



Effects of socio-demographic and technological factors on Indonesian lecturers' TPACK: insights from emergency remote learning

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Abstract

Little research has explored the effects of socio-demographic and technological factors on university lecturers' Technological, Pedagogical, and Content Knowledge (TPACK). Conducted in the context of emergency remote learning during the pandemic, the mixed-methods study reported on this paper examined Indonesian lecturers' TPACK during the emergency online teaching, and how their gender, length of teaching experience, prior platform training, and mostly used platform affected their TPACK. 555 lecturers from different parts of Indonesia participated in the e-survey used in this study. Follow-up semi-structured interviews were conducted with ten of the participants. Results revealed that the lecturers' pedagogical and content knowledge components were higher than their technological knowledge components. Findings also showed that gender and mostly used platform affected TK, whereas teaching experience affected pedagogical (PK) and content knowledge (CK). Prior platform training did not affect TPACK. Further, the absence of Learning Management Systems (LMS) forced some to use social media platforms to conduct remote teaching, impacting their TK, impacting their TK. Given the low TK levels, it is suggested that higher education institutions increase the use of online learning platforms (e.g., LMS) and technologies (e.g., augmented reality and virtual reality technologies, which will be highly useful especially for practice-based courses).

Keywords TPACK · Learning platforms · Remote learning · Lecturers · Indonesia · Mixed-methods

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Introduction

This study aims to investigate the technological, pedagogical, and content knowledge (TPACK) of Indonesian lecturers during the emergency online learning situation that emerged during the COVID-19 pandemic. It also studies the effects of socio-demographic and technological factors on the lecturers' TPACK rating.

Three knowledge domains—content knowledge (CK), which refers to teachers' knowledge of theories and concepts within the subject matter, pedagogical knowledge (PK), which describes teachers' knowledge of teaching and learning approaches, methods, and practices, and technological knowledge (TK), which refers to teachers' knowledge of and ability to utilize a range of technologies—comprise the TPACK framework (Saubern et al. 2020). These interwoven knowledge domains overlap, creating four additional domains: pedagogical content knowledge (PCK), which describes teachers' knowledge on fundamental aspects of teaching and learning, and creates the link between content and the pedagogy to deliver it, technological content knowledge (TCK), which refers to teachers' understanding of how content can be delivered through different educational technologies and examining which technological tools might be best applicable for specific subject matters, technological pedagogical knowledge (TPK), which describes teachers' knowledge of how particular educational technologies along with their affordances and constraints can improve the teaching and learning experiences in ways that are well-suited to the development of the lesson being taught, and technological pedagogical content knowledge (TPACK), which is the combination of these components and describes teachers' understanding of effective use of educational technologies to improve teaching and learning and to deliver the subject matter (Koehler and Mishra 2009). Based on the framework, to effectively deliver online learning during the pandemic, lecturers should possess a combination of TK about online platforms and their functionalities, PK to create effective teaching and learning situation through the platforms, and CK about the subjects taught (Yang et al. 2019). The framework is useful to study lecturers' knowledge base in facilitating the delivery of subject content to the students and supporting a wide variety of delivery methods using their chosen technological platforms (Njiku et al. 2020). TPACK's importance for delivering technology-supported instruction and integrating technology into the curriculum among educators has been widely acknowledged, making it a very popular theoretical framework for researchers in this field (Wu and Wang 2015). Previous studies on TPACK have largely been in the context of orderly adoption of technology for education purposes, but the emergency learning that occurred during the COVID-19 pandemic was accompanied with instantaneous adoption of technology without pre-configured guidelines (Sutrisno 2022; Yang et al. 2019). Hence, the present study provides a unique context of adopting technology during emergency learning using the TPACK framework.

