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TPACK Towards ICT Integration: Does Creativity Have a Moderating Effect?

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ABSTRACT

This study aimed to examine the effect of the Technological Pedagogical and Content Knowledge (TPACK) framework on Information and Communication Technology (ICT) integration in Indonesia, moderated by creativity. The data for this study were obtained from respondents comprising 405 economics teachers using voluntary sampling techniques. The survey method was used for this quantitative research, conducted by distributing questionnaires to the respondents. The questionnaire was developed according to the current condition and the data met the requirements for the confirmatory analysis test. Inferential analysis using structural equation modelling with a moderating effect showed that TPACK has a positive and significant effect on ICT integration (β = 0.143, p = 0.008<0.05). The interaction of creativity with TPACK has no positive and significant effect on ICT integration (β = -0.037, p = 0.238>0.05). Creativity has a positive and significant effect on ICT integration (β = 0.513, p = 0.00<0.05). Based on the results of the study, creativity is not a pure moderator but rather a moderator predictor, which means it acts as a predictor or mediator variable. This study provides useful information that can be used as a guide in enabling teachers to increase their creativity or as the basis for further research to measure teacher creativity as either a predictor or mediator variable.

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1. INTRODUCTION

The Covid-19 era has presented a unique and challenging opportunity, forcing teachers to operate outside their comfort zone and employ the available information and communication technology (ICT) as a channel and resource of communication (Chick et al., 2020; Simó, Hartmann, & Reinke, 2020). The pandemic has nevertheless provided teachers with opportunities to develop their skills, particularly by incorporating ICT into online or virtual learning (Bakioğlu & Çevik, 2020; Spoel, Noroozi, Schuurink, & Ginkel, 2020). The results of a survey by the Ministry of Education and Culture showed that more than 80% of teachers in Indonesia use only social media to communicate with their students (Retnawati, 2020a). Previous studies have shown that 84% of Indonesian online learners use only WhatsApp as a group messaging platform, which supports this finding (Lie et al., 2020). For the majority of teachers, the role of ICT integration is complicated and challenging, meaning that adequate understanding is required of the knowledge model that incorporates ICT in virtual learning during the Covid-19 era or pandemic, namely the Technological Pedagogical and Content Knowledge (TPACK) framework (Gao & Zhang, 2020; Nasri, Husnin, Mahmud, & Halim, 2020). Teachers employing TPACK as their framework for learning can incorporate ICT into their learning activities (Carpendale, Delaney, & Rochette, 2020). The Ministry of Education and Culture has provided guidance on ICT-based learning techniques, referred to as "*PembaTIK"* and available from https://simpatik.belajar.kemdikbud.go.id/, with the aim for teachers to optimise the use of ICT in learning with the TPACK approach (Yanuarti, Atiko, & Hastomo, 2021). To explore ICT, it is necessary to interact with teacher creativity on TPACK (Koehler et al., 2011). Teachers can design ICT in learning with specific knowledge covering subject matter/content, pedagogy and technology and must also draw on creativity to find new ways of integrating ICT (Koehler et al., 2011). However, there has been relatively little study of how TPACK affects ICT integration (Reyes, Reading, Doyle, & Gregory, 2017), and while there have been numerous studies on creativity, few have focused on creativity in learning (Henriksen, Mishra, & Fisser, 2016). The results of previous studies have nevertheless highlighted that TPACK has a positive effect on teachers' ability to integrate

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ICT in learning practices with a β value = 0.354 and p-value < 0.01 (Habibi, Yusop, & Razak, 2020). In accordance with the findings of earlier studies, TPACK has no impact on intentions to use technology with a β value = 0.00, t = 0.000 and p-value > 0.05 (Joo, Park, & Lim, 2018). Teachers must have creativity in order to create learning with the TPACK framework (Chai, Koh, & Tsai, 2013). It is therefore essential to determine the relationship between creativity and TPACK and the effect on ICT integration.

