20% of American students do not do well on tests of higher-order thinking skills when TPACK does not support online learning.

In other words, a student's proficiency in mathematics during the COVID-19 pandemic can be explained by their TPACK and other higher-order thinking skills. TPACK helps create a positive classroom environment by making it easier and faster for students to learn and use math through [20]. Also, students with higher-order thinking skills can use a broader range of their knowledge and experience to make good math decisions and create creative answers to problems they have never seen before [21].

Based on the results of several studies [22]–[24], the researcher has concluded that it takes much work to ensure that low TPACK is met in online learning. So, it may be hard for students to learn higher-order thought skills in school [25]. This shows how vital assistance is and how these three things can help students deal with this problem [26].

Instead, the creation of researchers will be able to answer better issues like, "How can students learn mathematics online during the COVID-19 pandemic emergency?" with the aid of the structural model and "Does the presence of the COVID-19 pandemic emergency influence TPACK and higher-order thinking skills in online mathematics learning?". The skeleton of this strategy is still relevant in modern-day online lecture halls. Therefore, this research aims to investigate the connection between TPACK and higher-order thinking skills and use the findings to develop a model for 21st-century students learning mathematics online.

2. RESEARCH METHOD

2.1. Research design

A model called a structural equation modelling (SEM) is used in the work. The SEM combines factor analysis from the measurement model and regression thinking from the structural model. The structural and measurement models show how factors and the things used to measure them are related. The structure model is based on statistics, while the measurement model is based on psychometrics [27]. In this study, a structure model was made to show how TPACK fits in with more complicated ways of knowing and thinking. It could be a cause or just something that makes a difference. A line with arrows at both ends shows that two variables are related, while an arrow at one end shows that one variable has an effect [28]. Figure 1 shows the link between TPACK and getting more advanced information.

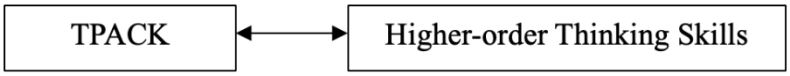

Figure 1. The principal relationship between constructs

2.2. Population and sample respondents

The study demographics comprised students from the Faculties of Teacher Training and Education at Universitas Muhammadiyah Purwokerto (UMP) and Universitas Riau (UNRI), Indonesia. The group comprises people who took an online math class during the 2020-2021 school year. These students participate in the math education study program's second, fourth, sixth, and eighth semesters. The number of students in this study's group was 279.

2.3. Data analysis

A structural equation modelling can examine several factors' real-time relationship [29]. SEM is a way to use statistics to look at a path structure with one or more characteristics [30]. This model can figure out how well something will do. This study looks at the link between information and communication technology (ICT) knowledge and TPACK, both critical to the success of classroom situations. SEM plans to look into how reliable it is and what problems it has later. This study used the computer program Statistical Product and service solutions-analysis of moment structures (SPSS-AMOS) to run SEM [31].

2.4. Data collection and measurement

Root mean square error of approximation (RMSEA), Chi-square statistics, adjusted goodness of fit index (AGFI), and goodness of fit index (GFI) all modify the goodness-of-fit (GOF) in SEM. GFI and AGFI values of more than 0.90 in each area of the evaluation show that the model made is good. The GFI and the AGFI can go as high as one at their highest point. Chi-square/df, on the other hand, is statistically significant (Chi-square/df>3.0). So, with an RMSEA of 0.08, the model is close to meeting the standards for the best model [32]. With a 95% level of statistical significance, the model and parameter values are checked to see if they differ from zero.

3. RESULTS AND DISCUSSION

3.1. Data respondents

Students from Universitas Muhammadiyah Purwokerto or Universitas Negeri Riau comprised 279 people in the study's sample group. There are 312 students at this school. Of those, 248 (or 88.89%) are male and 121 (or 11.11%) are female. There are 279 students still in school for all seven semesters. Of those 279, 28.67% are in the third semester, 36.93% are in the fifth semester, and 34.4% are in the seventh semester. If we look at where students live, 63.80% of them live in cities and only 36.2% live in rural places. Furthermore, there were two students use the internet for less than three hours a day, 242 students use the internet between three and five hours a day, and 35 use the internet for more than five hours a day.

