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The more experienced, the better prepared? New evidence on the relation between teachers' experience and their readiness for online teaching and learning

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ABSTRACT

In the present study, we tested the common assumption that teachers with more experience consider themselves better prepared for online teaching and learning (OTL). Utilizing the data from a survey of 366 higher-education teachers from Portugal at the beginning of the COVID-19 pandemic in 2020, we performed structural equation modeling to quantify the experience-readiness relationship. The survey contained an assessment of teachers' OTL readiness which was measured by their perceptions of the institutional support, online teaching presence, and TPACK self-efficacy. In contrast to the linearity assumption "the more experienced, the better prepared", we found robust evidence for a *curvilinear* relationship. Teachers' readiness for OTL increased first and then decreased with more experience—this applied especially to the self-efficacy dimension of readiness. Further analyses suggested that the experience-readiness relationship does not only exist at the level of aggregated constructs but also at the level of indicators, that is, specific areas of knowledge, teaching, and support. We argue that both novice and experienced teachers in higher education could benefit from experience-appropriate, pedagogical, and content-related support programs for OTL.

1. Introduction

In recent years, lockdowns, school closures, and social distancing due to the COVID-19 pandemic have forced higher-education teachers in many countries into transitioning to online teaching and learning (OTL), also referred to as "remote teaching" (Brooks & Grajek, 2020). This move to OTL has brought to attention teachers' *readiness* to adopt new or adapt existing ways of teaching (Damşa, Langford, Uehara, & Scherer, 2021; Núñez-Canal, de Obesso, & Pérez-Rivero, 2022)—a concept that comprises multiple dimensions, including knowledge, skills, and competence, teaching practices, and institutional support (Christensen & Knezek, 2017; Hung, 2016). To effectively promote OTL readiness and competences, professional development and teacher training programs need to be tailored to the teachers' various needs and backgrounds (Darling-Hammond, Hyler, & Gardner, 2017). As a consequence, OTL research has been aimed at identifying the factors that may explain why or why not teachers consider themselves ready for OTL (Sailer, Schultz-Pernice, & Fischer, 2021)—experience is one of these factors (Scherer, Howard, Tondeur, & Siddiq, 2021).

Studies on teacher readiness are largely based on the assumption that the experience-readiness relationship is linear and either negative or positive (e.g., Downing & Dyment, 2013; Hung, 2016; Martin, Budhrani, & Wang, 2019; Scherer et al., 2021). This common linearity assumption suggests that more experienced teachers tend to consider themselves better (or worse) prepared for OTL than less experienced teachers. This assumption can result in overemphasizing support for inexperienced teachers and, at the same time, can put at risk experienced teachers by providing only little support. Moreover, the linearity assumption ignores teachers' needs for experience-appropriate support and professional development (e.g., Collinson et al., 2009). Christensen and Knezek (2017) and Cutri, Mena, and Whiting (2020) observed a piecewise linear relationship indicating that teachers with intermediate experience had maximal readiness scores. A possible curvilinear rather than a linear relation could explain the variation in the direction and statistical

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significance of the correlations across studies (e.g., Downing & Dyment, 2013; Martin, Wang, Jokiaho, May, & Grubmeyer, 2019). Another explanation refers to the level at which the experience-readiness relationship is reported. Most studies report this relationship at the construct level, yet not the indicator level. However, the latter is important for crafting a validity argument, because it uncovers possible indicator bias and unfairness of the readiness measures across the experience spectrum (AERA et al., 2014).

Overall, the evidence on the experience-readiness relationship is scarce and inconsistent, especially with respect to the *nature, strength, and direction of the relationship*. The present study addresses this challenge on these dimensions by generating new evidence on the experience-readiness relationship for different types of experience (i.e., general teaching experience vs. OTL experience) and for a sample of higher-education teachers at the beginning of the COVID-19 pandemic in 2020. We further test the robustness of our findings and discuss possible implications for supporting teachers in OTL.

2. Theoretical background

2.1. Conceptualizing and measuring teacher readiness for OTL

In our study, we refer to OTL as activities providing learning content and resources, creating experiences and interactions, communicating and collaborating using online platforms or tools (based on Ally, 2008). In the extant literature on OTL, teacher readiness has been defined in many ways. It generally refers to "a state of faculty preparedness for online teaching" (p. 97Martin, Budhrani, & Wang, 2019) and represents a system of knowledge, skills, attitudes, beliefs, and facilitating conditions (Cutri & Mena, 2020; Graham, Woodfield, & Harrison, 2013). Some studies represented this system as a unidimensional readiness construct (e.g., Chua & Chua, 2017; Inan & Lowther, 2010; Paliwal & Singh, 2021), while others distinguished between multiple dimensions (see Supplementary Material S1). Scherer et al. (2021) argued that teachers' readiness comprises both personal and contextual readiness and includes multiple dimensions. Three core dimensions dominated these conceptualizations: (a) Knowledge, skills, and competence; (b) teaching practices; and (c) institutional support, and eight studies provided empirical evidence on their distinction (e.g., Chou, Hung, Tsai, & Chang, 2020; Hung, 2016; Petko, Prasse, & Cantieni, 2018). For instance, Hung (2016) distinguished between two core dimensions of teacher readiness, namely self-efficacy and institutional support. The former comprised several subdimensions, such as self-efficacy in communication, learning transfer, and self-directed learning. For multiple samples of school teachers, the self-efficacy subdimensions and institutional support were positively and moderately correlated (ρ = 0.42-0.59).