Information Communication and Technology Integration (ICT Integration)

ICT integration involves the technology used by teachers during learning practices (Habibi et al., 2020). The Ministry of Education and Culture detailed the following types of ICT intended for use in learning practices: social media platforms including WhatsApp, Facebook, and Messenger; telephones; SMS; learning management systems (LMS) such as Indonesia's Rumah Belajar Maya Class, Quipper Schools, Moodle, Google Classroom, and the school's own platform; video conferencing tools including Zoom, Skype, and Google Meet; email; home visits by teachers and vice versa, and Google Forms (Retnawati, 2020a). When implementing technology in the classroom, teachers should consider its disadvantages, such as poor video quality, network connectivity issues, or operators who lack technical expertise (Sucipto, Efendi, Hanif, & Budiyanto, 2017). The types of ICT integration examined in this study are categorised in Table 1:

Table 1. ICT Used during Online Learning

Indicators	Description
Learning preparation-based ICT	ICT such as Google Classroom, Edmodo, Zoom, Moodle, Schoology, WhatsApp group, and other educational websites or applications using the internet and the Google search engine to find additional content on the economics subject.
Learning process-based ICT	ICT for implementing virtual learning and the sharing of economics subject content with learning methods and models, such as Google Classroom, Edmodo, Zoom, Moodle, Schoology, and WhatsApp groups.
Learning evaluation-based ICT	Employing ICT such as Google Forms, Typeforms, Planetary Surveys, or other online assessment platforms to conduct student assessments and evaluations.

Technological Pedagogical and Content Knowledge (TPACK)

TPACK refers to the types of knowledge that teachers draw on to teach using technologies. It reflects how knowledge of technology alone is insufficient and that overall, knowledge and insight combined will underpin future actions to integrate ICT (Voogt, Fisser, Tondeur, & Braak, 2016). Teachers must pursue learning based on the TPACK framework, which comprises technological, pedagogical and content knowledge, because education developed in line with the TPACK structure helps students to acquire leading 21st-century abilities (Cherner & Smith, 2016).

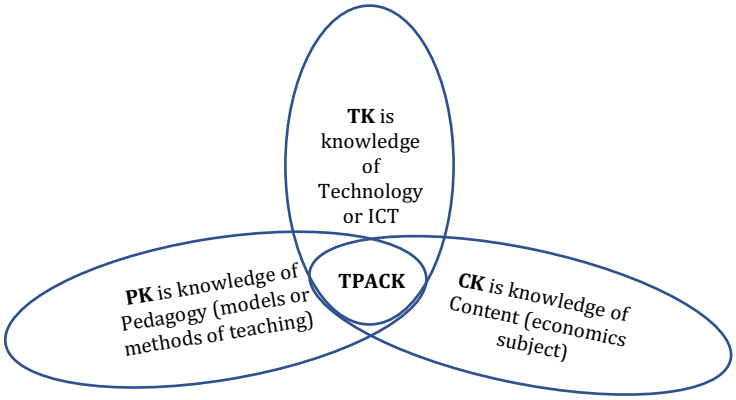

Figure 1. TPACK Mapping

Teacher Creativity

Creativity was originally thought to be genetically innate to individuals. However, with the evolution of research, creativity is now understood as a construction related to intelligence that is unique and different depending on human experience and can be developed further (Sharma & Sharma, 2018). Teachers play a crucial role in promoting students' creative thinking skills by encouraging their creativity, which is why teachers must also be

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creative in the first place. Creativity is a crucial skill that students must develop in the twenty-first century (Akyıldız & Çelik, 2020; Hung & Sitthiworachart, 2019; Rubenstein, McCoach, & Siegle, 2013). ICT integration requires creativity as a skill to develop original and new ideas or to consider such concepts in innovative ways and develop them into products, services or processes (Laar, Deursen, Dijk, & Haan, 2017). To integrate ICT, it is therefore necessary to leverage both teachers' creativity and TPACK (Wilkin, Rubino, Zell, & Shelton, 2013). Furthermore, innovations in teaching will undergo a process of adaptation (adaptation process) to meet the technical standards, productivity and social influence of technology applications (Handoko, 2017).

Study and Hypotheses

A review of the literature revealed the existence of an interaction between creativity and TPACK in ICT integration. However, it also highlighted differences in previous studies and exposed a research gap, thereby providing the basis upon which to conduct further research.

TPACK has been shown to affect the use of ICT with $p<0.05$ (Habibi, Yusop, & Razak, 2019), while the TPACK framework has also been reported to ease the burden on teachers to use ICT (Dong, Xu, Chai, & Zhai, 2019; Özgür, 2020). The results of other studies, meanwhile, have shown that TPACK does not affect intentions to use ICT (Joo et al., 2018). Further examination of these research gaps is required, which leads to the proposal of the following hypothesis:

Hypothesis 1: TPACK has a positive effect on ICT integration.