3.2. Exploratory factor analysis

The study showed that both Kaiser-Meyer-Olkin (KMO) scores were above 0.50 on the TPACK and higher-order thinking skills construct questionnaires. This showed that the data did not have any significant problems with multicollinearity. Factor analyses could be done on the things that make up the construct. Since the result of 0.000 ($p<0.05$), the item passes the sphericity test according to Barlett; it can be used in a factor analysis as shown in Table 1.

Table 1. The structures of the exploratory factor analysis (EFA)

KMO measure and Barlett's test of sphericity		TPACK	Higher-order thinking skills
KMO measure of sampling adequacy		0.860	0.840
Bartlett's test of sphericity	Approx. Chi-square	3845.677	955.250
	Df	561	66
	Sig.	0.000	0.000

3.3. Confirmatory factor analysis

Cronbach's alpha is a safe way to determine how good the measurement model. They can only be determined if two other criteria are satisfied: average variance extracted (AVE) and composite reliability (CR). Each structure must have a Cronbach's alpha value of 0.7 or higher, a Cronbach's rho value of 0.6 or higher, and an average validity estimate of 0.5 or higher before a rating can be assigned. Following a confirmatory factor analysis (CFA), TPACK analysis, the following values were selected for the CR, AVE, and Cronbach's alpha. The TPACK construct's reliability estimates (CR, AVE, and Cronbach's alpha) are provided in Table 2.

The CFA showed that TPACK comprises seven sub-constructs. The CK has five items (Tpack9, Tpack12, Tpack15, Tpack22, and Tpack23). The TK has four items (Tpack5, Tpack6, Tpack17, and Tpack21). The TPK has 7 items (Tpack1, Tpack2, Tpack3, Tpack4, Tpack27, Tpack28, and Tpack29). The TPACK is made up of four parts, which are (Tpack7, Tpack8, Tpack10, and Tpack11). Because some eigenvalues did not meet the requirements (e=0.4), the CFA analysis had to move on to the second analysis. Because of this, some parts like Tpack13 (e=0.21), Tpack 16 (e=0.15), and Tpack 28 (e=0.21) were left out. Figure 2 shows the last time the CFA model of TPACK was changed.

Table 2. The CFA of CR, AVE, and Cronbach's alpha numbers for TPACK

Constructs	Item	Factor loading	CR>0.6	AVE>0.5	Cronbach's alpha>0.70	Decision
Content knowledge (CK)	Tpack9	0.673	0.783	0.587	0.893	Significant
	Tpack12	0.783				
	Tpack15	0.763				
	Tpack22	0.652				
	Tpack23	0.583				
Technological knowledge (TK)	Tpack5	0.783	0.673	0.568	0.876	Significant
	Tpack6	0.639				
	Tpack17	0.642				
	Tpack21	0.742				
Pedagogical knowledge (PK)	Tpack1	0.674	0.639	0.538	0.863	Significant
	Tpack2	0.672				
	Tpack3	0.784				
	Tpack4	0.633				
	Tpack27	0.623				
	Tpack29	0.748				
Technological pedagogical knowledge (TPK)	Tpack24	0.632	0.784	0.583	0.786	Significant
	Tpack25	0.633				
	Tpack26	0.782				
	Tpack33	0.572				
	Tpack34	0.733				
Technological content knowledge (TCK)	Tpack30	0.633	0.644	0.588	0.873	Significant
	Tpack31	0.632				
	Tpack32	0.783				
Pedagogical content knowledge (PCK)	Tpack14	0.663	0.672	0.673	0.775	Significant
	Tpack18	0.573				
	Tpack19	0.773				
	Tpack20	0.653				
TPACK	Tpack7	0.667	0.674	0.633	0.733	Significant
	Tpack8	0.663				
	Tpack10	0.673				
	Tpack11	0.676				

