Examining Language Teachers' Change in TPACK-HOTS Self-Perception during the COVID-19 Pandemic in Indonesia

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Abstract

In light of the ongoing concern of the Indonesian Ministry of Education to continuously upgrade teachers' competence in the use of technology and impart critical thinking as part of 21st-century skills, this study sought to examine language teachers' self-perception of their TPACK and Higher-Order Thinking Skills (HOTS) competence during the COVID-19 pandemic. To this end, an explanatory sequential mixed-method study was designed to gather data from 137 languages (English and Bahasa Indonesia) teachers from various parts of Indonesia, employing a questionnaire and interview for data collection. The quantitative and qualitative data analysis revealed that the teachers perceived a rise in all TPACK subdomains, with the highest increment in TK and the smallest for CK. The teachers also rated themselves higher in HOTS and opined that TPACK supported HOTS-based lesson implementation. The implications for teacher training and pedagogy are also discussed.

Keywords: Higher Order Thinking Skill (HOTS), Indonesia, language teachers, pandemic, Technological Pedagogical Content Knowledge (TPACK)

Introduction

The COVID-19 pandemic has undoubtedly impacted the lives of people all over the planet, including the extensive country-archipelago that is Indonesia. Apart from the disastrous consequence of the emergency situation on the nation's health system, the Ministry of Education also had to act quickly to switch to a distance learning mode, which was enacted differently depending on the technological readiness of each region and the teachers' prior technological knowledge (Lie et al., 2020). Now, more than two years after President Jokowi announced the first COVID-19 case on March 2, 2020, the pandemic has been mainly brought under control due to aggressive vaccination drives

and different stages of mobility restriction. It seems thus opportune at this juncture to look back at how the pandemic has changed the educational landscape in Indonesia, especially in terms of teachers' competence in integrating technology into their teaching, which has been brought to the fore during the Emergency Remote Learning situation.

When it comes to assessing teachers' technological competence concerning their pedagogical and knowledge of the subject matter, the TPACK (Technological Pedagogical and Content Knowledge) framework (Koehler & Mishra, 2009) might be the first that comes to mind. Indeed, Indonesia's national teacher certification program, locally termed the *Program Profesi Guru*, included TPACK mastery as one of the criteria in the rubric for the in-service teachers' micro-teaching evaluation. Besides its utilization as an assessment instrument, TPACK surveys have been extensively used by scholars in studies related to teachers' self-perception of their TPACK skills (Castéra et al., 2020; Efwinda & Mannan, 2021; Novita et al., 2022; Roussinous & Jimoyiannis, 2019). In light of the pandemic, it can be intuited that teachers' TPACK self-perception might have undergone a substantial change. Does technology incorporation mean better teaching? Is managing online classes better or worse than the 'offline' ones? Did the work-from-home mode mean that teachers could enhance their content knowledge through the various online professional development (PD) programs? A TPACK-based survey, complemented with qualitative, extended response data, might be able to shed light on those questions.

However, technological integration alone is insufficient to prepare students, and their teachers, for the Society 5.0 that looms ahead. Together with 'technological skill and digital literacy', the Organization for Economic Cooperation and Development (OECD) proposed 'critical thinking' as one of the components that make up the 21st-century skills (Ananiadou & Claro, 2009). Inculcating critical thinking skills in Indonesian students has also been the thrust of the educational policy in the country, as spelled out by the prevailing 2013 Curriculum. The concept of 'critical thinking' is further operationalized into Higher Order Thinking Skills (henceforth, HOTS), which was first postulated by Bloom et al. (1956, as cited in Krathwohl, 2002) and subsequently modified by Anderson and Krathwohl (2001). The Indonesian Ministry of Education and Culture mandated that teachers ought to design and implement HOTS-based assessments (Suhardi, 2018). Hence, teachers are faced with a herculean task: apart from incorporating technology into the classroom in the upcoming blended, hybrid, or limited face-to-face lessons, they still need to ensure that they are conversant with the HOTS concept and apply it in their teaching and assessment. This challenge raises more interesting questions: is there any relationship between HOTS and technology-integration skills? Does the pandemic have any bearing on the perceived HOTS skills of the teachers?

This study then attempts to provide some insights into the answers to the aforementioned questions. Besides, given the paucity of research relating TPACK and HOTS among language teachers, this study also intends to fill the contextual gap. Hence, this study specifically addresses the following research questions:

1. Is there any difference between language teachers' self-perceived TPACK competence at the beginning of the pandemic compared to 19 months after?
2. Is there any difference between language teachers' self-perceived HOTS level at the beginning of the pandemic compared to 19 months after?

3. Is there any perceived relationship between TPACK and HOTS competence of the language teachers?

Literature Review

Coined first as TPCK in 2006, TPACK is a further development by Mishra and Koehler of Shulman's (1986) PCK construct (Mishra & Koehler, 2006). It represents the central intersection of the three domains of Technology, Pedagogy, and Content Knowledge that a teacher should have. Seen in this way, the TPACK framework consists of seven subdomains; Technological Knowledge (TK), Pedagogical Knowledge (PK), Content Knowledge (CK), as well as the intersection between two or three domains, namely Technological-Pedagogical Knowledge (TPK), Technological-Content Knowledge (TCK), Pedagogical-Content Knowledge (PCK), and finally the Technological Pedagogical Content Knowledge (TPACK). A diagrammatic representation of the TPACK framework, as well as a brief, tabulated explanation of the meaning of each subdomain, is given in Figure 1 and Table 1 respectively.