To create learning using the TPACK framework, teachers are assumed to possess creativity (Chai et al., 2013). Creativity exists at the intersection of content, pedagogy, and technology, which is also where tools and technology can be creatively reused (Koehler et al., 2011). In educational contexts, it is crucial to investigate how creativity construction and technology integration are related (Henriksen et al., 2016). The following hypothesis is therefore proposed:

Hypothesis 2: The interaction of creativity with TPACK has a positive effect on the integration of ICT.

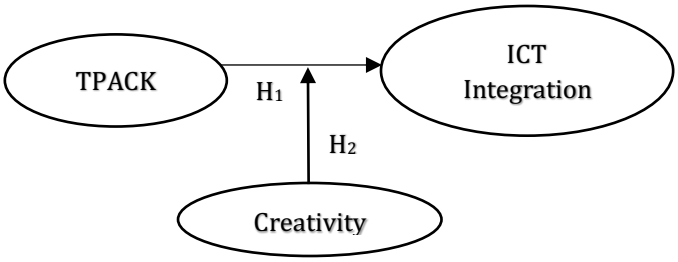

Figure 2. Conceptual Model

2. MATERIALS AND METHODS

The research methods outlined as follows explain the design, research sample, data collection, and data analysis:

Research Design

This study employs survey methods, inferential data analysis, and quantitative techniques. Confirmatory factor analysis (CFA) and structural equation modelling (SEM) were used to analyse the data, and SmartPLS 3.3.3 was used as the analysis tool. The instrument used comprised a 16-item survey with a 6-point Likert scale (1 – Strongly Agree, 2 – Agree, 3 – Slightly Agree, 4 – Slightly Disagree, 5 – Disagree, 6 – Strongly Disagree). To collect sufficient information to process and conduct the research, a voluntary online sampling process was conducted using Google Forms and distributed via social media to respondents within Indonesia. This was in line with the methods used in previous studies (Alharbi, 2019; Castéra et al., 2020; Mulyadi, Wijayatingsih, Budiastuti, Ifadah, & Aimah, 2020; Oakley, 2020; Prasojo et al., 2020; Sanchez & Trigueros, 2020). This research takes the form of a

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teacher self-assessment designed to measure the actual situations they face (Voogt, Fisser, Roblin, Tondeur, & Braak, 2012).

Research Sample

A total of 405 economics teachers responded, from the areas displayed in Figure 3. The respondents comprised 283 women and 122 men. In terms of the age of the respondents, 40 were aged between 21 and 30; 63 were between 31 and 40 years of age; 165 were between 41 and 50 years of age, and 137 were aged over 50. A total of 313 public and 93 private schools were represented. In terms of the number of years of teaching experience, 38 respondents had one to five years' experience, 28 had six to ten years, 67 had eleven to fifteen years, 132, and 140 respondents had over twenty years' experience. Concerning their educational background, up to 315 respondents held a bachelor's degree, while 90 had a master's degree. Based on certification ownership, a total of 331 respondents were certified and 74 were not.