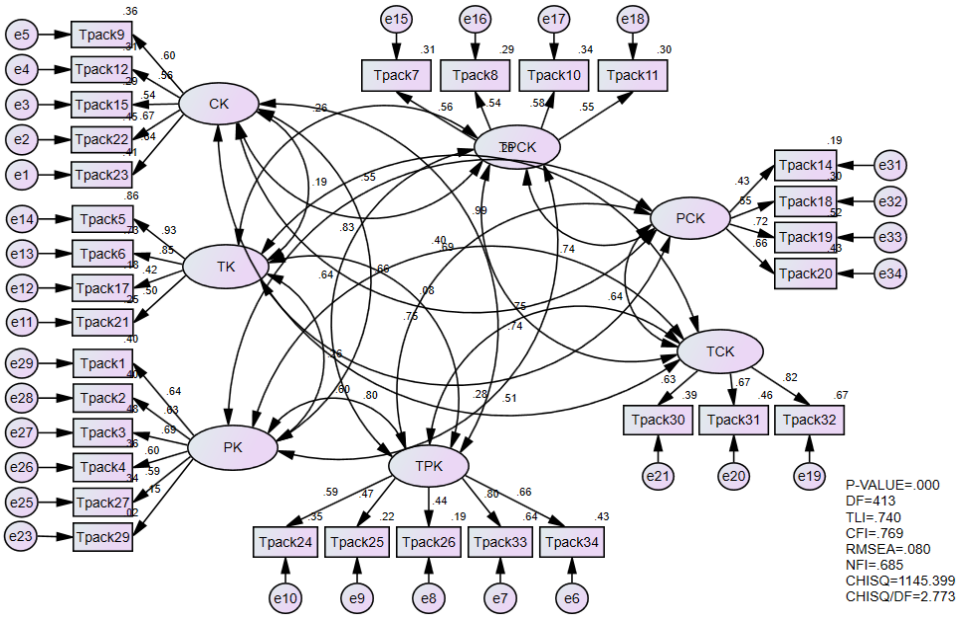

Figure 2. CFA model of higher-order thinking skills

On the other hand, the CFA analysis says that the three parts of higher-order thinking skills/PLT are analysis, review, and creation. The first building block is analyzed (AN). There are four things in the AN section (Plt1, Plt2, Plt4, Plt9, Plt10, Plt11, Plt12), four things in the evaluate (EV) section (Plt9, Plt10, Plt11, Plt12), and four things in the create (CR) section (Plt5, Plt6, Plt7, Plt8). Also, the CFA analysis went on to the next step because some eigenvalues had to be less than 0.4 to meet the criteria. So, Plt3 (e=0.34) cannot be right. Figure 3 shows higher-order CFA model completion. Then, the study of higher-order thinking skills (CFA) was continued to find the CR, AVE, and Cronbach's alpha values (Table 3).

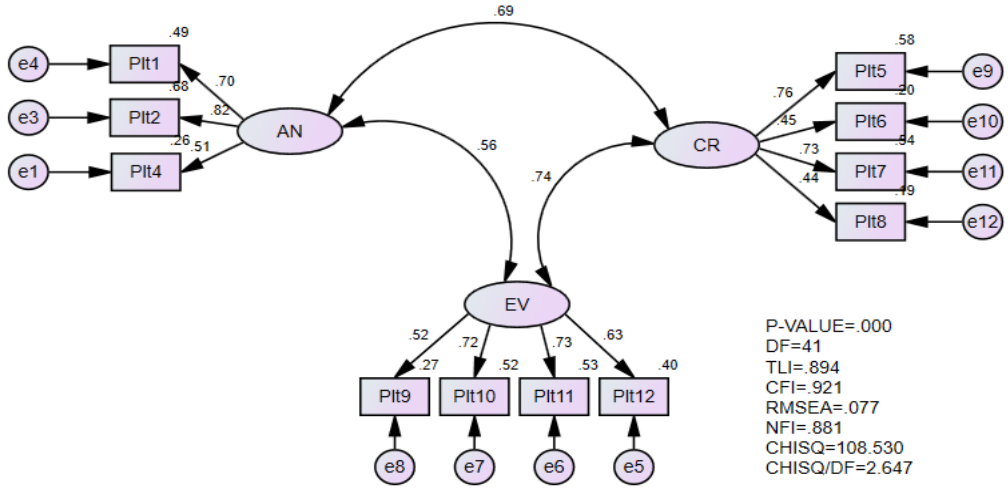

Figure 3. Higher-order thinking skills as shown by the CFA model

Table 3. The scores of CFA on higher-order thinking skills

Constructs	Item	Factor loading	CR>0.6	AVE>0.5	Cronbach's alpha>0.70	Decision
AN	Plt 1	0.887	0.633	0.664	0.779	Achieved
	Plt 2	0.784				
	Plt 4	0.767				
EV	Plt 9	0.674	0.783	0.539	0.897	Achieved
	Plt 10	0.776				
	Plt 11	0.762				
	Plt 12	0.663				
CR	Plt 5	0.876	0.794	0.673	0.887	Achieved
	Plt 6	0.766				
	Plt 7	0.688				
	Plt 8	0.632				