Literature review

In Indonesia, the outbreak of the COVID-19 pandemic was viewed as an excellent chance to launch higher education into a technology-enhanced era, in which lecturers and students managed to innovate and made swift adaptation to online learning despite the challenges (Belawati and Nizam 2020). Within a month since the first COVID-19 case announcement in March 2020, 98% of Indonesian higher education institutions (HEIs) transitioned to online learning, mostly without much preparation (Nizam 2020). Aware of the lack of preparation, as in other countries, the Government through the Directorate General of Higher Education (DGHE) provided trainings about online learning platforms, among other supports (Guo et al. 2020; Nizam 2020). A subsequent e-survey on online learning situations by DGHE reached 237,193 HEI students. The most used hardware was mobile phones (68.7% of surveyed students). Approximately 70% of the students had very good understanding of the material taught online, and about 85% found their lecturers delivered adequate or very good online learning (Nizam 2020). Despite providing some reasons to be optimistic about online learning in Indonesia during the pandemic, the survey was based on convenience sampling and without a theoretical framework, rendering it difficult to extrapolate to the whole population and identify remaining challenges. Relying only on students' views, lecturers' views about online learning have remained unknown. In other countries, studies reported that lecturers faced significant personal, technological, and pedagogical hardships when transitioning to emergency online learning and had little interest to sustain digitalisation of higher education (Moorhouse and Kohnke 2021; Watermeyer et al. 2021; Wut and Xu 2021). This calls for a study on Indonesian lecturers based on TPACK theoretical framework. Self-rating of TPACK correlates with TPACK's adoption among lecturers and is useful to design appropriate training support for online learning (Mourlam 2017; Voithofer et al. 2019).

TPACK studies in the context of higher education have revealed a nexus between the TPACK components and socio-demographic and technological factors. In Myanmar, Thinzarkyaw (2020) found that higher PCK scores correlated with longer teaching experience, while younger lecturers rated their TK the highest. Rajassekharan et al. (2020) found that although Malaysian male lecturers agreed about the benefits of learning technologies, they were skeptical about the use of mobile phones for learning. In his literature review, Mourlam (2017) identified teaching experience, age, and academic position as factors influencing TPACK of lecturers, but did not find conclusive results. On the platforms used for online learning, lecturers viewed the Learning Management System (LMS) as useful for improving the learning process, but the availability of LMS itself does not guarantee its effective utilization. IT service support and lecturer training were required to increase utilization of LMS (Rajassekharan et al. 2020). Whereas social media, i.e., Facebook, could be used for supporting learning, its features, long associated with socializing, could not be easily accepted as platforms for learning (Rajassekharan et al. 2020). Considering the continuously

evolving online learning situation due to the COVID-19 pandemic, more research is needed to understand it. Further, research on the effects of socio-demographic and technological factors on TPACK in the higher education context is still scarce. In light of the above discussion, the purpose of this study is twofold: (1) to investigate Indonesian lecturers' TPACK during the COVID-19 pandemic online learning period and (2) to understand the socio-demographic and technological factors (i.e., gender, length of teaching experience, platforms used, and prior platform training) that influence lecturers' TPACK.

Methods

This study utilizes survey research design, supported by semi-structured interviews to explore the reasons behind the survey findings.

Quantitative method: e-survey

The e-survey is aimed at gathering socio-demographic data on the participants and their TPACK rating. The TPACK items in the survey were based on an instrument developed by Yang et al. (2019), translated by one of the authors into Indonesian and adjusted to the Indonesian higher education context. Two other authors reviewed the translation and made necessary revision. The e-survey was conducted from July to October 2020 through snowball sampling. The e-survey was shared through social media and contacts, and respondents were asked to share the survey link with their colleagues. These respondents were anonymous, protecting their identity.

The use of snowball sampling was driven by three reasons. First, there are more than 4000 higher education institutions in Indonesia. To randomly select from the 4000 institutions was risky as the researchers might end up selecting small institutions with a very limited number of lecturers or those that did not use significant technology for teaching and learning. Negotiating access to unknown, potentially remote institutions was also a formidable and perhaps unnecessary challenge. The focus of the study is on the lecturers, rather than the institutions per se. Second, the research team did not want to just collect data from their own universities. While this entailed easy access and cooperative respondents, the study would have been limited to the greater Jakarta region and only in universities. This would be a disadvantage as Indonesia cannot only be represented by Jakarta, and there are many other types of higher education institutions in the country, such as polytechnics, academies, and institutes. Third, the snowball sampling through the use of social networks and connections fit well with the purpose of reaching out to many different types of higher education institutions in many different provinces of Indonesia. The researchers eventually were able to reach lecturers in remote provinces such as West Papua, East Nusa Tenggara, and Bangka Belitung, teaching in a variety of institutions by using snowball sampling.