Figure 1
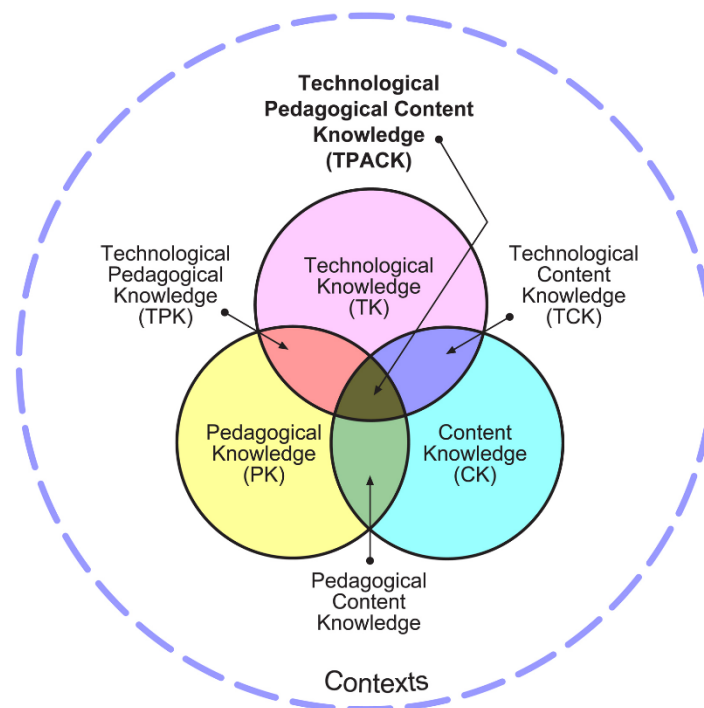*The TPACK Framework (Mishra & Koehler, 2006)*

Table 1
Brief Explanation of each TPACK Domain (Mishra & Koehler, 2006)

No.	Domain	
1	Pedagogical Knowledge (PK)	Knowledge about process and practices or methods of teaching and learning and how it encompasses educational purposes, values, and aims (e.g. student learning, classroom management, lesson plan development, and implementation).
2	Content Knowledge (CK)	Knowledge about the actual subject matter that is to be taught (e.g., central facts, concepts, theories, procedures).
3	Technological Knowledge (TK)	Knowledge about standard technologies and how to operate them (e.g., from books and chalkboards to the internet and digital video).
4	Pedagogical Content Knowledge (PCK)	Knowledge about pedagogy that is applicable to the specific teaching content (e.g., knowing what teaching approaches fit the content, knowing how elements of content can be arranged for better teaching).
5	Technological Pedagogical Knowledge (TPK)	Knowledge of how teaching may be changed as the result of using particular technologies (e.g., knowing that a range of tools exists, the ability to select based on fitness, and knowledge of affordances of these tools for pedagogical practice).
6	Technological Content Knowledge (TCK)	Knowledge about how technology and content are reciprocally related (e.g., knowing how subject matter can be changed by the application of technology).
7	Technological Pedagogical Content Knowledge (TPCK)	Knowledge for good teaching with technology which requires understanding how technologies can support teaching subject matter (e.g., knowing how technologies can help overcome problems in the process of teaching and learning, and how they can be used for constructive content and pedagogy).

The TPACK framework is typically used to assess teachers and their self-perception of their skill at teaching with technological integration, with extensive research having been done in this respect (Castéra et al., 2020; Efwinda & Mannan, 2021; Roussinos & Jimoyiannis, 2019). The TPACK instrument, in the form of a survey operationalizing each of the TPACK domains, has been developed and tested (Bostancıoğlu & Handley, 2018; Chai et al., 2010; Schmidt et al., 2009), as well as adapted by a plethora of other studies (Scott, 2021). In the field of language teaching, studies on teachers' TPACK are likewise burgeoning (Aisyah et al., 2021; Cheng, 2017; Ersanli, 2016; Habibi et al., 2019; Raygan & Moradkhani, 2020; Tseng et al., 2020).

Raygan and Moradkhani (2020) underscored the strongly mediating effect of EFL teachers' attitude and TPACK in integrating technology, with supportive school climate playing only secondary role. In their critical review of research on TPACK in language teaching, Tseng et al. (2020) revealed that language teachers in the studies reviewed have not demonstrated an optimal level of self-confidence in digital teaching and the deployment of technology for student-centered learning, focusing its use mainly for motivation, exercises, and course presentation.

During the COVID-19 outbreak, the challenges teachers faced during the emergency remote teaching, specifically when jump-started with hardly any prior experience with the online mode, have been the subject of numerous research (Arcueno et al., 2021; Kholik et al., 2020; van der Spoel et al., 2020; Wen & Kim Hua, 2020; and many more). In particular, teachers' aptitude for incorporating technology before and during the pandemic as measured by TPACK attracted the attention of several scholars (Chen & Hsu, 2021; Mourlam et al., 2021; Nelson, 2020). Mourlam et al. (2021), for example, carried out a survey study involving 167 teachers in the USA to investigate their self-perception of TPACK competence before and during the pandemic. The survey was administered in June 2020 through email list from public school websites and social media. The result showed that the teachers perceived a decrease in five out of the seven TPACK domains, with only TK and TCK domains remaining relatively similar before and during the pandemic. They concluded that the instructional context the teachers found themselves in (the sudden shift to online teaching) had caused the teachers to brush up on their knowledge of technological tools, which explained their confidence in their TK and TCK, while at the same time making them sense the inadequacy of their pedagogical skill in the new, online environment. Similarly, Chen and Hsu (2021) conducted a two-phase survey study before (in 2017) and during the pandemic (in 2020), making use of the TLPACK (Technology, Learner, Pedagogy, Academic discipline content, and Content Knowledge) survey engaging 500 teachers in Taiwan. TLPACK is a further elaboration of TPACK, with the inclusion of Learners and Academic discipline content domains (Hsu & Chen, 2019 in Chen & Hsu, 2021). Adopting a quota sampling method, they disseminated more than 500 survey forms in 2017 and 2020, and the returned forms were randomly stratified to obtain a balanced representative of each teaching level. They discovered that, overall, the teachers' perception of their TLPACK was lower during the pandemic, particularly knowledge about the learners, which exhibited the most significant decrease. They concluded that, just like Mourlam et al. (2021), teachers might lose some of their confidence in their overall teaching competence due to the emergency online learning situation (Chen & Hsu, 2021). Yet another "pre vs. in" pandemic study was conducted by Nelson (2020), who administered a TPACK survey to preservice teachers before the pandemic (2019) and clinical teachers in the Spring of 2020. For the pre- to post-survey, the result showed a statistically significant increase for the clinical teachers in the TPK domain after partaking in the Emergency Remote Learning. In addition, both preservice and clinical teachers rated themselves low in TK self-efficacy, which might be attributed to the insufficient technology integration in the program's curriculum (Nelson, 2020). Overall, it can be seen from the above-cited studies that the effect of the pandemic on teachers' TPACK self-efficacy has not been conclusive, specifically on the technological and pedagogical dimensions.