In their study of higher-education teachers, Scherer et al. (2021) distinguished between three readiness dimensions—self-efficacy, online teaching presence, and institutional support—and assessed them via self-reports. Similar to Hung's (2016) observations, these three dimensions were positively correlated (ρ = 0.25-0.87) and could be distinguished empirically. This study extended the range of readiness dimensions by including teachers' perceptions of online teaching presence as representatives of teaching practices. Online teaching presence is key to high-quality instruction and unites social, teaching, and cognitive presence (Law, Geng, & Li, 2019). Specifically, creating these forms of presence includes, but is not limited to active communication, interaction between learners, feedback, cognitively activating tasks, clarity of instruction, and assessment (Gurley, 2018; Kreijns, Xu, & Weidlich, 2022; Rapanta, Botturi, Goodyear, Guàrdia, & Koole, 2020).

Moreover, the Scherer et al.'s (2021) measures of self-efficacy were based on the TPACK (Technological and Pedagogical Content Knowledge) framework (see Koehler, Mishra, Kereluik, Shin, & Graham, 2014) and included technology-specific knowledge domains in pedagogy and teaching content that were relevant for implementing OTL and teaching with technology in general (Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013). Specifically, Scherer et al. (2021) assessed self-efficacy in TPCK (i.e., knowledge about the interplay between pedagogy, teaching content, and technology), TCK (i.e., knowledge about the ways of representing teaching content with technology), TPK (i.e., knowledge about the instructional use of technology), and TK (i.e., knowledge about and of technology). The TPACK framework has been adopted in studies of teachers' technology integration and provides a nuanced perspective on self-efficacy via multiple types of knowledge (Brinkley-Etzkorn, 2018; Gudmundsdottir & Hathoway, 2020; Voogt et al., 2013). Notably, most studies adopting this framework used self-efficacy measures based on teachers' perceptions of their knowledge (Lachner, Backfisch, & Stürmer, 2019).

Several studies have highlighted the importance of institutional support as a condition facilitating readiness for OTL (e.g., Chou et al., 2020; Graham et al., 2013; Scherer et al., 2021). Institutional support can operate through different processes. For instance, institutional support via creating a shared vision for OTL can motivate teachers to adopt new teaching approaches with technology (Tondeur et al., 2019). Moreover, institutional support that facilitates teacher collaboration can increase teachers' innovativeness and improve teaching practices (Blömeke, Nilsen, & Scherer, 2021). Especially during the rapid transition to OTL at the time of the COVID-19 pandemic, pedagogical and technological support, leadership, and vision building were critical elements of the institutional support for higher-education teachers (Bao, 2020; Mittal, Mantri, Tandon, & Dwivedi, 2021).

Overall, the extant research considers teachers' readiness for OTL a multidimensional concept that is largely based on several areas of knowledge, teaching, and support. These dimensions were measured mainly by self-reports and existing scales, such Hung's (2016) "Teacher Readiness for Online Learning Measure" or Archambault's and Crippen's TPACK self-efficacy measure (e.g., Howard, Tondeur, Siddiq, & Scherer, 2021; Scherer et al., 2021).

2.2. Readiness for OTL and teacher experience

Teachers' readiness for OTL does not only depend on contextual characteristics, such as the professional development opportunities provided by educational training institutions or the universities' technical resources (Baran & Correia, 2014; Graham et al., 2013; Sailer et al., 2021), but also teachers' background characteristics, digital competence, and especially their experience (Guillén-Gámez, Cabero-Almenara, Llorente-Cejudo, & Palacios-Rodríguez, 2021; Hung, 2016). As a consequence, OTL readiness research has examined the connections between teacher readiness and experience, oftentimes assuming that experienced teachers are better prepared for OTL than less experienced teachers (e.g., Downing & Dyment, 2013; Prieto & Altmaier, 1994; Scherer et al., 2021). From a theoretical perspective, this assumption is backed, for instance, by self-efficacy theories which postulate that persons who experience mastery more often tend to show higher self-efficacy (Tschannen-Moran & McMaster, 2009). Empirical studies of teacher samples have documented this positive correlation between teacher experience and teaching self-efficacy: For instance, Prieto and Altmaier (1994) examined the relationship between teaching experience and self-efficacy among graduate teaching assistants and found a positive correlation. Tschannen-Moran and Woolfolk Hoy (2007) compared several dimensions of self-efficacy between novice and expert teachers and found consistently higher score for more experienced teachers. This tendency also transferred into teachers' perceptions of the support they have received from their institutions. In the OECD Teaching and Learning International Survey (TALIS), on average, novice teachers reported lower levels of confidence in teaching than experienced teachers with five or more years of teaching experience (OECD, 2019). The linearity assumption thus has some empirical backing for teachers' self-efficacy. Other perspectives pointing to the possibility of linear experience-readiness relationship is based on the decline of adaptability or openness to change with increasing age (Donnellan & Lucas, 2008; Ferguson, Brunsdon, & Bradford, 2021) or the increase in innovativeness with more experience (Blömeke et al., 2021; Vanderlinde, Aesaert, & van Braak, 2014). However, some studies on general teaching self-efficacy uncovered curvilinear relationships. For instance, Klassen and Chiu (2010) found an inverted U-shaped relation between the years of teaching experience and three dimensions of self-efficacy (i.e., classroom management, teaching strategies, and student engagement). According to this observation, self-efficacy increases with experience up to an optimum and then declines with more experience.