Cronbach's alpha was used to determine the inter-item reliability of the survey items. Afterward, the survey data were analyzed using descriptive statistics

to calculate ratings of each TPACK component. The data were further analyzed by utilizing a one-way between groups MANOVA to explore differences in average ratings of each TPACK component. Then, follow-up univariate ANOVAs were performed on independent variables that were statistically significant in the MANOVA to examine differences within groups. The independent variables utilized in the MANOVA were gender, prior training, platform most often used, and years of teaching.

Qualitative method: semi-structured interviews

The semi-structured interviews were administered from September to October 2020 in the Indonesian language. Ten interviewees were identified by means of the e-survey. Respondents willing to participate in the interview provided their contact details and stated their consent to participate in the interviews. The authors then purposively selected interviewees based on a wide variety of socio-demographic background such as gender, platform most commonly used, and length of teaching experience. This provides a rich understanding of the range of Indonesian lecturers' accounts of TPACK and relevant issues during the pandemic. In line with ethical research practices, the names of the interviewees and their institutions were withheld, and pseudonyms were used to identify them. Appendix 1 shows the details of these interviewees, whereas Appendix 2 lists the interview questions.

Thematic analysis was employed to understand the interview data using NVivo 12. In accordance with Braun and Clarke's (2006) six step approach, the data were read repeatedly to generate initial codes and identify the themes—platform usage, ICT training, TPACK, and challenges and solutions. In the thematic analysis, the abovementioned TPACK components and independent variables were also used to select appropriate interview excerpts to be included in this article. The entire analysis was done in Indonesian, and then the selected excerpts were translated into English by one author and reviewed by two other authors.

Findings

There were a total of 555 respondents who completed the survey and were included in the analyses (Table 1). Of these, 48.8% identified as female and 51.2% identified as male. Regarding teaching experience, 244 (55%) had between 0 and 12 years of teaching experience at the time they completed the survey, while 311 (56%) had 13 or more years of teaching experience. Moreover, a slightly larger portion of the sample participated in some sort of online teaching training prior to switching to fully online instruction, with 52.4% indicating that they did participate in training and 47.6% indicating that they did not participate in training. Finally, 32.1% of respondents indicated that they primarily utilized an LMS, such as Moodle, to support instruction and engage in online teaching, whereas 67.9% indicated that they primarily utilized different online tools to support instruction and engage in online teaching, such as social media, video conferencing, and instant messenger.

Table 1 Survey respondents' socio-demographic information ($N=555$)

Variable	<i>N</i>	%
Gender		
Female	271	48.80
Male	284	51.20
Teaching experience		
0–12 years	244	44.00
13 or more years	311	56.00
Training		
Yes	264	47.60
No	291	52.40
Platform		
LMS	178	32.10
Non-LMS	377	67.90

Table 2 displays the average item ratings for all scale items from the survey as well as inter-item reliability scores for each TPACK component. Generally, there were high average ratings on all items with no average ratings falling below a 3.8 on a 5.0 scale. However, respondents' ratings on their knowledge of the subjects they teach as well as methods to teach their subjects were higher than their knowledge related to technology and effectively utilizing technology for instruction. For example, respondents' composite scores for their PK, CK, and PCK were 4.26, 4.41, and 4.11, respectively, compared to their composite scores for TK, TCK, TPK, and TPACK which ranged from 3.96 to 4.09. Moreover, across all components, the only items that had average ratings that fell below a 4.0 were directly related to online learning and creating effective online learning environments. Such items included solving technical problems, choosing effective features of online platforms to improve learning, and creating online environments to support new knowledge and skill development in students. Lastly, regarding inter-item reliability, all TPACK components had Cronbach's alphas, α , of 0.70 or above with only one component, PCK, having an α of 0.66. These high values indicate acceptable reliability values for each TPACK component (George and Mallery 2003; Hair, et al. 2010).