In the context of Indonesia, where the present study is situated, research on the effect of the pandemic on teachers' TPACK competence has also been carried out. In

terms of language teachers, the pandemic has had varying impacts on the teachers' competence in integrating technology, mediated by their TPACK readiness. For example, a vocational high school English teacher in the study of Aisyah et al. (2021) has been teaching using the Telegram Bot application for a few years, and hence the advent of the pandemic did not constitute a major difficulty for him to switch to the full online lessons. Consequently, this teacher demonstrated a highly-developed TPACK competence and is a model of a successful implementation of teacher-made teaching applications. On the other hand, another study involving 43 EFL teachers demonstrated that the teachers are only at the median level of readiness in learning and applying technology in the classroom due to, among others, their low self-efficacy in using technology (Surayya et al., 2021). Teachers who were perceived to have a high level of TPACK nevertheless still fail to leverage on technological affordances to enact sociocultural practices in their English language teaching (Novita et al., 2022). Overall, the aforementioned studies had not provided conclusive evidence of the impact of the pandemic on language teachers' self-perceived TPACK competence. In other words, to the best of our knowledge, no study has been conducted in Indonesia pertaining to teachers' TPACK self-rating for the onset and during the pandemic.

Higher-Order Thinking Skills (HOTS), in turn, originated from the six cognitive categories of Benjamin Bloom, which comprise Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation (Bloom et al., 1956, as cited in Krathwohl, 2002). HOTS is constituted by the last three categories. Subsequently, Anderson and Krathwohl proposed a revision to the concept and terminology of the taxonomy into Remember, Understand, Apply, Analyze, Evaluate, and Create (Krathwohl, 2002). In Indonesia, where teachers are encouraged to incorporate HOTS into their teaching approaches and activities, it is customary to denote each verb in Anderson and Krathwohl's taxonomy with the letter "C" (for Cognitive) and the number indicating their levels. Therefore, HOTS is known to be the ability to Analyze (C4), Evaluate (C5), and Create (C6) in the corresponding subject matter.

Arising from the directive from the Indonesian Ministry of Education and Culture to incorporate HOTS into the school curriculum, a plethora of studies have been conducted in this respect to depict the impacts, successes, and challenges of the endeavor (Singh & Marappan, 2020). In the field of English language learning, scholars have examined the inclusion of HOTS in teachers' questioning strategy (Gozali et al. , 2021; Yulia & Budiharti, 2019), in English textbooks (Tyas et al., 2020), in cultivating reading skills (Indriyana & Kuswandono, 2019), and in formative assessment (Rachmawati & Purwati, 2021). Despite the sporadic success illustrated by some of the aforementioned studies, implementing HOTS in a language classroom still meets with numerous challenges stemming from teachers' inadequate understanding of HOTS, the lack of infrastructural support from the institution, and unclear government policy (Singh & Marappan, 2020). These manifold challenges are exacerbated by the emergency remote learning enforced by the pandemic. Teachers were unsure of how to deliver HOTS-based lessons online (Umam et al., 2022; Widyastuti, 2022), or were compelled to adjust the syllabus requirement with regards to HOTS incorporation (Faradella, 2022). Notwithstanding this rather bleak outlook, the online learning involuntarily imposed by the pandemic could also constitute an opportune moment to investigate the relationship between HOTS integration and teachers' technological aptitude in a language class. However, the literature in this respect is still rather scarce.

Outside of the language teaching milieu, several studies have attempted to elucidate the interplay between TPACK and HOTS. Researchers developed TPACK-based teaching media in online physics lessons (Bakri et al., 2021; Ilmi et al., 2020; Sinuraya et al., 2021) and science classes (Nisfah & Purwaningsih, 2022) to improve students' HOTS capabilities. At the same time, reinforcing teachers' TPACK and HOTS competence is seen to be a priority in teachers' professional development (Mansyur et al., 2021). Indeed, by incorporating technology in the classroom, teachers will be able to promote students' problem-solving and critical thinking skills, which can be equated to HOTS (Pasani, 2018). Hence, the dearth of research examining the intertwining of TPACK and HOTS in language teachers is rather regrettable, since technological mastery in support of critical thinking skills should not be the purview of science and maths teachers alone. Therefore, the present study aims to shed light on the relationship between TPACK and HOTS in language teachers, while taking advantage of the emergency remote learning during the pandemic in which the teachers were largely obliged to use technology for teaching.

Method

Design

This study was designed primarily as mixed-method research, particularly as an explanatory sequential mixed-method type, which made use of qualitative data to provide further insight into the quantitative responses (Cresswell & Clark, 2017). Numerical data was obtained from a survey, while the written interview provided the qualitative part of the input. The mixed-method design was deemed the most apt for this study due to, in the first place, the ease of collecting quantitative data from validated and modified TPACK questionnaires. However, the third research question of this study, which seeks to delve into the relationship between TPACK and HOTS, necessitates qualitative data, hence the choice of mixed-method design. Lastly, since this study aims to first determine if a perceptual difference exists and then to explain the difference, the explanatory sequential mixed method was selected among the different mixed method designs. A simplified diagram of the design is shown in Figure 2.