To map the empirical evidence on the nature, strength, and direction of the experience-readiness relationship, we performed a rapid systematic review of empirical readiness studies across all educational levels and retrieved 26 publications, including 13 higher-education teacher samples (for a detailed description of the review methodology and the empirical studies, please refer to Supplementary Material S1). In this sample of publications, Scherer et al. (2021) found a positive correlation between OTL experience and two readiness constructs, that is, teachers' self-efficacy and the perceived online teaching presence (up to $r = 0.22$) for 739 higher-education teachers. For a German higher-education teacher sample, Martin, Wang, et al. (2019) observed a significant and negative correlation between OTL experience and self-efficacy in technology use ($r = -0.16$). These linear relations suggested that more experienced teachers tended to consider themselves better (or worse) prepared for OTL than less experienced teachers. Our systematic review provided more examples of the diversity in the nature, strength, and direction of the experience-readiness relationship. Of the nine empirical studies investigating this relationship, six assumed a linear relationship which showed positive or negative and significant or insignificant correlations (see Supplementary Material S1). Three studies reported piecewise linear relations that peaked for teachers with intermediate experience (e.g., Cutri et al., 2020). In conclusion, the possibility of a curvilinear rather than linear experience-readiness relationship could explain the divergent findings in the field of OTL.

While existing research has reported and quantified the experience-readiness relationship at the aggregated level of constructs, this relationship may also exist at the more fine-grained level of construct indicators. Construct indicators represent specific areas of knowledge, teaching, and support and form the "backbone" of reflective measurement models of constructs (Borsboom, Mellenbergh, & van Heerden, 2003). If teacher experience is related to the construct indicators beyond its relation to the aggregated readiness constructs, then the readiness measurements can neither be considered invariant nor fair across the experience spectrum. In this situation, the readiness indicators exhibit differential item functioning—a property that compromises the validity argument for a measure (Bauer, 2017). Hence, it is critical to rule out or control for the relations between teacher experience and readiness indicators when drawing inferences on the experience-readiness relationship at the construct level. In our review, none of the nine studies that reported the relationship considered the indicator level.

To rule out possible dependencies of research results on methodological, contextual, or measurement artefacts and to address the credibility and validity of scientific evidence (e.g., Duncan, Engel, Claessens, & Dowsett, 2014), robustness checks are critical. In the context of teacher readiness for OTL, several dependencies can occur: First, given that readiness measures are often based on reports of self-efficacy, they may function differently across subgroups of teachers. Specifically, the existing body of research uncovered gender differences in the levels of technology-related self-efficacy and the possible non-invariance of the respective measures (Martin, Wang, et al., 2019; Scherer & Siddiq, 2015). Second, the nature, strength, and direction of the experience-readiness relationship could be biased due to extreme cases at both the lower and the upper end of the years of experience. This bias may occur when data from novices and experts or pre- and in-service teachers are combined. Third, the indicators of teaching experience can be confounded by teachers' age, so that the effects of experience on readiness may actually represent effects of age (Klassen & Chiu, 2010).

Fourth, variation in responses to readiness and especially self-efficacy measures could also be due to variation in teachers' actual digital competences. In this line of thinking, teachers with limited digital competences may overestimate their capabilities and thus tend to provide more positive self-reports (Schmid, Brianza, & Petko, 2021)—an effect referred to as the "Dunning-Kruger Effect" (Kruger & Dunning, 1999). While this effect may bias the teachers' perceptions of their digital competences and the competences of teaching with technology, the extant evidence base supporting its existence is mixed, likely due to the lack of empirical studies assessing both self-reported and performance-based digital (teaching) competences (Lachner et al., 2019). In fact, some researchers argued that the Dunning-Kruger Effect may only represent a statistical artefact (e.g., Gignac & Zajenkowski, 2020).

Fifth, at the beginning of the COVID-19 pandemic and the first lockdowns in early-2020 in many countries, higher-education teachers were facing a challenging, uncertain, and novel situation that required them to transition to OTL (OECD, 2021). Given that many teachers had to upskill and develop their digital (teaching) competences during this time, they may have struggled evaluating their own readiness, let alone the effectiveness of their online teaching practices. Hence, reported low levels of readiness could be associated with a lack of prior experience.

In the sample of the 26 studies we reviewed, seven studies reported gender differences in the experience-readiness relationship, only three studies performed outlier checks, and age confounding was not tested. However, to craft a validity argument, we consider the checking of these three dependencies (i.e., gender differences, experience outliers, and age confounding) to be critical to research on teachers' readiness for OTL.

2.3. The present study

Among others, OTL readiness research is concerned with the relations among teacher background characteristics, such as gender, age, and experience, and teachers' readiness levels (Scherer et al., 2021). This is essential, because knowledge about the extent to which such characteristics may explain why or why not teachers consider themselves ready for OTL can uncover the possible needs for support (Christensen & Knezek, 2017; Cutri et al., 2020). In the present study, we focus on teacher experience as one of these characteristics and present new evidence on the nature, strength, and direction of the experience-readiness relationship for a sample of higher-education teachers. We first examine the experience-readiness relationship across three readiness dimensions—namely TPACK self-efficacy, perceived online teaching presence, and perceived institutional support—and across two experience indicators—namely, general teaching experience and experience with OTL (see Fig. 1). In doing so, we extend the current body of research and address the aforementioned key challenges as follows: Instead of including only a single readiness dimension, we include *multiple readiness dimensions* beyond self-efficacy. Instead of assuming a linear experience-readiness relationship, we test for *curvilinear relations*. Moreover, we do not only consider aggregated scores of readiness at the level of *constructs*, but also specific areas of knowledge, teaching, and support at the level of *indicators*. Our research questions (RQs) are:

RQ 1. To what extent are teachers' experience and readiness for online teaching and learning related? (Construct level)

RQ 2. To what extent does the functioning of the readiness measurement depend on teachers' experience? (Indicator level)

We examine the robustness of the experience-readiness relationship at the levels of constructs and indicators across gender, the sensitivity to outliers, possible confounding by age or the days of preparing for OTL, and differences across subject domains. Our research draws from a convenience sample of higher-education teachers and makes an initial