Based on interview data, it is understandable that lecturers generally claimed higher grasps of PK, CK, and PCK than the technology-related knowledge because before the pandemic, there was no urgency to make use of online learning platforms, even if they were provided to them by their universities. Lecturers primarily relied on printing materials and face-to-face communication. The pandemic forced them to welcome these platforms and think about the possibility of improving their online delivery during the pandemic, as exemplified by Lecturer KH below.

Maybe it's a blessing in disguise, we were not expecting a pandemic, but we had never thought that much about online learning although e-learning [platform] already existed. But, with this prolonged pandemic, we have been forced to be creative and adaptive. Previously we weren't familiar with Google Meet,

Table 2 Average item ratings for all scale items and inter-item reliability scores for each TPACK component

Scale items	Mean ^a	SD	α
Pedagogical knowledge (PK)			0.71
I know how to do an assessment on students' learning progress	4.37	0.67	
I can adapt my teaching based upon what students currently understand or do not understand	4.16	0.66	
I can teach students using various methods	4.21	0.69	
<i>PK composite score</i>	4.26	0.59	0.75
Technological knowledge (TK)			
I often explore online learning platform	4.06	0.79	
I know how to solve the technical problems about online learning technologies	3.83	0.81	
I can keep up with new online learning technologies	4.09	0.70	
<i>TK composite score</i>	4.01	0.67	0.71
Content knowledge (CK)			
I have sufficient knowledge about my subject	4.63	0.52	
I can create learning materials (e.g., exercises, creative activities, etc.) for my subject based on the curriculum standard currently implemented	4.41	0.60	
I can create various ways and strategies in designing the sequence of concepts taught within my class	4.17	0.66	
<i>CK composite score</i>	4.41	0.55	0.80
Technological content knowledge (TCK)			
I can use technological aids (e.g., multimedia, visual demonstrations, etc.) to teach specific concepts in my course with online platforms	4.05	0.74	
I can use various courseware programs in online learning platforms (e.g., educational videos or online quizzes) to teach	4.16	0.71	
I can use the online learning platforms to impart the content knowledge in the course accurately to the students	3.97	0.73	
<i>TCK composite score</i>	4.09	0.66	

Table 2 (continued)

Scale items	Mean ^a	SD	α
Pedagogical content knowledge (PCK)			0.66
I apply effective teaching approaches to guiding students' thinking and learning	4.13	0.65	
I can choose effective features from online learning platforms to increase the impact of my teaching	3.88	0.78	
I can distinguish problem solving attempts between correct and incorrect by students	4.20	0.64	
<i>PCK composite score</i>	4.11	0.59	0.82
Technological pedagogical knowledge (TPK)			
I use online learning platforms to enhance students' learning performance	4.13	0.75	
I can create an online learning environment which allows students to develop new knowledge and skills	3.89	0.77	
I can moderate interactivity among students on an online learning platform	3.88	0.80	
<i>TPK composite score</i>	3.96	0.71	0.86
Technological pedagogical content knowledge (TPACK)			
I can use online learning platforms as a means to create a teaching context that is suitable for subject content	4.08	0.72	
I can use online learning platforms and choose appropriate teaching strategies to promote students' understanding and mastery of subject knowledge	4.04	0.71	
I can use online learning platforms to create effective representations of the teaching materials that meet the teaching needs	4.07	0.71	
<i>TPACK composite score</i>	4.08	0.67	

^a5-point rating scale: 5 highly agree to 1 highly disagree

Zoom, Webex, so we had to use those platforms so our online learning could be improved. (Lecturer KH)

Lecturer KH was compelled to really harness her campus’ e-learning platform and combine it with video conferencing platforms, such as Zoom and Webex, to deliver lessons. In doing so, lecturers became more creative and adaptive in online learning, potentially building their TPACK along the way.

Nevertheless, some lecturers who teach practice-based courses, such as those in polytechnics, still perceived that there was no real substitute to face-to-face meetings, as voiced by Lecturer NM.