Figure 2
The Diagram of the Research Design (Explanatory Sequential Mixed-Method)
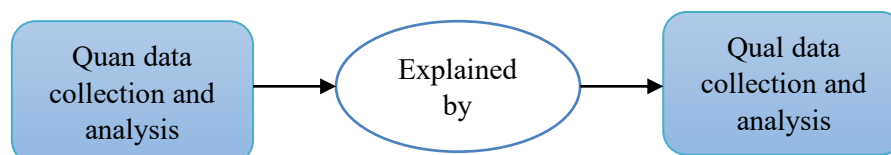
Participants

The institution where the authors are affiliated is involved in a nationwide, in-

service teachers certification program locally termed *Program Profesi Guru* or PPG. The alumni of this PPG program were then invited to take part in this research. During the pandemic, the PPG program was conducted fully online, and so the alumni were likewise contacted through either personal messages or WhatsApp groups, which were kept active to maintain contacts and disseminate news to the alumni. Out of the hundreds of alumni spread throughout several WhatsApp groups, 137 language teachers (English and Bahasa Indonesia) indicated their willingness to participate. They work in various schools in Indonesia, hailing from 56 cities and 13 provinces of the country. The profile of the participants is shown in Table 2.

Table 2
The Profile of the Participants

		N	**%**
Teaching subjects	English	102	74.5
	Bahasa Indonesia	35	25.5
Gender	Male	44	32.1
	Female	93	67.9
School level	Senior high school	57	41.6
	Junior high school	70	51.1
	Elementary school	10	7.3
Teaching experience (years of service)	Senior (>15 years)	31	22.6
	Practitioner (10-15 years)	46	33.6
	Apprentice (5-9 years)	45	32.8
	Novice (<4 years)	15	10.9

Instruments

Quantitative part

For the quantitative part of the study, this research made use of a survey that has been adapted from Rolando et al. (2021) and Zaeni et al. (2021) and has also been subsequently shown through Structural Equation Modeling (SEM) and Confirmatory Factor Analysis (CFA) to be valid and reliable (Tamah et al., 2022). Briefly, the questionnaire consists of 26 self-reported statements spread across the seven TPACK subdomains, with HOTS-related verbs (e.g., "analyze, evaluate, create,) in the question formulation. An example of a statement under the TK (Technological Knowledge) subdomain is "I can **solve** my technical problems using technology," with the "solve" verb being considered as at the Analyze level (C4) of the revised Bloom's Taxonomy. The respondents provided their answers by choosing from a 4-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree." The entire survey statements are reproduced here as Appendix A.

To answer Research Question 1 (the difference between teachers' TPACK perception at the beginning of the pandemic and at present), all the statements were posed in a pair-wise manner, in a 'then and now' fashion. In other words, for the 'then' statements, the participants were asked to provide the answers by thinking retrospectively to the beginning of the pandemic, approximately in March 2020 in the case of Indonesia. The 'now' context means October 2021, when the data collection was conducted. The use

of retrospective perception in this questionnaire is in line with Mourlam et al. (2021) who studied the teachers' self-perception of TPACK before and after the pandemic. Indeed, retrospective perception has been a popular methodological choice among scholars to gauge the impact of the pandemic on various aspects of life, such as the use of technology (Guazzini et al., 2022), teenagers' lifestyle and mental health (Ali et al., 2021), and people's psychological vulnerability (Silveira et al., 2022). Overall, the part of the questionnaire corresponding to RQ 1 is termed Part 1.

For RQ 2 (the difference between self-perceived HOTS level at the beginning of the pandemic and at present), Part 2 was added to the questionnaire. It simply asked the participants to rate themselves, on a scale of 1-10, on their HOTS level both at the beginning of the pandemic and now (October 2021).

Lastly, to answer RQ 3 (the perceived relationship between TPACK and HOTS), the participants were asked to choose from a 4-point Likert scale to express their agreement to the following statement: "By implementing TPACK, my HOTS competence increases."

Qualitative part

The demographic data collected through the survey included an option for the participants to indicate whether or not they were willing to be interviewed after filling out the questionnaire. Out of the 137, a total of 111 participants indicated their consent to be interviewed. Among the 111 participants, eight were selected for the interview through purposive sampling, namely depending on their responses to Part 1 of the survey, in line with the explanatory sequential mixed-method design. In addition, they were also selected based on stratified random sampling in order to achieve a balanced representation of participants in terms of gender, teaching level, and teaching experience. The interview took the form of a written structured interview or WSI (Whetzel et al., 2003), carried out through WhatsApp chats. The WSI was chosen due to its ability to garner responses from several participants simultaneously, scattered in different locations, in a relatively short time. This is deemed necessary owing to the hectic schedule of the participants at the time of data collection (the academic year was in full swing) and the need to seize the moment while online classes were still in force. Although WSI suffers from the absence of non-verbal cues and the negotiation of meaning, its reliability rests on the premise that there is a uniform means of interview administration, and the minimization of interviewers' bias for not having direct communication with the participants (Whetzel et al., 2003). Besides, the interview transcript has high validity since it comes directly from the participants themselves. Due to the nature of the research design, in which the qualitative data is devised to provide explanatory information to the quantitative ones, the interview questions were only drafted upon the completion of the statistical data. The complete interview questions are presented in the Results section.

Data collection

After formulating the content, translating into Bahasa Indonesia, trying out, and testing the validity and reliability (Tamah et al., 2022), the survey was distributed in Google Form format through various WhatsApp groups and social media. The first part of the Google Form contained the identity of the researchers, the research purpose, a

statement of confidentiality, and a consent form. The participants indicated their consent to partake in the research by proceeding to fill out the questionnaire. Reimbursement of internet data was given to those who completed the survey.

As has been previously explained, the interview was carried out to shed further insights into the quantitative data analysis result. Hence, after discovering the pattern shown by the quantitative data, eight participants were selected based on their responses, as detailed in the Results section. They were first contacted through WhatsApp according to the cell phone numbers indicated in the Google Form and were asked once again for their willingness and consent to take part in the interview. The questions were given in writing through WhatsApp chat, and they responded in a similar manner. The profile of the interviewees is shown in Table 3.