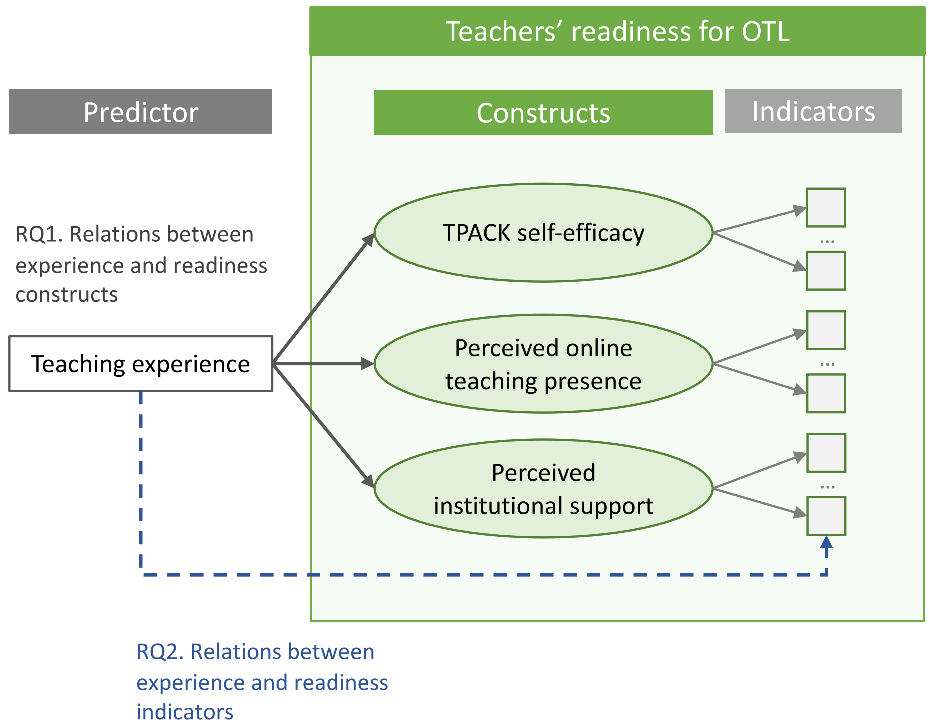

Fig. 1. Research Model Describing the Relationship between Teacher Experience and OTL Readiness
Note. OTL = Online teaching and learning, RQ = Research question, TPACK = Technological and pedagogical content knowledge.

exploration into this relationship, which needs to be further understood to be able to appropriately support teachers in ongoing change.

3. Method

3.1. Sample and procedure

We analyzed the data of teachers in higher education (e.g., universities and university colleges) who participated in an online survey at the beginning of the COVID-19 pandemic (between March and May 2020). After an informed consent, teachers were invited to provide information about their background, teaching experience, and the context of the shift to OTL, and indicate their levels of readiness for OTL. The initial study sample contained 731 teachers in 58 countries, primarily from Europe and Central Asia (84.1%) and other world regions (East Asia & Pacific: 5.1%, Latin America & Caribbean: 2.6%, Middle East & North Africa: 2.6%, North America: 2.5%, South Asia: 1.2%, Sub-Saharan Africa: 1.9%; World regions according to World Bank). The details of the sampling and recruitment procedures are described in greater detail by Scherer et al. (2021). To rule out possible country effects and contextual differences in online teaching and learning at the time of the assessment, we selected the largest sample of teachers for the present study. This sample was comprised of 366 teachers in Portugal.

Given that this study was conducted at the beginning of the COVID-19 pandemic and the respective lockdowns, a random sampling of higher-education teachers within the country was problematic and not feasible, as several other studies during this period testified (e.g., Damşa et al., 2021; Gudmundsdottir & Hathoway, 2020; Los, De Jaeger, & Stoesz, 2021; Strietholt, Fraillon, Liaw, Meinck, & Wild, 2021). Although teachers faced similar challenges and uncertainty associated with the first COVID-19 lockdown, higher-education institutions' responses may have varied (OECD, 2021; UNESCO IESALC, 2020), so that the contexts teachers' responses are based in may differ as well (Sailer et al., 2021). To control for such differences, we captured several indicators of the responses to the lockdown, such as the time teachers were given to transition to OTL, and whether the transition was mandatory (see Supplementary Material S3).

On average, teachers were 51.6 years of age ($SD = 8.4$, $Mdn = 52$), and the sample comprised 54.9% women. Most teachers taught in the Engineering (22.5%), followed by Business (17.4%), and the Social Sciences (15.4%). Fig. 2 details the proportions of subject domains in the sample. About 27.6% of the teachers had some experience with OTL, and teachers were given 7.3 days ($SD = 6.2$, $Mdn = 7$), on average, to adopt OTL, yet not more than 33 days.

3.2. Measures

3.2.1. Teacher readiness for OTL

The readiness for OTL measure contained three dimensions: teachers' self-efficacy in their TPACK, perceived online teaching presence, and the perceived institutional support. These dimensions covered teachers' readiness perceptions of core aspects of knowledge, teaching, and support (e.g., Christensen & Knezek, 2017; Hung, 2016; Scherer et al., 2021). All readiness indicators in the teacher questionnaire can be accessed via the Supplementary Material S2.

TPACK self-efficacy. In the TPACK framework, the pedagogical and content-related dimensions are represented by TPK, TPCK, and TCK. Drawing from Archambault and Crippen's (2009) measure, these dimensions were assessed as teachers' self-efficacy beliefs (Scherer et al., 2021). Specifically, teachers were asked to indicate their agreement with ten statements about TPK (e.g., "I am confident in my ability to implement different methods of teaching online"; 4 items), TPCK (e.g., "I am confident in my ability to use technology to predict students' skills/understanding of a particular topic"; 4 items), and TCK (e.g., "I am confident in my ability to use various programs to deliver instruction"; 2 items) on a 5-point scale (*0 = I strongly disagree, 4 = I strongly agree*). The resultant internal consistencies ranged between Cronbach's $\alpha = 0.80$ and 0.86 (see Table 1).