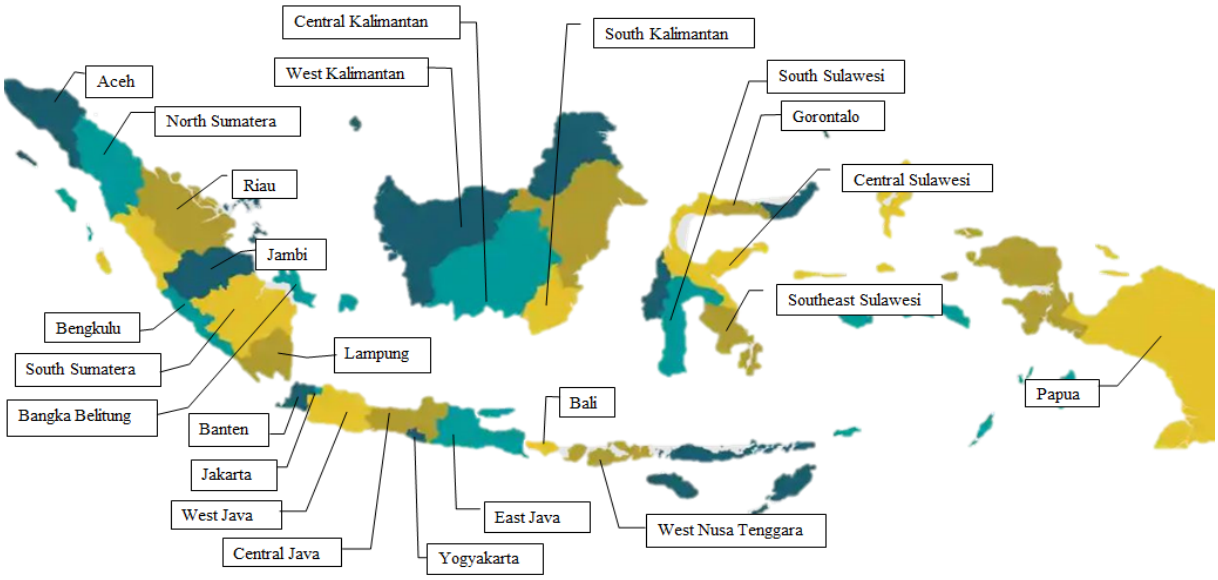

Figure 3. Distribution of Respondents' Area

Data Collection Instrument

The survey questions used in this study were adapted from those used in earlier research and adjusted and modified in light of the circumstances at hand. TPACK comprises two items (Barišić, Divjak, & Kirinić, 2017; Castéra et al., 2020; Habibi et al., 2020; Schmid, Brianza, & Petko, 2020). The creativity construct consists of four indicators: creative thinking, creative mindset, creative teaching, and creative learning, each of which has two items (Chao et al., 2010; Karwowski, 2014; Kumar, Kemmler, & Holman, 1997; Vasudevan, 2013). The ICT integration construct is made up of three indicators: learning preparation, learning process, and learning evaluation-based ICT, each of which contains two items (Habibi et al., 2020; Hsu, 2017; Türel, Özdemir, & Varol, 2017).

Data Analysis

Based on the findings of the CFA, data analysis was performed to test the indicators using measures of construct reliability (Cronbach's alpha and composite reliability), convergent validity (outer loadings), discriminant validity (cross-loadings), and goodness of fit such as SRMR, d_ULS, d_G, NFI and RMS Theta measurements, as well as SEM, to test the hypotheses or structural validity (t-statistic and p-value). Table 2 displays the determination of the type of moderation for the creative variable concerning the moderating variable cutoffs (Ghozali, 2018).

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Table 2. Moderating Variable Cut-Off

Order	Moderation Type	Moderating Variable	Moderation Effect
1	Pure moderation	x	√
2	Moderation potential	x	x
3	Quasi-moderation	√	√
4	Moderation predictor	√	x

Notes: √ is an effect; x is no effect

In this study, the moderating variable is teacher creativity (Z), while the moderating effect is the interaction between TPACK as an independent variable (X) and creativity (Z) on the ICT integration variable (Y). A pure moderator is really a moderator variable. Moderation potential is also called the homologise moderator, which means the variable has the potential to be a moderating variable. Quasi-moderation is also termed pseudo-moderation or specifically, a variable that is both the independent variable and a moderator of the link between the independent and dependent variables. The moderating predictor, namely the moderating variable in question, is not a moderator variable but rather acts as a predictor variable or independent, exogenous or antecedent in the model formed, in addition to being an independent variable, according to Ghozali (2018); it can also be an intervening or mediator variable.

3. RESULTS AND DISCUSSION

RESULTS

This section presents the findings from the analysis of the research data, which is divided into the discussion section, moderating variable cut-off, goodness of fit, SEM, and CFA.

Confirmatory Factor Analysis (CFA)

The item is valid if the outer loading factor value is greater than 0.7, as indicated by the cross-loading value. This also shows that the indicator's correlation with its variables must be higher than that of other variables; hence, a composite reliability score of 0.6 is acceptable alongside a Cronbach's alpha value of at least 0.7 (Sarwono & Narimawati, 2015). The outer loading values indicate that items Z2, Z4, Z8 and Y1 are less than 0.7; they were thus removed from the model. The cross-loading values show that all items met the validity requirements, whereby the correlation between the indicator and its variables must be higher than that of the other variables. Additionally, the reliability test satisfied the criteria for a Cronbach's alpha greater than 0.7 and a composite reliability value greater than 0.6. The fit test, or the Goodness of Fit (GoF) test, was performed next.