Polytechnics prepare students for practical work. If the material is about online business, there might not be any problems if we use online learning, but our students will work in motorcycle manufacturing factories, like Honda and Toyota, and it is impossible to work there online. Besides, if the materials are not related to anything practical, it should be okay... But programs like us— Mechanical Engineering—have a lot of challenges as we have a lot of practical sessions, do research, work in a lab and in a workshop. Even after the pandemic is over, it is difficult to insist on online learning. (Lecturer NM)

The type of training required for these mechanical engineering students posed extra challenges for online delivery during the pandemic. There was skepticism about how online learning could be utilized for such practical skills courses after the pandemic ends. Such strong opposition to the adoption of platforms might mean the TPK of such lecturers did not grow.

Furthermore, survey data demonstrated some group-based differences for TPACK component scores. Table 3 shows the results of the multivariate test with the TPACK components dependent variables. Using Pillai’s trace, three variables were shown to have a significant effect on respondents’ TPACK component scores: gender [$V=0.059$, $F(7, 533)=4.732$, $p\leq 0.001$], teaching experience [$V=0.032$, $F(7, 533)=2.557$, $p=0.013$], and platform [$V=0.033$, $F(7, 533)=2.569$, $p=0.013$]. On the other hand, participating in training was not shown to have a significant effect on respondents’ TPACK component scores [$V=0.017$, $F(7, 533)=1.290$, $p=0.253$].

Once again, interview data helps explain some of these findings. Lecturer BB described why prior training on online learning platforms was not useful for her.

Table 3 MANOVA test results with effects of independent variables on combined TPACK components

	Combined scale components				
	Pillai’s trace	<i>F</i>	<i>df</i>	Error <i>df</i>	Sig.
Gender	0.059	4.732	7	533	0.000 ^b
Teaching experience	0.032	2.557	7	533	0.013 ^a
Training	0.017	1.290	7	533	0.253
Platform	0.033	2.569	7	533	0.013 ^a

^a $p\leq 0.05$

^b $p\leq 0.001$

I got into my university in 2017. I attended training... in that training, we were taught about effective teaching methods. Media or platforms were explained... [The training did] not... provide sufficient facilities. So, for example, it was only for audio tutorials, and whiteboard for visualizing, but I don't really use that [for online teaching]. (Lecturer BB)

The above excerpt showed that the training was not sufficiently resourced. The facilities used were not useful for preparing the lecturer to face the massive migration to online learning at the onset of pandemic. Additionally, training done far before the pandemic might be no longer relevant given the rapid development of new platforms.

The follow-up univariate ANOVA showed varying effects of gender, teaching experience, and platform on the seven TPACK components (Table 4). First, regarding gender, males had significantly higher ratings for TK than females [$F(1, 539) = 11.433, p = 0.001$], however, there were no significant differences based on gender for any of the other TPACK components.

Only one of the interviewed lecturers talked about how gender could influence technological knowledge. In the below excerpt, Lecturer IN commented on the impact of the transition to online learning on her confidence to use technology.

Of course, the confidence to operate application and play it around [increased]. Before that, I was worried if I mistakenly tap the wrong button, then it's gone, then it'll be screwed up. You know, a middle-aged lady... but now, we can try it first. (Lecturer IN)

Lecturer IN acknowledged her hesitance to use an application before the pandemic and attributed this to her demographic profile as a middle-aged woman. She lent support to the stereotype that women, particularly older ones, had low TK due to the fear that a simple mistake in tapping a button would ruin the work. Nevertheless, she also had growing confidence to use and experiment with the platforms after the transition to online learning because of the pandemic.

Next, respondents with 13 or more years of teaching experience had significantly higher ratings for PK [$F(1, 539) = 7.625, p = 0.006$] and CK [$F(1, 539) = 5.778, p = 0.017$] than respondents with 0 to 12 years of experience. There were no other statistically significant differences based on teaching experience for the other TPACK components. Understandably, those who spent long time teaching the same subjects had more confidence in rating their PK and CK. Moreover, the Indonesian higher education system usually recruits new lecturers with just master's qualification. Lecturers who had served more than 13 years might have gone on to pursue their doctoral degrees, and as a consequence, had better CK about their teaching subject areas.

Nevertheless, the interview data revealed comments on the technological problems faced by senior lecturers. Lecturer KS below contrasted how, as a more junior lecturer, she quickly adopted online learning, owing to her better technological literacy, against how slow her senior counterparts understood online learning and the associated technology.