3.4. Structural equation modelling

In the meantime, the trustworthiness of validation or SEM depends on three things: being one-dimensional, valid, and reliable. A pooled CFA must be done first to assess the structural model in a way that meets these three conditions. The dimensions are consistent when the loading factor for each item and measure is more than 0.6. This is one way to get to this result. This EFA study could show that there is convergent validity, construct validity, or biased validity. We will babble about these kinds of validity in more detail. When every part of the equation model is statistically confirmed using the AVE value, this is called "convergent validity." All items should have the same value to ensure the measurement model is correct.

GOF values demonstrated construct validity, while the absence of items measuring the same two constructs demonstrated biases in the measurement model. The fit indicator number (GOF) was used to determine whether these two claims were true. If the value of the relationship between two external constructs is less than 0.4, then discrimination holds [33]. Figure 4 shows the finished SEM and thoroughly explains what each part does. Based on the results of the SEM model analysis, the analysis was done to figure out which SEM model was the best. In Table 4, all of the results of the relationships between the two categories are shown.

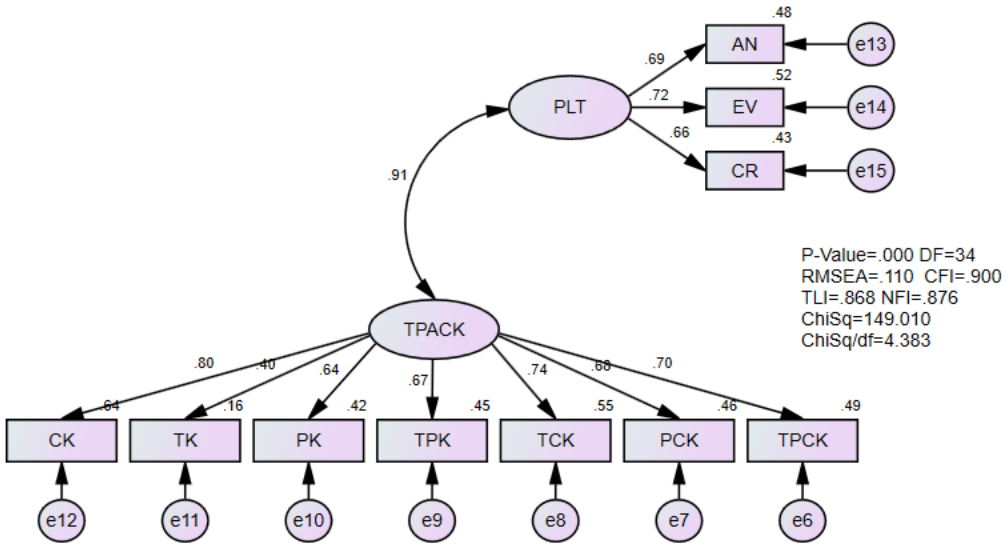

Figure 4. Higher-order thinking skills and TPACK are modelled by a set of equations

Table 4. Higher-order thinking skills and TPACK were looked at with SEM

Sub-constructs			β	SE	CR	p	Decision
AN	←	PLT	0.692	0.484	1.909	0.056	Significance
EV	←	PLT	0.723	0.522	2.430	0.000	Significance
CR	←	PLT	0.663	0.431	3.401	0.004	Significance
CK	←	TPACK	0.793	0.644	0.498	0.618	Significance
TK	←	TPACK	0.402	0.464	2.529	0.011	Significance
PK	←	TPACK	0.644	0.421	2.434	0.015	Significance
TPK	←	TPACK	0.672	0.452	3.099	0.002	Significance
TCK	←	TPACK	0.743	0.550	3.097	0.002	Significance
PCK	←	TPACK	0.683	0.462	2.409	0.042	Significance
TPACK	←	TPACK	0.703	0.492	3.915	0.000	Significance

For this discussion, the value of the connection is put into three groups: low, medium, and high [34]. Connections with less than 0.10 have low values, connections between 0.10 and 0.50 have middle values, and connections with more than 0.50 have high values. The study showed that there was a moderate correlation (0.010). The SEM study showed a correlation of=0.912, which is statistically significant.