Table 3. Outer Loadings

Construct	Items	Code	Value
TPACK	I know how to combine knowledge from the subject matter, online classroom technology, and teaching methods to conduct online learning.	X1	0.927
	I know how to convey the subject of economics with the online lecture / discussion / question-and-answer method assisted by Zoom Meet, Google Meet, WhatsApp, Skype, etc.	X2	0.935
Creative Thinking	I tend to encourage students to actively ask and be able to answer the questions I ask about economics when learning online later.	Z1	0.708
	I usually produce assignments based on additional material that I get from the internet/other sources that can encourage students to study independently during online learning.	Z2	0.678
Creative Mindset	I usually practise using G-Classroom / Edmodo / Zoom / Moodle / Schoology / WhatsApp or other educational sites/apps referred by the school so that I can do online learning smoothly.	Z3	0.760
	I tend to be diligent in designing lesson plans using G-Classroom, Edmodo, Zoom, Moodle, Schoology, WAG, and online learning sites/apps so that students can easily follow learning.	Z4	0.691
Creative Teaching	I usually deliver the economics subject by displaying MS PowerPoints while lecturing and asking questions to address students' different learning styles via Zoom or other online apps.	Z5	0.709
	I tend to use more than one online class site/application (such as combining WhatsApp and Google Classroom) to ensure each student gets information/economics course material.	Z6	0.723
Creative Learning	I usually create new teaching ideas using online classroom sites/apps by modifying (replacing, rearranging, elaborating, etc.)	Z7	0.756
	I usually do a lot of experimentation (trial and error) to obtain the right teaching method by using an online class site/application that can easily be applied to online learning.	Z8	0.687

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Construct	Items	Code	Value
Preparation	I use the internet and access google.com to find additional material on economics.	Y1	0.662
	I determine the learning technology before online classes, including Google Classroom, Edmodo, Zoom, Moodle, Schoology, WhatsApp group, and other educational sites/applications.	Y2	0.826
	I determine the learning technology before online classes, including Google Classroom, Edmodo, Zoom, Moodle, Schoology, WhatsApp group, and other educational sites/applications.	Y2	0.826
Process	I use PowerPoint to present the economics subject shared via G-Classroom / Moodle / Edmodo / Schoology / Zoom Meet / WhatsApp / other educational sites / apps referenced by the school.	Y3	0.772
	I use Google Classroom / Moodle / Edmodo / Schoology / Zoom Meet / WhatsApp / etc. to conduct online learning with lectures, and discussions or to respond to questions asked by students.	Y4	0.767
Evaluation	I do an online assessment of student learning outcomes using Google Forms / Typeform / Planet Survey or other online assessment sites.	Y5	0.812
	I follow up the scores under the Minimum Completeness by giving independent assignments designed to improve student understanding through Google Classroom / other online apps / sites.	Y6	0.732

Table 4. Cross Loading Value

Codes	ICT Integration	Creativity	TPACK	Valid
Y2	0.826	0.598	0.506	√
Y3	0.772	0.557	0.441	√
Y4	0.767	0.589	0.428	√
Y5	0.812	0.582	0.460	√
Y6	0.732	0.526	0.449	√
Z1	0.484	0.708	0.508	√
Z3	0.554	0.759	0.540	√
Z4	0.508	0.710	0.526	√
Z6	0.530	0.720	0.489	√
Z7	0.534	0.761	0.599	√
X1	0.490	0.657	0.926	√
X2	0.577	0.706	0.935	√

Table 5. Reliability Test

Variables	Cronbach's Alpha	Composite Reliability	Reliable
ICT Integration	0.856	0.893	√
Creativity	0.863	0.893	√
TPACK	0.846	0.929	√

Goodness of Fit (GoF)

According to the output model's findings, this study satisfies the cut-off value requirement for the model fit index's GoF, thus enabling the hypothesis testing to proceed.