Perceived online teaching presence (POTP). Three dimensions captured the teachers' perceptions of the online presence they created during their teaching (Gurley, 2018; Howard et al., 2021): Instructional clarity (POPCLA; e.g., "Overall, I can clearly communicate important

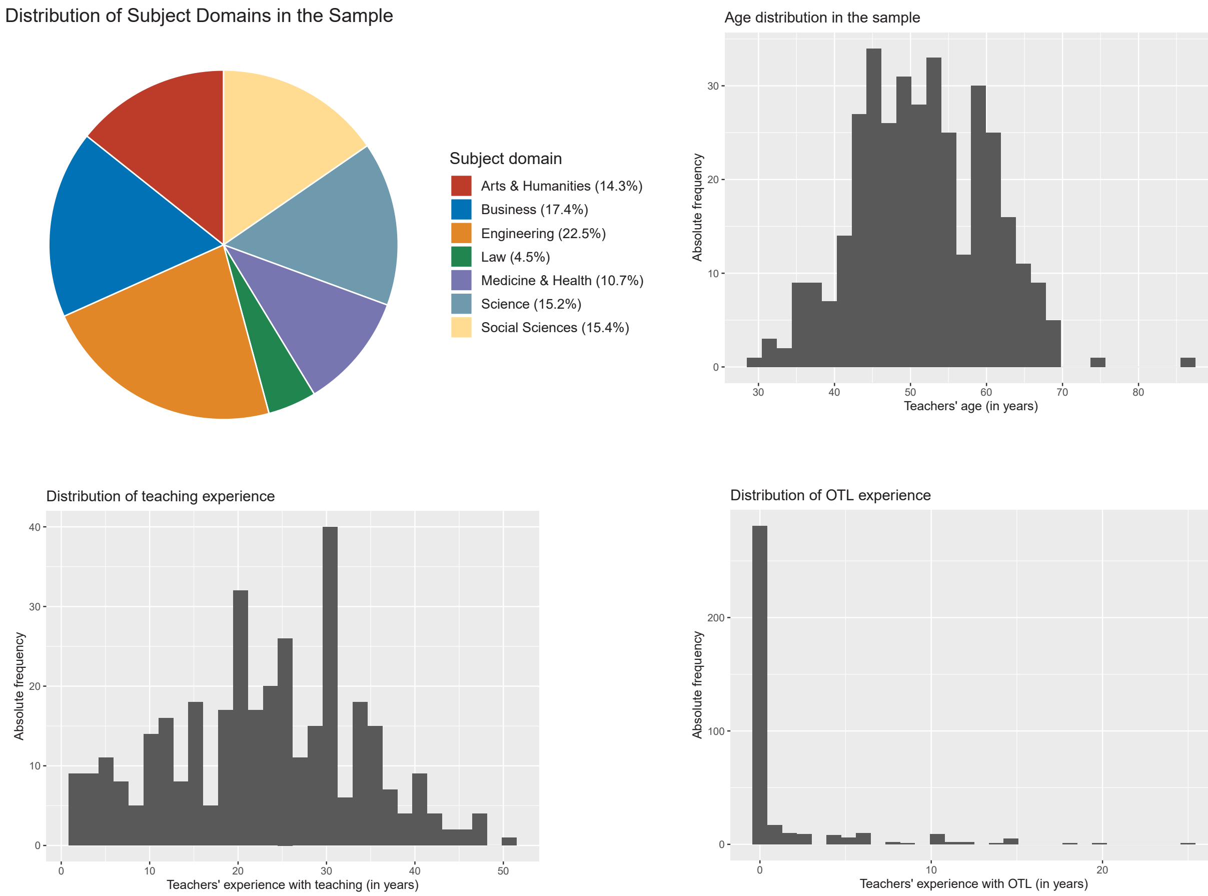

Fig. 2. Description of the teacher sample in higher education.

Table 1
Descriptive statistics and correlations for the average scale scores of the readiness dimensions.

Readiness dimension	*M*	*SD*	n_I	α	ω_h	1.	2.	3.	4.	5.	6.
1. Perceived institutional support	2.90	1.19	8	.94	.88						
2. Technological content knowledge (TCK) self-efficacy	2.89	0.77	2	.80	–	.34* [.25, .43]					
3. Technological pedagogical knowledge (TPK)self-efficacy	2.73	0.76	4	.84	.76	.38* [.29, .47]	.80* [.76, .83]				
4. Technological pedagogical content knowledge (TPCK) self-efficacy	2.51	0.83	4	.86	.80	.42* [.33, .50]	.71* [.66, .76]	.80* [.76, .83]			
5. Perceived online presence: Clarity of instruction	3.12	0.65	4	.91	.85	.33* [.23, .42]	.68* [.62, .74]	.61* [.54, .67]	.55* [.47, .61]		
6. Perceived online presence: Feedback	2.84	0.81	2	.80	–	.31* [.21, .40]	.56* [.48, .63]	.58* [.50, .64]	.52* [.43, .59]	.71* [.65, .76]	
7. Perceived online presence: Cognitive activation	2.72	0.73	7	.93	.85	.37* [.27, .45]	.60* [.53, .66]	.70* [.64, .75]	.64* [.57, .70]	.77* [.72, .81]	.75* [.71, .80]

Note. *M* and *SD* represent the mean and standard deviation, respectively, of the average scale score. n_I = Number of items, α = Cronbach's Alpha, ω_h = Omega hierarchical for dimensions with more than two indicators (e.g., Flora, 2020). Values in square brackets indicate the 95% confidence interval for each correlation. $N = 366$. $^*p < .01$.

course goals"; 4 items), feedback and assessment (POPFED; e.g., "Overall, I provide feedback in a timely fashion"; 2 items), and cognitive activation (POPCOG; e.g., "Overall, I encourage course participants to explore new concepts in courses"; 7 items). Teachers responded to the items using a 5-point agreement scale (*0 = I strongly disagree*, *4 = I strongly agree*). The resultant internal consistencies ranged between Cronbach's $\alpha = 0.80$ and 0.93 (see Table 1).