4. CONCLUSION

Students at Universitas Muhamamdiyah Purwokerto and Universitas Riau majoring in mathematics education were surveyed for this study feel about the growth of TPACK and the learning of higher-order thinking skills. The results of this study could lead to new ways of thinking about mathematics, which would give high school students more opportunities to learn mathematics and help them develop TPACK and higher-order thinking skills. More study is needed to understand the causes and effects of the COVID-19 pandemic fully and to find out the latest information about the factors that affect how well people learn.

Education is always changing to meet the needs of modern society and keep up with the growing complexity of science and technological advances. In the same way, the education field needs to pay close attention to even the smallest changes and improvements in science and technology. This is a necessary first step that must be taken. Given the situation, the job of the teacher is an important one. Lecturers or professors must always work to broaden their views and improve their skills because they are at the front lines of education.

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REFERENCES

[1] C. S. Patil, R. R. Karhe, and M. A. Aher, "Development of mobile technology: a survey," *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, vol. 1, no. 5, pp. 374–379, 2012.

[2] E. Bolat, "Why to Use Mobile Technology?" *Journal of Educational Computing Research*, vol. 4, no. 20, pp. 445–459, 2019.

[3] H. T. Mashrah, "The impact of adopting and using technology by children," *Journal of Education and Learning (EduLearn)*, vol. 11, no. 1, pp. 35–40, Feb. 2017, doi: 10.11591/edulearn.v11i1.5588.

[4] J. Traxler, "Students and mobile devices," *ALT-J: Research in Learning Technology*, vol. 18, no. 2, pp. 149–160, Jul. 2010, doi: 10.1080/09687769.2010.492847.

[5] S. Warner and A. Kaur, "The perceptions of teachers and students on a 21st century mathematics instructional model," *International Electronic Journal of Mathematics Education*, vol. 12, no. 2, pp. 193–215, May 2017, doi: 10.29333/iejme/609.

[6] D. Genkin, L. Valenta, and Y. Yarom, "May the Fourth Be With You: A Microarchitectural Side Channel Attack on Several Real-World Applications of Curve25519," in *Proceedings of the 2017 ACM SIGSAC Conference on Computer and Communications Security*, New York, NY, USA: ACM, Oct. 2017, pp. 845–858. doi: 10.1145/3133956.3134029.

[7] C. J. Maker, S. Jo, and O. M. Muammar, "Development of creativity: the influence of varying levels of implementation of the DISCOVER curriculum model, a non-traditional pedagogical approach," *Learning and Individual Differences*, vol. 18, no. 4, pp. 402–417, Oct. 2008, doi: 10.1016/j.lindif.2008.03.003.

[8] W. Trisnawaty, A. Citrasukmawati, and M. A. Thohir, "Self assessment for student performance based on higher order thinking skills in physics learning," *Journal of Education and Learning (EduLearn)*, vol. 11, no. 4, pp. 446–452, Nov. 2017, doi: 10.11591/edulearn.v11i4.6456.

[9] Z. Schlesinger and W. I. Wang, "Higher order thinking skills and the evolution of learning technology in the 21 century," *Journal for Research in Mathematics Education*, vol. 4, no. 3, pp. 15–28, 2019.

[10] C. Hosmer, C. Jeffcoat, M. Davis, and T. McGibbon, "Use of Mobile Technology for Information Collection and Dissemination," A DACS Technology Assessment Report, 2011. [Online]. Available: https://csiac.org/state-of-the-art-reports/use-of-mobile-technology-for-information-collection-dissemination.

[11] R. P. Yudha, "Higher Order Thinking Skills (HOTS) Test Instrument: Validity and Reliability Analysis with The Rasch Model," *Eduma: Mathematics Education Learning and Teaching*, vol. 12, no. 1, p. 21, Jun. 2023, doi: 10.24235/eduma.v12i1.9468.

[12] P. Eynde and E. Corte, "Students' higher order thinking and achievement for mathematics learning," *Journal of Advanced Research Design*, vol. 4, no. 2, pp. 23–37, 2020.

[13] J. Traxler, "Students and mobile devices," *ALT-J: Research in Learning Technology*, vol. 18, no. 2, pp. 149–160, 2019, doi: 10.1080/09687769.2010.492847.

[14] C. M. Crane, "Teacher perceived impact of technology on elementary classrooms and teaching," Ph.D. Dissertation, University of Missouri, 2005.