Table 6. Goodness of Fit (GoF) of Output Model

Model Fit Index	Cut-Off Value	Output Model	Fit
SRMR	SRMR < 0.1	0.1	√
d_ULS	> 0.05	5.408	√
d_G	> 0.05	0.983	√
NFI	*Almost 1*	0.741	√
RMS Theta	*Almost 0*	0.16	√

Hypothesis or Structural Test

With a path coefficient value of 0.143, a t-statistic value > t-table (2.779 > 1.966), and a p-value of 0.008 0.05, the test results demonstrate that TPACK has a positive and significant impact on ICT integration. Accordingly, hypothesis 1—that TPACK has a positive effect on ICT integration—was accepted. With a path coefficient of -0.037, a t-statistic value < t-table (1.404 < 1.966), a p-value of 0.238 > 0.05, and other test results indicating that the interaction of creativity with TPACK has no positive or significant effect on ICT integration, hypothesis 2—that the interaction of TPACK with creativity has a positive and significant effect—was rejected.

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Table 7. Hypothesis Test Outcome

Hypothesis	Path Coef.	T Statistic	P-value	Status
TPACK → ICT Integration	0.143	2.779	0.008	Accepted
Moderating Effect (Teacher Creativity*TPACK) → ICT Integration	-0.037	1.404	0.238	Rejected

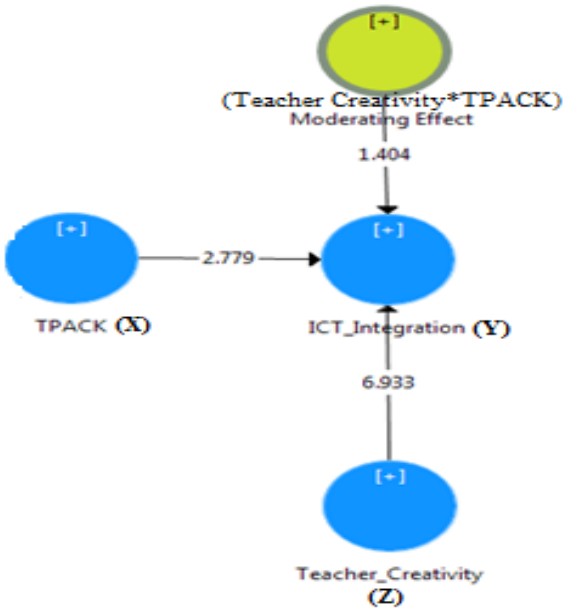

Figure 4. Hypothesis Test Outcome (T-Statistic Value)

Based on the outcomes of the estimation algorithm using SmartPLS, it can be seen that the coefficient of determination of ICT integration is 0.513, which means that 51.3% of teachers' ICT integration is influenced by an independent factor, namely TPACK, while the remaining portion is influenced by other factors not included among the variables of the study.

Table 8. Moderating Effect Cut-Off

Hypothesis	Path Coef.	T Statistic	P-value	Status
Teacher_Creativity →ICT_Integration	0.513	6.933	0.000	Has effect
Moderating Effect →ICT Integration	-0.037	1.404	0.238	No effect

The results in Table 8 identify the type of moderation in relation to the moderating effect cut-off. With a path coefficient value of 0.513, a statistical t value > t-table (6.933 > 1966), and a p-value of 0.000 < 0.005, the test results demonstrate that teacher creativity has a positive and significant impact on ICT integration. While the moderating effect, which was the interaction of creativity and TPACK as independent variables, had a path coefficient value of -0.037, a t-statistic value < t-table (1.404 < 1.966), and a p-value of 0.238 > 0.05, and thus no positive or significant impact on ICT integration. As a result, the creativity variable serves as a moderating predictor. Creativity is not a moderating variable but rather a predictor or independent variable that can also act as an intervening or mediating variable, in addition to being an independent variable (Ghozali, 2018).

DISCUSSION

The TPACK framework complies with Law Number 14 of 2005 Section 20 (Mulyadi et al., 2020), which requires teachers to develop and enhance their technological skills in addition to taking professional education courses that address standard competencies or skills, such as pedagogical competence, personality, social skills, and qualifications. A teacher's professional abilities will enable them to guide the subject matter of this research, which is a complex and wide-ranging area of economics. The government has also attempted to address this requirement with training related to the TPACK approach aimed at boosting teachers' ICT proficiency. This

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training is conducted online, free of charge and is accessible from https://simpatik.learning.kemdikbud.go.id (Yanuarti et al., 2021). TPACK impacts economics teachers' ICT integration as, before integrating ICT, teachers must know the types of ICT that will be used in learning, the teaching strategies that will be used during the learning, and the extensive and in-depth content to be taught to students (Gan & Zhang, 2020).