Table 3
The Profile of the Interviewees

No	Name (Pseudonyms)	Gender	Teaching level	Teaching subject	Teaching experience
1	Esther	F	Junior high school	English	Apprentice
2	Andy	M	Senior high school	English	Apprentice
3	Diana	F	Senior high school	English	Senior
4	Elsie	F	Senior high school	English	Apprentice
5	Danny	M	Junior high school	English	Apprentice
6	Ivan	M	Elementary school	English	Practitioner
7	Sally	F	Junior high school	English	Practitioner
8	Mary	F	Senior high school	English	Apprentice

Data analysis

For the descriptive statistics, Microsoft Excel was used to analyze the data, while IBM SPSS 22 was employed for the inferential statistics.

For RQ 1, the scores for each TPACK subdomain were first aggregated to produce the average value for the 'then' and 'now'. Then, descriptive statistics were used to find the means for each of the composite values of the subdomains, both in the 'then' and 'now' contexts. The highest and lowest values of the means were then identified. Other data obtained from the descriptive statistics include the skewness values, which revealed that the data in this Part 1 were only moderately skewed (the values ranging from -0.812 to 0.387). This, together with the fact that n>30, warrants the assumption that the data is normally distributed. Hence, the independent, two-sample t-test was used to check for significant differences between the 'then' and 'now' values for each TPACK subdomain. Cohen's d was also calculated with the help of Microsoft Excel to provide alternatives to the result of the t-test.

Likewise, the data in Part 2 on the different perceptions of HOTS' level at the beginning and 'now' were quantified and analyzed statistically. Here, it was also assumed that the data was normally distributed based on the skewness values (from -0.277 to 1.000) and the number of participants (n>30). The independent, two-sample t-test was thus performed to determine whether there are any significant differences between the self-rated HOTS level of the participants at the beginning of the pandemic and 20 months after. Similarly, Cohen's d was also computed. Part 3 of the data was only analyzed using

descriptive statistics.

The qualitative information from the interview was first translated into English, tabulated, and analyzed for themes and patterns using simple code formatting (Miles et al., 2014). The emerging themes were then summarized and displayed.

Findings

Research question 1

The first research question is the quest to discover if there is any difference between teachers' self-perceived TPACK competence, encompassing all the individual TPACK subdomains, at the beginning of the pandemic and at the point when the data was collected (October 2021). To this end, the survey result summary showing the descriptive statistics of the responses is given in Table 4.

Table 4
The Summary of the Descriptive Statistics of the TPACK-HOTS Survey Result at the Beginning of the Pandemic (March 2020) and Now (October 2021)

No	Domains	Mar-20		Oct-21		
		M1	SD1	M2	SD2	M2 - M1
1	TK	**2.562**	0.605	3.119	0.481	**0.557**
2	PK	**2.860**	0.643	3.197	0.558	0.337
3	CK	2.856	0.554	**3.056**	0.554	**0.200**
4	TCK	2.776	0.539	3.148	0.468	0.372
5	PCK	2.839	0.511	3.097	0.473	0.258
6	TPK	2.838	0.521	3.170	0.433	0.332
7	TPACK	2.759	0.559	**3.222**	0.470	0.463

Firstly, assuming a mid-point value of 2.5 on the 4-point Likert scale, it can be seen that the participants rated themselves as above average in all the TPACK domains, as all the mean values were above 2.5. Next, at the beginning of the pandemic, namely March 2020, the highest mean was shown for the PK (Pedagogical Knowledge) domain (M=2.860) and the lowest for TK (Technological Knowledge) (M=2.562). On the other hand, circa October 2021, the highest value of the means was obtained for the TPACK domain (M=3.222) and the lowest for CK (Content Knowledge) (M=3.056).

Looking at the column showing the difference between the two means (M2-M1), positive figures indicate an increase in all domains. In other words, the participants perceived that they have, on average, improved in all TPACK aspects during the pandemic. The biggest increase is indicated for the TK (Technological Knowledge) domain (M2-M1=0.557) and the lowest for CK (Content Knowledge) (M2-M1=0.200).

The summary of the t-test and Cohen's d computation result to check the significant difference is given in Table 5.

Table 5
The t-test and Cohen's d Result for the Difference between the Beginning of the Pandemic (March 2020) and Now (October 2021)

No	Domains		n	M	SD	Sig (2-tailed)	Cohen's d
1	TK	Mar-20	137	2.562	0.605	0.000	1.020
		Oct-21	137	3.119	0.481		
2	PK	Mar-20	137	2.860	0.643	0.000	0.560
		Oct-21	137	3.197	0.558		
3	CK	Mar-20	137	2.856	0.554	0.000	0.360
		Oct-21	137	3.056	0.554		
4	TCK	Mar-20	137	2.776	0.539	0.000	0.737
		Oct-21	137	3.148	0.468		
5	PCK	Mar-20	137	2.839	0.511	0.000	0.523
		Oct-21	137	3.148	0.473		
6	TPK	Mar-20	137	2.838	0.521	0.000	0.693
		Oct-21	137	3.097	0.433		
7	TPACK	Mar-20	137	2.759	0.559	0.000	0.896
		Oct-21	137	3.222	0.470		

The inferential statistics revealed that there existed a significant difference in all the TPACK subdomains ($p<0.05$), from March 2020 to October 2021. Besides, the effect sizes also fell in the range of 'high' for TK and TPACK domains (both > 0.8) and 'medium' for the remaining subdomains (all > 0.5) following Cohen's standard (Cohen, 1988).