Perceived institutional support (PIS). In total, eight items captured teachers' reports of the support they receive at their institution in general (e.g., "In our institution, there are clear objectives as regards online learning"; 6 items; Philipsen, Tondeur, Scherer, Pynoo, & Zhu, 2022) and at the time of the pandemic (e.g., "Additional pedagogical support has been provided to transition face-to-face teaching to online because of COVID-19"; 2 items). This item set was based on a 6-point scale (*0 = I completely disagree*, *5 = I completely agree*) and showed high internal consistency (Cronbach's $\alpha = 0.94$; see Table 1). This scale captured instructional support broadly; it did not cover detailed aspects of instructional leadership, the subjective norms within the institutions, facilitating conditions, or the agents providing the support (e.g., Harris and Jones, 2020; Sailer et al., 2021; Schepers & Wetzels, 2007). Instead, the scale was based on six action recommendations, such as providing timely feedback, considering teachers' professional identities and educational beliefs, and setting clear objectives for OTL (Philipsen et al., 2022).

3.2.2. Teacher experience

We assessed teacher experience by two measures: First, we asked teachers to indicate the years of their general teaching experience, starting from their entry into the teacher profession and ending with the day of the assessment in 2020. On average, teachers reported 22.8 years of experience ($SD = 10.7$, $Mdn = 23$) within a range between one and 50 years (Fig. 2). Second, we asked teachers to indicate their years of experience with online teaching and learning in their profession up until the day of assessment. On average, teachers had 1.4 years of OTL experience ($SD = 3.5$, $Mdn = 0$), with a reported maximum of 25 years (Fig. 2).

3.3. Methodological approaches

3.3.1. Structural equation modeling (SEM)

Prior to testing the experience-readiness relationship, we developed a measurement model to represent the readiness dimensions as constructs. Following Scherer et al. (2021), we estimated a correlated-traits model via confirmatory factor analysis. We evaluated multiple fit indices of resultant measurement model against the following criteria: A non-significant χ^2 statistic ($p > .05$), a Comparative Fit Index (CFI) greater than or equal to 0.95, a Root Mean Square Error of Approximation (RMSEA) smaller than or equal to 0.06, and a Standardized Root Mean Squared Residual (SRMR) smaller than or equal to 0.08 typically indicate an acceptable fit (Hu & Bentler, 1999). However, we did not apply these cut-offs as strict rules, because they heavily depend on the sample size, factor loadings, number of factors, type of measurement model, and other factors describing the model features and study contexts (Mai, Niemand, & Kraus, 2021). To account for such dependencies, we also evaluated dynamic fit index cut-offs applying McNeish and Wolf's (2021) simulation method using their R Shiny app "Dynamic Model Fit" (Wolf & McNeish, 2020). The resultant measurement model formed the basis for the subsequent SEM.

To address **RQ1** (experience-readiness relationship at the level of constructs), we extended the measurement model of readiness by including teachers' experience as a predictor of the latent readiness variables—this approach is often referred to as the Multiple-Indicators-Multiple-Causes (MIMIC) approach (Brown, 2015). Teacher's experience in years was standardized, and the corresponding quadratic terms were included to test for curvilinearity.

To address **RQ2** (experience-readiness relationship at the level of indicators), we extended the MIMIC models by using teacher experience and the respective squared term as predictors of the latent readiness variables *and* the manifest readiness indicators (Fig. 3)—this approach is often referred to as the MIMIC-DIF approach and tests for possible uniform differential item functioning (DIF) across the predictors (Bauer, 2017). If an indicator shows uniform DIF, then the unequal probabilities of a response to an indicator across groups is the same for all levels of the latent variable (Millsap, 2011). We followed Woods' (2009) approach of regressing one readiness indicator onto the predictors at a time. This approach resulted in 31 models per teacher experience variable, which were subsequently compared to the MIMIC models without the DIF regression paths via χ^2 difference testing. Since this DIF-testing procedure resulted in multiple model comparisons, we adjusted the p-values of the χ^2 difference statistics to control the false discovery rate via the Benjamini-Hochberg procedure (Benjamini & Hochberg, 1995). We estimated all models in the R package "lavaan" (Rosseel, 2012), choosing the robust maximum-likelihood (MLR) estimator to account for possible deviations in the readiness indicators from normality, obtaining robust test statistics, and handling missing data via the full information maximum-likelihood procedure.