Table 4 MANOVA test results of between-subjects effects (univariate test results)

	Group Mean (SD) ^a		F	Sig.		
	Female	Male				
Gender						
Pedagogical knowledge	4.27(0.04)	4.25 (0.04)	0.179	0.673		
Technological knowl- edge	3.92 (0.04)	4.09 (0.04)	11.433	0.001 ^d		
Content knowledge	4.39 (0.03)	4.43 (0.03)	0.789	0.375		
Technological content knowledge	4.05 (0.04)	4.13 (0.04)	1.853	0.174		
Pedagogical content knowledge	4.10 (0.04)	4.11 (0.03)	0.138	0.711		
Technological pedagogi- cal knowledge	4.01 (0.04)	3.92 (0.05)	1.716	0.191		
TPACK	4.11 (0.04)	4.05 (0.04)	0.825	0.364		
			0–12 years	13 or more years		
Teaching experience						
Pedagogical knowledge		4.19 (0.04)		4.32 (0.03)	7.625	0.006 ^c
Technological knowledge		4.03 (0.04)		3.99 (0.04)	0.289	0.591
Content knowledge		4.35 (0.03)		4.46 (0.03)	5.778	0.017 ^b
Technological content knowledge		4.12 (0.04)		4.06 (0.04)	0.076	0.783
Pedagogical content knowledge		4.07 (0.04)		4.14 (0.03)	2.473	0.116
Technological pedagogical knowledge		3.97 (0.04)		3.96 (0.04)	0.121	0.728
TPACK		4.09 (0.04)		4.07 (0.04)	0.000	0.987

Table 4 (continued)

	LMS	Non-LMS	
Platform			
Pedagogical knowledge	4.23 (0.05)	4.27 (0.03)	0.518
Technological knowledge	4.13 (0.05)	3.95 (0.03)	6.900
Content knowledge	4.36 (0.04)	4.44 (0.03)	2.676
Technological content knowledge	4.15 (0.05)	4.06 (0.04)	0.877
Pedagogical content knowledge	4.12 (0.04)	4.10 (0.03)	0.196
Technological pedagogical knowledge	4.03 (0.05)	3.93 (0.04)	2.083
TPACK	4.12 (0.05)	4.06 (0.03)	0.373

^a5-point rating scale; 5 highly agree to 1 highly disagree

^b $p \leq 0.05$

^c $p \leq 0.01$

^d $p \leq 0.001$

So, the pandemic hit and to be honest I was quite ready, in the context of campus, infrastructure, platform and perhaps because I'm different from the senior lecturers. So, my generation and my juniors' technological literacy is pretty good. If we talk about adaptation, we're very fast. In two weeks' time, we had all things [ready]... Some of the senior lecturers were a little bit slow, but for us [i.e., younger lecturers], we understood it pretty fast... So my university was well prepared and the less senior [lecturers] understood it [the e-learning platform] faster. (Lecturer KS)

Another lecturer similarly viewed the senior lecturers as having more challenges in using e-learning technology than the junior lecturers. However, he added that the university provided extra training to help them cope with the online learning.

That's the problem for the lecturers. Usually it comes from senior lecturers, but for young lecturers they are familiar with the online system—the ones who are below 50, many of them use online system. But for the seniors, our university provides help by giving them training to create modules, etc. (Lecturer NC)

The training given after the pandemic was arguably relevant and useful for senior lecturers to adapt to online learning, as it fit the situation and current technology used at their universities. From this perspective, the senior lecturers might increasingly be equipped with TK, supplementing their higher rating for CK and PK.

Finally, regarding platform, respondents who primarily utilized an LMS rated their TK significantly higher than those who primarily utilized other online tools [$F(1, 539) = 6.900, p = 0.009$]. Like the other analyses above, there were no significant differences found for any other TPACK components based on the type of platform lecturers used. The following interview excerpts compare the use of an LMS and non-LMS. Those who used LMS at the early days of the pandemic usually had done so prior to the pandemic, such as Lecturer PH below.