Upon obtaining the findings as revealed by the quantitative data as previously mentioned, the interview questions were formulated to gain a deeper insight into the reason behind the numerical results. Hence, the first question posed to the interviewees is as follows: "(1) In the survey, you have indicated a substantial increase in your Technological Knowledge (TK), since the beginning of the distance learning up to now. Could you explain why?" The replies from the respondents were analyzed for common or interesting themes. Invariably, almost all interviewees implied that an increment in technological know-how is inevitable in the online learning situation due to the need to engage and motivate learners to study online, or as fruits of institutionalized training. Excerpts from two of the interviewees illustrate this point (the responses are quoted as they were written):

> "With distant learning, teachers have to use technology, like it or not. Students lack motivation to study from home, so teachers have to learn to use interesting teaching media." (Sally, practitioner, English teacher in a junior high school)

> "During the pandemic, I was invited to attend the *Program Profesi Guru* (Teacher Certification Program), which was held fully online. From there, I learned about online learning media that I can apply to my students." (Danny, apprentice, English teacher in a junior high school)

The second question asked to the participants was, "(2) In the survey, you have indicated that there is not much increase in the Content Knowledge (CK) during the pandemic. Could you explain why?" Here, one respondent attributed it to the need to

focus on improving technological skills, the *status quo* condition in the syllabus mandated by the government, and another to the lack of interaction during online learning, as shown by the excerpts:

> "During the pandemic, teachers have to adapt more in terms of the teaching medium and delivery rather than the object, so the object or Content Knowledge, in this case English, is still the same." (Andy, apprentice, English teacher in a senior high school)

> "The syllabus mandated by the government during distant learning didn't change, but the teachers had to adjust the method of delivery," (Mary, apprentice, English teacher in a senior high school).

> "Face-to-face meetings make it easier for me to improve my Content Knowledge (CK). Students' responses, in terms of content and motivation, to the material that I delivered, tend to be static [in online classes] because of one-way communication. Critical questions or students' difficulties in understanding the material [in offline classes] spur me to improve in my CK." (Esther, apprentice, English teacher in a junior high school)

Thirdly, the interviewees were asked for the reason behind their high self-rating for the TPACK subdomain 20 months into the Emergency Remote Learning situation with the following question: "(3) In the survey, you indicated high agreement for statements related to TPACK subdomain. Could you explain why?" Here, the participants credited their high confidence in their TPACK rating either to schools' support, self-motivation, or the increase in the enthusiasm and engagement of their students. Extracts from their replies are given:

> "[My school] implemented various platforms at the beginning of distance learning, such as *Quipper, Quizziz*, and *Google Classroom.* At first, it wasn't easy. However, slowly the teachers honed their skills and now they are used to it." (Andy, apprentice, English teacher in a senior high school).

> "Due to the demand to be innovative and creative in using technology for teaching, it made me learn on my own so I can master various applications such as making teaching videos and using gamification-based interactive media." (Esther, apprentice, English teacher in a junior high school).

> "I crafted my lesson in *Google Jamboard* in such a way that the students forgot that they are learning school materials. I can see the enthusiasm of the students in actively participating in online classes." (Danny, apprentice, English teacher in a junior high school).

Research question 2

RQ2 aimed to determine if a difference existed between teachers' self-perceived HOTS levels at the beginning of the pandemic (March 2020) and at the moment of data collection (October 2021). In the survey, the participants were asked to rate themselves on a scale of 1-10, both in the 'then' and 'now' time frame.

Similar to RQ1, the descriptive statistics and the significant difference test were computed, the result of which is presented in Tables 6 and 7, respectively.

Table 6

The Descriptive Statistics of Self-Rated HOTS Level at the Beginning of the Pandemic (March 2020) and Now (October 2021)

	Mar-20		Oct-21	
	M1	**SD1**	**M2**	**SD2**
HOTS rating	6.270	1.704	7.533	1.485

Table 7

The t-value and the Cohen's d for the Difference between the Self-Rated HOTS Level at the Beginning of the Pandemic (March 2020) and Now (October 2021)

|		**n**	**M**	**SD**	**Sig (2-tailed)**	**Cohen's d**
HOTS rating	Mar 2020	137	6.270	1.704	0.00	0.790
	Oct 2021	137	7.533	1.485		

The preceding tables show that there is an increment in the teachers' self-rating of HOTS capability in the 20 months into the pandemic, as evidenced by the positive rise in the means from March 2020 to October 2021 shown in Table 6. It is further confirmed by Table 7 that this rise is statistically significant ($p < 0.05$). The effect size as presented by Cohen's d also falls under the 'medium' category (> 0.5) by Cohen's standard.

Research question 3

The third and the last RQ sought to discover the perceived relationship, if any, between TPACK and HOTS competence according to the language teachers. Here, the participants were asked to indicate their agreement in the form of a 4-point Likert scale to a statement that says, "By implementing TPACK, my HOTS competence increases." A summary of their responses to this statement is displayed in Figure 3.

Figure 3

The Summary of the Participants' Responses to the TPACK-HOTS Relationship Statement
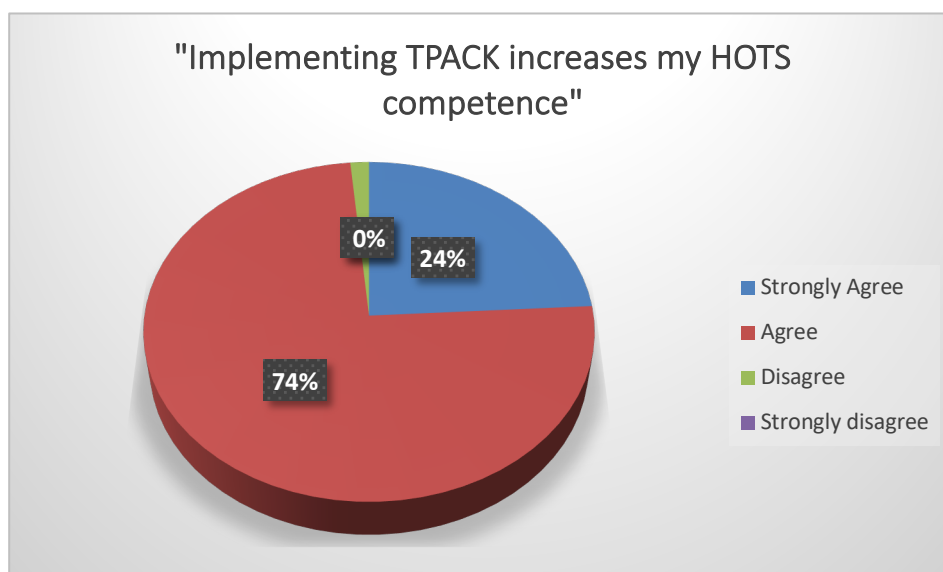
The pie chart shows that an overwhelming majority of the participants (74%) chose Agree, 24% selected Strongly Agree, an almost negligible number chose Disagree, while none answered Strongly Disagree.