[15] K. Changwong, A. Sukkamart, and B. Sisan, "Critical thinking skill development: analysis of a new learning management model for Thai high schools," *Journal of International Studies*, vol. 11, no. 2, pp. 37–48, Jun. 2018, doi: 10.14254/2071-8330.2018/11-2/3.

[16] H. M. Alakrash and N. A. Razak, "Education and the fourth industrial revolution: lessons from COVID-19," *Computers, Materials & Continua*, vol. 70, no. 1, pp. 951–962, 2022, doi: 10.32604/cmc.2022.014288.

[17] L. Richard, "Covid-19 and its reformation education caused," *Journal Basic of Education*, vol. 2, no. 31, pp. 44–59, 2020.

[18] E. Lopez-Caudana, M. S. Ramirez-Montoya, S. Martínez-Pérez, and G. Rodríguez-Abitia, "Using robotics to enhance active learning in mathematics: A multi-scenario study," *Mathematics*, vol. 8, no. 12, pp. 1–21, 2020, doi: 10.3390/math8122163.

[19] K. Saedah, "High-level learning in student mathematics learning in Medan Region, North Sumatra," (in Indonesian), *Jurnal Ilmiah Pendidikan Matematika*, vol. 3, no. 1, pp. 331–346, 2019.

[20] S. Booker, "The evolution of pre-service teachers TPACK after completing an undergraduate technology integration course," Ph.D. Dissertation, Kennesaw State University, 2017.

[21] B. R. Lamichhane, "TPACK about Mathematics and Instructional Practices," *Journal for Research in Mathematics Education*, vol. 8, pp. 14–22, 2018.

[22] D. Maesuri, "Technological pedagogical content knowledge (TPACK) among secondary school mathematics teachers in Manado," (in Indonesian), *Jurnal Sains dan Matematik*, vol. 31, no. 2, pp. 1–19, 2018.

[23] N. Othman and S. M. Maat, "TPACK framework based research in mathematical education: a systematic literature review," *International Journal of Academic Research in Progressive Education and Development*, vol. 9, no. 2, pp. 136–142, Jun. 2020, doi: 10.6007/IJARPED/v9-i2/7284.

[24] N. Supriatna and M. Winarti, "Enhancing Higher Order Thinking Skills through Utilization of Technology in Social Studies," *SHS Web of Conference*, vol. 01018, no. 149, pp. 11–15, 2022.

[25] Y. Setiyowati and A. Shodikin, "Analysis of Students Critical Thinking Ability in Solving HOTS (Higher-Order Thinking Skills) Problems with Creative Problem-Solving Model," *Jurnal Inovasi Pendidikan dan Pembelajaran Matematika*, vol. 8, no. 1, pp. 13–20, 2022.

[26] P. Johnson, J. V. Freemyer, and O. Fitzmaurice, "The perceptions of Irish mathematics teachers toward a curriculum reform 5 years after its implementation," *Frontiers in Education*, vol. 4, no. 13, pp. 1–11, Mar. 2019, doi: 10.3389/feduc.2019.00013.

[27] R. B. Kline, *Principles and practice of structural equation modeling*. New York: Guilford Publications, 2017.

[28] B. M. Byrne, *Structural equation modeling with AMOS: basic concepts, applications, and programming*. New York: Routledge, 2010.

[29] J. W. Creswell, *Research design: qualitative, quantitative, and mixed methods approaches*. Thousand Oaks: SAGE Publications, 2014.

[30] J. de Carvalho and F. O. Chima, "Applications of structural equation modeling in social sciences research," *American International Journal of Contemporary Research*, vol. 4, no. 1, pp. 6–11, 2014.

[31] H. Harahap, D. Andriani, and H. Oemar, "Structural equation model to measure the leveraging factors of research productivity in private universities: lecturers' perceptions," *International Journal of Scientific Research and Management*, vol. 8, no. 10, pp. 1964–1982, Oct. 2020, doi: 10.18535/ijsrm/v8i10.em02.

[32] J. F. Hair, W. C. Black, B. J. Babin, and R. E. Anderson, *Multivariate data analysis*, 7th ed. Pearson Education Limited, 2013.

[33] B. G. Tabachnick and L. S. Fidell, *Using multivariate statistics*. Pearson Education, 2013.

[34] L. Cohen, L. Manion, and K. Morrison, *Research methods in education*, 6th ed. London: Routledge, 2007.

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