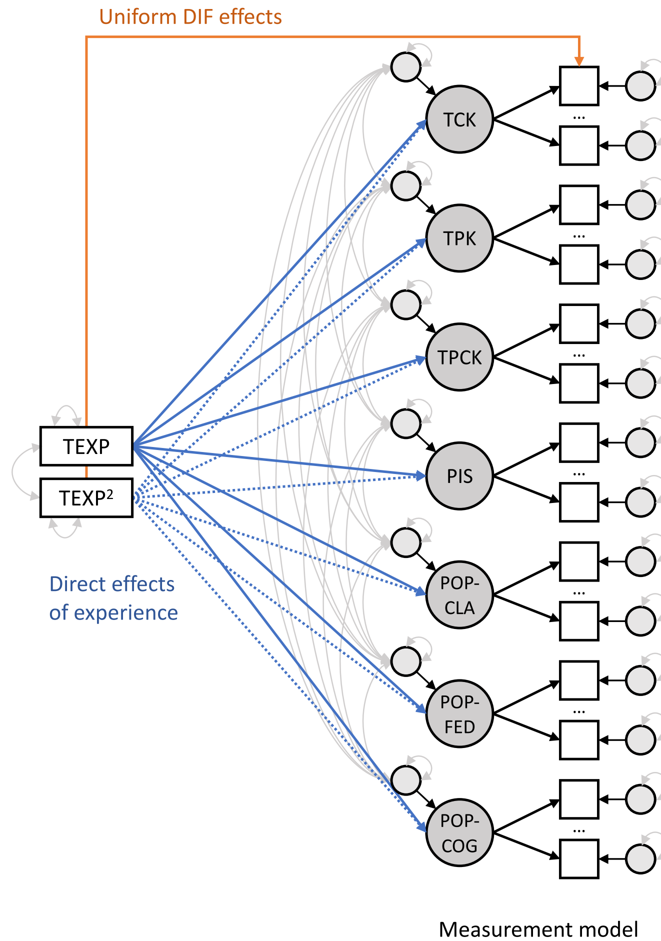

Fig. 3. Structural Equation Model Describing the Relationship between Teacher Experience and OTL Readiness

Note. DIF = Differential item functioning, PIS = Perceived institutional support, TEXP = Teaching experience (in years), $TEXP^2$ = Squared teaching experience (in years), TCK = Technological content knowledge, TPK = Technological pedagogical knowledge, TPCK = Technological pedagogical and content knowledge, POPCOG = Perceived online presence: Cognitive activation, POPCLA = Perceived online presence: Clarity of instruction, POPFED = Perceived online presence: Feedback. TEXP is centered to the grand mean before creating the squared variable $TEXP^2$.

3.3.2. Robustness checks and reproducibility

To examine the robustness of our findings, we identified the extent to which the nature, strength, and direction of the experience-readiness relations held across gender and subject domains, were sensitive to the exclusion of possible outliers in the reported years of OTL experience, and may be confounded by teachers' age or the days they were given to prepare for the transition to OTL. We inspected the boxplot and interquartile range of the experience distribution and performed several statistical tests to identify outliers, including the Grubbs and Rosner tests in the R package "outliers" (Komsta, 2011). To achieve maximal reproducibility, we pre-registered this study via the Open Science Framework (OSF) at [https://doi.org/10.17605/OSF.IO/GYHZE]. The analytic codes and outputs can be accessed at [https://doi.org/10.17605/OSF.IO/MHKG3]. All supplementary material is disclosed via the OSF project page.

4. Results

4.1. Descriptive statistics, correlations, and measurement model

Inspecting the descriptive statistics of the readiness indicators, we did not observe ceiling or floor effects in the teachers' responses. Given their categorical nature with 5 or 6 response options, responses deviated to some extent from normality. Hence, we chose a robust estimation of the measurement model to account for such deviations. As expected, indicators pertaining to the same readiness dimension exhibited moderate to high correlations. Supplementary Material S3 contains the respective statistics and figures at the level of indicators.

Given the evidence on the factor structure of the readiness dimensions in previous studies (e.g., Howard et al., 2021; Scherer et al., 2021), we estimated an initial readiness measurement model distinguishing between seven correlated factors—these factors represented the readiness dimensions of perceived institutional support, TPK, TCK, and TPCK self-efficacy, and perceived online teaching presence in classroom management, assessment and feedback, and cognitive activation. The respective correlated-traits model showed a reasonable fit, χ^2 (413) = 1042.7, $p < .001$, CFI = 0.916, RMSEA = 0.071, SRMR = 0.050. As Scherer et al. (2021) suggested, we introduced some residual covariances between indicators of similar wordings or references to similar concepts (e.g., "online interactivity", "curricular demands", and "variation of teaching methods") and two cross-loadings to this model (i.e., TPK1 and TPCK4). The modified model showed an acceptable fit to the data (χ^2 [393] = 595.5, $p < .001$, CFI = 0.974, RMSEA = 0.041, SRMR = 0.037) and was superior to the initial model ($\Delta\chi^2$ [20] = 332.4, $p < .001$). Moreover, the dynamic model fit index cut-offs for our model with two misspecifications (i.e., two cross-loadings; CFI = 0.974, RMSEA = 0.042, and SRMR = 0.051) were met. We therefore accepted the modified model as the baseline model (see Supplementary Material S3).

Within this model, the readiness dimensions were all positively correlated (ρ = 0.31-0.80), and the respective scores did not show ceiling or floor effects (see Table 1). As expected, the average scale score correlations were higher within constructs (e.g., within TPACK self-efficacy: r = 0.71-0.80) and lower across constructs (e.g., between perceived institutional support and TPACK self-efficacy: r = 0.34-0.42). The correlations among latent variables supported this observation, and