The eight participants interviewed were asked for the reason behind their strong agreement to the relationship between TPACK and HOTS in teachers. Almost all of the teachers responded to the effect that teaching with technology facilitates them in making HOTS-based tasks, exercises, and assessments. The following excerpts illustrate this point:

> "In my opinion, TPACK is related to HOTS, or to be exact, it facilitates the implementation of HOTS-based lessons. For example, in HOTS-based English lessons, students are expected to be able to analyze, compare, and categorize verbs according to the tenses. I used *Jamboard* which I designed in such a way that students can do it in a collaborative manner." (Ivan, practitioner, English teacher in an elementary school).

As a corollary, teachers' TPACK competence is also seen to promote HOTS in the students, as affirmed by an interviewee:

> "The more creative the teachers are in presenting lessons that engage students, the higher the students' motivation will be to explore their thinking skills, in accordance with the use of technology in the 21st century." (Elsie, apprentice, English teacher in a senior high school).

Discussion

Employing a validated TPACK-HOTS questionnaire, this study set out to find out first whether there is a change in the language teachers' perception of their TPACK competence from the beginning of the pandemic in Indonesia (circa March 2020) to the moment when the data was collected (October 2021). From the 137 survey forms analyzed, the quantitative data analysis showed a statistically significant increase in all the TPACK domains, particularly in those of TK and TPACK. This result differs from those reported by Chen and Hsu (2021), Mourlam (2021), and Nelson (2020), whose results presented a decline in some domains. One of the possible reasons might simply be the time frame when the data was collected. The above-cited studies collected data in 2020, when the pandemic was still in full swing, and a relatively shorter time (about a few months) has elapsed between the beginning of the outbreak and the data collection. This study, on the other hand, was conducted around 20 months after the start of the pandemic in Indonesia. Therefore, as attested by one of the interviewees, at this juncture, the teachers have "honed their [technological] skill and are now used to [technology]." Hence, they perceived that, overall, their TPACK competence had somewhat improved during the pandemic. The outcome of this study is also in line with that of Huang et al. (2022), who provided statistical evidence on the mediating role of TPACK on teachers' increased self-efficacy during the pandemic.

Another possible reason for the significant increase of all TPACK domains in this study is the profile of the participants being surveyed. Most of the teachers who responded to the call to participate in the research were alumni of the *Pendidikan Profesi Guru ("PPG")* or Teacher Certification Program course held by the university where the

researchers are affiliated with. Improving in-service teachers' TPACK competence has been one of the focuses of the PPG training (Apriliaswati, 2020; Hartarti et al., 2019). During the pandemic, this short-term (approximately four months) course was conducted entirely online, with the in-service teachers being trained and assessed on how they employ technology in their teaching. It is then of little wonder that many of them perceived an increase in their TPACK competence.

A potentially interesting finding is the fact that the teachers did not indicate a marked improvement in their Content Knowledge (CK), which in this case is English language skills, during the pandemic. One would expect that the flourishing of free, online webinars in recent times should have facilitated the acquisition of CK for teachers, but it is not the case. The reasons put forward by the interviewees were quite revealing. On the one hand, teachers did not seem to put too much premium on increasing their CK during the Emergency Remote Learning and focused their attention on technological know-how instead. While this might be understandable and sensible, one wonders if the emphasis on TK is done at the expense of other types of knowledge. On the other hand, it was also interesting that for some teachers, CK is seen to be a function of students' critical inquiry, as well as the government's mandate on the emergency curriculum. This way of acting appears to imply a lack of internal motivation in the teachers to improve their CK.

Although research on CK *per se* attracted lesser attention on the part of scholars these days, it can be imagined that knowledge of subject matter for teachers is fundamental. Some studies documented a positive relationship between teachers' subject knowledge and students' achievement (Metzler & Woessmann, 2012; Shepherd, 2013). Teachers' CK has also been shown to have a direct impact on their ability to teach the relevant points and to make clarifications (Jadama, 2014). During the pandemic, some EFL students even admitted that the teachers' content knowledge matters more to them than the teachers' technological competence (Gozali & Cahyono, 2022). In fact, Renandya et al. (2018) had voiced their concerns regarding the English proficiency of Indonesian EFL teachers, which directly impacted the effectiveness of their lesson delivery. Hence, considering the importance of continuously developing the CK competence in the teachers, further research can be done to verify whether the pandemic has had a detrimental effect on teachers' CK in overall professional development.

Secondly, this study was also aimed at finding whether the language teachers perceived a change in their level of HOTS from the beginning of the pandemic to twenty months later. The quantitative data revealed a statistically significant increase in the participants' self-perception of HOTS levels. It is interesting to contrast this finding with several studies that documented the challenges faced by teachers in implementing HOTS-based lessons or assessments to students during the pandemic (Lie et al., 2020; Ritonga et al., 2021; Sirait et al., 2021). The difficulties in implementing HOTS range from the lack of support from schools, students' mixed ability, or even teachers' own (deficient) understanding of HOTS.