Stakeholders, including the Ministry of Education and Culture of the Republic of Indonesia, have taken notice of the TPACK framework, with the latter offering guidelines on ICT-based learning methods called *"PembaTIK"* at level 2 to equip teachers to optimise the use of ICT in learning using the TPACK approach (Yanuarti et al., 2021). The Covid-19 pandemic necessitated a shift to online learning. This forced teachers to increase their knowledge and understanding of the ICT to be used, the requisite pedagogy or teaching methods as well as the content to teach to increase their knowledge and skills to integrate ICT, which in turn grew and became increasingly honed. According to the results of a survey by the Indonesian Ministry of Education and Culture (Retnawati, 2020b), the Covid-19 pandemic required online learning practitioners to improve their command of technology that supports learning, develop a more varied approach to teaching, and increase the capacity to support distance learners along with the capacity for learning assessment and lesson planning.

Although conventional learning methods continue to dominate, the Indonesian Ministry of Education and Culture is increasingly implementing more diverse learning strategies, including the use of digital learning resources and interactive materials, and developing creative projects, so that this online learning model can serve as both a supplement to and a replacement for current strategies (Abdykhalykova, Turusheva, Beysembayeva, & Dukembay, 2020; Gulati, Reid, & Gill, 2020). Additionally, after the Covid-19 pandemic, teachers can gain pedagogical knowledge both in person and online (Murphy, 2020) using the TPACK framework to integrate ICT into their teaching and learning activities. While the study's findings show that TPACK significantly influences teachers' use of ICT by 51.3%, they also enable researchers to test other variables or factors that may have an impact on teachers' ICT integration. Creativity, readiness, and other teacher competencies, along with TPACK, can have an impact on how ICT is integrated to support online learning during the Covid-19 pandemic (Anoba & Cahapay, 2020; Basilaia & Kvavadze, 2020; Cascini, Nagai, Georgiev, & Zelaya, 2020; Chemi, 2020; Hadar, Ergas, Alpert, & Ariav, 2020; Kalloo, Mitchell, & Kamalodeen, 2020; Morales, Morales, & Taibo, 2021; Nuere & de Miguel, 2020).

In contrast to the assertion by prior experts that collaboration between creativity, technology, pedagogy, and teacher content is necessary for students to explore technology (Chai et al., 2013; Koehler et al., 2011), this study demonstrates that the creativity variable functions as a predictor or mediator rather than a moderator. This is because creativity concerns the creation of content or products using ICT in the generation of ideas or in developing new ways of doing an activity (Hinrichsen & Coombs, 2013). While creative elements can be taught, creativity must be discovered alone (Haynes, 2019). Teachers' creativity should be improved through training in creative thinking and creative practice (Cachia & Ferrari, 2010). Based on the previous experts' statement, the creativity variable can have a direct effect on the integration of technology by the teacher and not as a moderating variable. The integration of ICT in learning will encourage teachers to increase their creativity and improve the quality of learning (Cachia & Ferrari, 2010). Most prior studies have positioned creativity as both a predictor and a mediating variable in the context of work so that creative work is applied, including in education (Karwowski & Kaufman, 2017). This is also supported by Conradty, Sotiriou, and Bogner (2020), who declared creativity as a key and core skill for the 21st century while also highlighting its importance as an educational goal.

4. CONCLUSION

This study provides insight for stakeholders in terms of education regarding the effect of TPACK on ICT integration and how creativity and TPACK interact with ICT integration. Although it has focused only on economics teachers in Indonesia, this research has provided an overview of teachers' readiness to adapt to ICT. As a next step, it is therefore necessary to expand the research respondents to various fields of study in the future. The results show that TPACK influences ICT integration while creativity and TPACK interaction have no effect on ICT integration. In this study, the assumption of the creativity variable as a moderating variable is rejected because it is a moderating predictor variable and not a moderating variable. The findings of this study can be used as a guide to instruct Indonesian teachers on the significance of TPACK, which every teacher must possess before carrying out classroom instruction. It can also serve as a guide for future research examining the effects of creativity as an independent variable on the ICT integration variable or other variables.

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