Since I have taught remotely before, I have utilized LMS—Moodle at that time. The transition [to online learning] was fast... So, in LMS, we learned about its features. For example, how to create a class in Moodle... We create the questions there and those questions can be used for midterm tests or... quizzes... We can have the students follow all the materials asynchronously, flexibly. They can study the materials anytime they want—sometimes they can study material 1 and skip material 2. Using LMS, we can set that up... if they want to access the second or third material, they need to access the first material first. They need to finish the task first then they can click the following material. So how to create...a PowerPoint presentation, assignments, etc. (Lecturer PH)

Having explored the features of the LMS, Lecturer PH had good TK to make use of the different functions of the LMS to do various academic activities. On the other hand, Lecturer IN used WhatsApp—a free and widely used instant messaging platform in Indonesia—for her online teaching at the beginning of the pandemic, as utilizing an LMS was not common in her university.

The ‘face-to-face’ meeting is held through a WhatsApp group. WhatsApp group can only have 4 people maximum in one call so it’s quite funny to have to meet for a few times to accommodate 30 people with me, like how we consult this and that. Handouts that we give to students, for example, they can read them, but they don’t have guidance. They feel like, “Why is it so difficult to interact with?” So I have the initiative, “Okay, for the part that you feel like you haven’t understood, we can meet through video call.” And I am not satisfied. It feels like there’s something missing. The students feel that too. (Lecturer IN)

Despite WhatsApp being limited in its ability to accommodate video conferencing needed for online teaching, this lecturer only relied on it and did not explore other possible video conferencing platforms demonstrating that she did not have adequate TK to look for alternatives. The complicated and unsatisfying way of teaching via WhatsApp also showed a lack of TPK, which cost Lecturer SH’s students the opportunity to study effectively.

Discussion and implications

The present study has shown that the TPACK instrument used for the data collection was reliable and the participating Indonesian lecturers rated their TPACK levels quite highly. The findings showed that TPACK components that primarily measured lecturers’ perceptions of their knowledge and expertise related to their subject areas, e.g., CK, and their capacities to teach and assess students, e.g., PK, had the highest ratings among all TPACK components. In contrast, lecturers’ generally rated items and components focused on online learning and creating effective online learning environments, e.g., TPK, lower than other items and components. This indicates that although lecturers felt confident teaching their subject areas, they felt less confident in their abilities to teach it as effectively using technology. This is likely due to the fact that prior to the pandemic lecturers primarily engaged in face-to-face instruction and relied less on the various technologies available to teach their courses. Then, as the pandemic emerged and they were forced to migrate to online learning suddenly without much preparation, lecturers likely recognized shortcomings in their capacities to teach their subject areas as effectively in online learning environments.

Regarding the various demographic variables that significantly influenced lecturers’ TPACK ratings, the finding showed that male lecturers had a higher average TK score than female lecturers. The qualitative data shed light on the female lecturers’ lack of confidence in using platforms, but also pointed to a changing situation where female lecturers, compelled by the pandemic, improved their mastery of online learning platforms. Hence, the study’s finding is in line with Rajassekharan et al. (2020) who found Malaysian male lecturers had greater appreciation of the technological platforms. It also mirrored research on female teachers who were found to have a lower level of TK components, albeit indications of their growing confidence in technology usage (Jordan 2013; Koh et al. 2010; Long et al. 2020).

While LMSs can facilitate cognitive knowledge transfer in online learning, undoubtedly, lecturers teaching practice-based courses need higher forms of ICT such as simulated work environments, virtual reality (VR), and augmented reality (AR) to address the practical skills developments of their students (Balakrishnan et al. 2019). Unfortunately, such forms of ICT were yet to be available to the lecturers in our study and as a result they could not deliver instruction that would lead to expected learning outcomes. Policy makers should therefore address this issue by considering developing schemes that can enable polytechnics and universities to purchase and integrate VR/AR technologies and simulated work environments into teaching and learning. Such integration would arguably affect lecturers' TPK.