So, why did the teachers perceive a rise in their HOTS level during the pandemic? The answer lies in the data analyzed under Research Question 3. When asked whether there is a relationship between TPACK and HOTS, a significant majority (74%) voted for "Agree." The qualitative data reveal that teachers perceived their improvement of TPACK skills to be in tandem with that of HOTS. In other words, TPACK is seen to empower teachers by facilitating the affordances of technologically-based HOTS media, materials, and teaching approaches. The perception of the language teachers is thus

aligned with the previously cited studies outside of the language teaching field evidencing the success of incorporating technology in the teaching and learning process, with the aim of improving the students' HOTS (Bakri et al., 2021; Ilmi et al., 2020; Pasani, 2018; Zainuddin et al., 2021). In sum, despite the possible challenges facing the teachers in their effort to inculcate HOTS in their students during the pandemic, they still perceived that their HOTS competence has improved, leveraged by their increased confidence in employing technology in the classroom. Therefore, even when classes revert to fully "offline"or face-to-face when the pandemic is over, the increased confidence of the teachers in technological competence as shown in this study constitutes a powerful arsenal not just for embedding technology in the classroom, but also to promote critical thinking, as embodied by HOTS, in the students. We then believe that this study, albeit conducted within the context of the COVID-19 pandemic, offers meaningful insight into the post-pandemic education milieu in demonstrating both the gain in teachers' self-rated competence in technological integration and its implication on the teachers' perception of their ability to enact HOTS-based lessons.

Conclusion

In the quest to find whether there are differences in the language teachers' self-rated level of TPACK and HOTS throughout the 20 months of the pandemic, as well as the perceived relationship between TPACK and HOTS, this study has unraveled three outcomes. Firstly, the teachers rated themselves higher on average in all of the TPACK domains, from the beginning of the pandemic (March 2020) until the data collection moment (October 2021). The largest increment, as measured by the means difference between "then" and "now," was noted in the TK subdomain, and the highest value for the means for the "now" time frame was in the TPACK subdomain. Overall, this quantitative data and the subsequent theme that emerged from interview data analysis point to the conclusion that the teachers in this study felt somewhat confident of their technological capability in teaching after 20 months of Emergency Remote Learning had elapsed. However, the relatively smaller rise in the mean difference of the CK subdomain may imply that teachers focused on technology at the expense of their subject matter knowledge. Secondly, this study also revealed that teachers also perceived their HOTS competence level to increase in a statistically-significant way during the pandemic. Lastly, the vast majority of the teachers concurred that implementing TPACK results in an increase in HOTS capability, which indirectly is the reason for their high self-rating for HOTS after 20 months of Emergency Remote Learning.

This study thus would like to recommend that, taking advantage of the teachers' familiarity with technology for pedagogy at the present moment, a more holistic professional development for teachers should be designed, in which this technological know-how is exploited to promote teachers' subject matter mastery. As mentioned earlier, more systematic research can be conducted to investigate the impact of the pandemic on teachers' level of Content Knowledge. Lastly, in view of the possibility of having a blended or hybrid learning mode when the pandemic is better managed, teachers should not rest on their laurels and continue to make use of their acquired technological knowledge to impart HOTS-infused media and assessment in the new setting.

Health protocol and time constraints have impeded the researchers from

conducting face-to-face interviews, and even a teleconference, which would have yielded richer qualitative data. The pooling of the participants could have been made more comprehensive so as to reach a more diverse type of participants. Despite the limitations, it is hoped that this study has made a contribution to the burgeoning literature on TPACK, specifically on TPACK-HOTS, which is highly applicable to teachers' professional development in Indonesia.

Acknowledgement

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Appendix A

The TPACK-HOTS Integrated Questionnaire

A	Technological Knowledge	
1	I can learn and use new technology easily.	(C3 Apply)
2	I can **solve** my technical problems using technology.	(C5 Evaluate)

3	I can be **creative** when using technology.	(C6 Create)
B	**Pedagogical Knowledge**	
1	I can choose **learning** strategies according to the needs and conditions of students	(C5 Evaluate)
2	I can **manage/organize** the steps of the learning method to make it easier for students to understand the material.	(C6 Create)
3	I can **manage/organize** the class so that students don't get bored in learning.	(C6 Create)
4	I can **choose** the correct form of assessment according to the characteristics of the material.	(C5 Evaluate)
5	I can **choose** the form of assignments that help students to think critically.	(C5 Evaluate)
C	**Content Knowledge**	
1	I judge that my **knowledge** of teaching English is sufficient.	(C5 Evaluate)
2	I can **solve** problems related to English.	(C5 Evaluate)
3	I can **develop** a deeper understanding of English.	(C6 Create)
D	**Technological – Content Knowledge**	
1	I can **search and use** technology created specifically for English	(C3 Apply)
2	I consider that my **knowledge** of technology for English research is sufficient.	(C5 Evaluate)
3	With technology, I can **collaborate** with colleagues to deepen my knowledge of English	(C6 Create)
E	**Pedagogical – Content Knowledge**	
1	Without technology, I can **explain** various theories and problems in English science.	(C4 Analyze)
2	Without technology, I can **choose** a suitable learning method for learning English.	(C5 Evaluate)
3	Without technology, I can **arrange** the stages of material to support the understanding of English.	(C6 Create)
F	**Technological – Pedagogical Knowledge: I can use technology to**	

1	Make students **apply** their knowledge in the real world.	(C3 in students)
2	Help students **find** information on their own.	(C5 in students)
3	Make students **design** forms of information representation in various ways (text, graphics, videos, comics, etc.).	(C6 in students)
4	Make students **collaborate** with each other in using technology.	(C6 in students)
G	**Technological – Pedagogical – Content Knowledge**	
1	I can **combine** technology with the methods used to teach English content.	(C6 Create)
2	I can **choose** technology in my classroom to improve what I teach, how I teach, and what students learn.	(C5 Evaluate)
3	I can **create** independent learning activities with technology for learning English.	(C6 Create)
4	I can **evaluate** English learning combined with technology based on indicators.	(C5 Evaluate)
5	I can **help** my colleagues integrate technology, pedagogy, and content in my school.	(C5 Evaluate)