Moreover, the training provided prior to the pandemic did not have any significant impacts on the lecturers' TPACK rating in this study. The interview data pointed to insufficient resources to support effective training and incongruent aims with the situation faced during the pandemic. It is also not possible to understand the quality of the training and the impact of forgetfulness after joining the training in the past. However, findings concerning the low rating for TPK in general and the lower TK among female lecturers could be used to sharpen the direction of future training and professional development for the lecturers and thus improve the quality and resources to deliver it (cf. Chai, 2015; Voithofer et al. 2019).

The higher TK rating among lecturers who often used LMSs in the present study may demonstrate that certain technology can require and help lecturers to improve their TK. The LMS most often used in the current study was Moodle, which arguably requires more familiarity with ICT, but also once mastered can facilitate a variety of learning activities. In contrast, those reliant on non-LMS platforms such as WhatsApp did so because of limited access to more education-friendly platforms and faced difficulties in harnessing its features for pedagogical purposes. Their features are often very user friendly, requiring almost no training, but have limited applicability for various pedagogical purposes. Hence, in using such platforms, the lecturers' TK and TPK might not ever improve. Moreover, akin to Rajassekharan et al.'s (2020) findings, the familiarity with social media platforms for socializing purposes hindered the transference of the platforms for educational purposes.

Lastly, lecturers teaching more than 13 years claimed higher PK and CK than their more recent counterparts. Possibly, more senior lecturers had significant teaching experience and had completed their PhDs, while many of the younger lecturers had not. While the interviews found lecturers associating younger lecturers with higher TK, the quantitative data found no significant correlation between years of teaching and TK. TK was more closely associated with the male gender and use of LMS. These rather conflicting findings point to the inconclusive findings of TPACK and lecturers' socio-demographic and technological factors (Mourlam 2017). There is a need to further study the socio-demographic factors in conjunction with the TPACK components.

Limitations

The current study has limitations. One apparent limitation is that the quantitative analyses are solely based on self-report data with their known validity problems such as socially desirable responding and Dunning-Kruger biases. Another limitation is that given the focus on Indonesia, the findings may have little relevance for ICT-rich countries. Further, the study found that participating in training prior to the migration to online learning caused by the pandemic did not affect participants' TPACK. However, we did not explore whether the participants attended training during the online learning period, which was purposefully for the pandemic-induced online learning, and whether this might have affected their TPACK. Research on the effect of training during the pandemic on TPACK is warranted. Finally, as countries are reopening universities, some of the findings presented here such as the ones regarding mostly used platforms may no longer be relevant. It remains to be investigated whether universities will provide LMSs and require lecturers to use them once the pandemic is fully under control.

Conclusions

To conclude, the findings of our study contribute to the literature on TPACK in the higher education context by exploring socio-demographic and technological correlates of TPACK in the context of emergency online learning caused by the pandemic. Our study found that lecturers had lower ratings on the TK components, indicating that they were not as confident in using online platforms for teaching online. Additionally, the effect of ICT training prior to the online learning on their TPACK was not significant, and teaching experience did not significantly affect their TK. Lastly, the study found that in the absence of LMS platforms, lecturers made do with instant messaging platforms not designed for teaching and learning, which accounts for their lower TK rating.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s43545-023-00630-w>.

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Author contributions NH: conducted interviews and commented on the literature review. MR: conducted the interviews and made corrections to the manuscript. AS and DW: conceptualized the study design, developed the study instruments, and wrote the manuscript. AS: did the qualitative data analysis and wrote the qualitative findings section. JPH: did the quantitative data analysis and wrote the quantitative findings section. DW and JPH: did the grammar check.

Data availability The datasets generated during and/or analysed during the current study are not publicly available because they contain personal and institutional information, which as promised to the respondents have to be kept confidential and known only to the researchers, but are available from the corresponding author on reasonable request.

Declarations

Conflict of interest The authors have no conflicts of interest to declare. The authors did not receive support from any funding organization for the submitted work.

Ethical approval In Indonesia, ethical approval from an ethics board is rare, and most universities do not have an internal review board. However, the study was approved by the Dean of Faculty of Education and Language at Atma Jaya Catholic University as the direct supervisor of the first author. As most authors of this paper are research graduates from Australian and American universities, we conduct our research in line with the ethical standards we are familiar with from those countries.

Informed consent Informed consent was obtained from all participants for participation in the study through the completion of the survey.

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