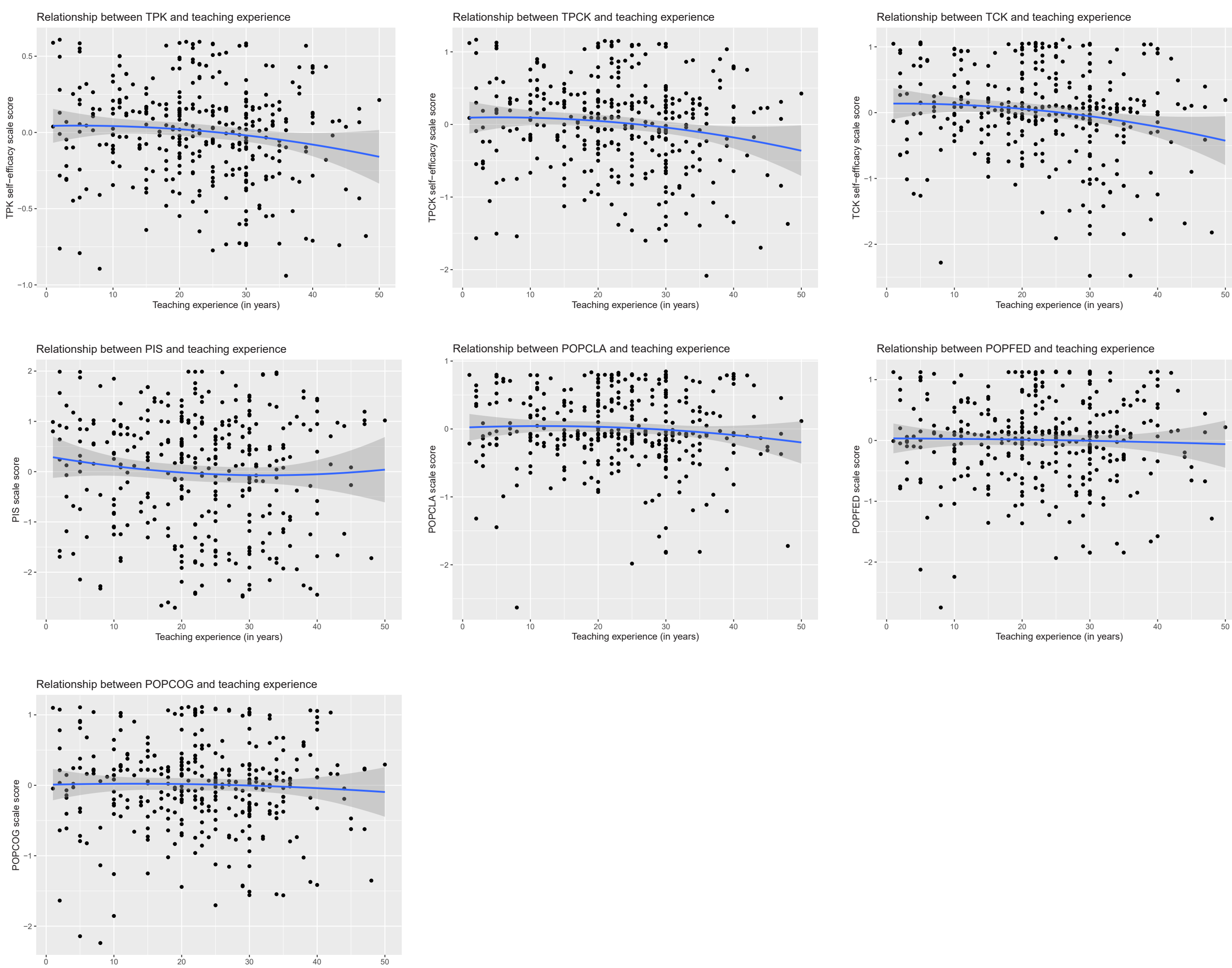

Fig. 4. Relations between the Readiness Dimensions and General Teaching Experience
Note. OTL = Online teaching and learning, PIS = Perceived institutional support, TCK = Technological content knowledge, TPK = Technological pedagogical knowledge, TPCK = Technological pedagogical and content knowledge, POPCOG = Perceived online presence: Cognitive activation, POPCLA = Perceived online presence: Clarity of instruction, POPFED = Perceived online presence: Feedback. TPACK self-report measures represent teachers' self-efficacy. The years of experience variables were standardized. The readiness dimensions were represented by their factor scores.

were higher than those among the average scale scores, after including the item-item residual covariances (see Supplementary Material S3).

4.2. Relations between readiness and experience at the construct level (RQ1)

Prior to statistical testing, we inspected the experience-readiness relationship graphically by plotting the readiness factor scores against teachers' experience. For general teaching experience, the TPACK self-efficacy dimensions indicated a curvilinear relationship, whereas the other dimensions indicated almost no correlation (Fig. 4). In contrast, the curvilinear relationships were pronounced for OTL experience (Fig. 5).

Testing the experience-readiness relationship statistically, we first estimated a MIMIC model for OTL experience and allowed for the curvilinear relations between the years of experience and the readiness dimensions. The model for OTL experience showed a good fit to the data (χ^2 [441] = 668.0, p < .001, CFI = 0.973, RMSEA = 0.040, SRMR = 0.036) and explained between 0.5% (PIS) and 9.4% (TPK self-efficacy) of the variance in the readiness dimensions (see Table 2). Except for perceived institutional support and perceived online teaching presence for instructional clarity, the relations followed an inverted U shape, indicating an increase in readiness with OTL experience until an optimum and a subsequent decrease.

Second, we estimated a MIMIC model for general teaching experience and obtained a good fit to the data, χ^2 (441) = 637.7, p < .001, CFI = 0.975, RMSEA = 0.038, SRMR = 0.036. This model explained between 0.0% (POPCOG) and 3.8% (TCK self-efficacy) of the readiness variance and confirmed a quadratic relationship for TCK and TPCK self-efficacy (see Table 3). Besides, TPCK self-efficacy and general teaching experience showed a linear and negative association, and all other readiness dimensions were not significantly related to general teaching experience. Supplementary Material S3 contains the full set of the respective model parameters.

In sum, the curvilinear experience-readiness relationship was pronounced for OTL experience yet hardly for general teaching experience and pointed to the existence of optimal readiness levels. These optima indicated that more *and* less experienced teachers exhibited low readiness levels (e.g., low TPACK self-efficacy).

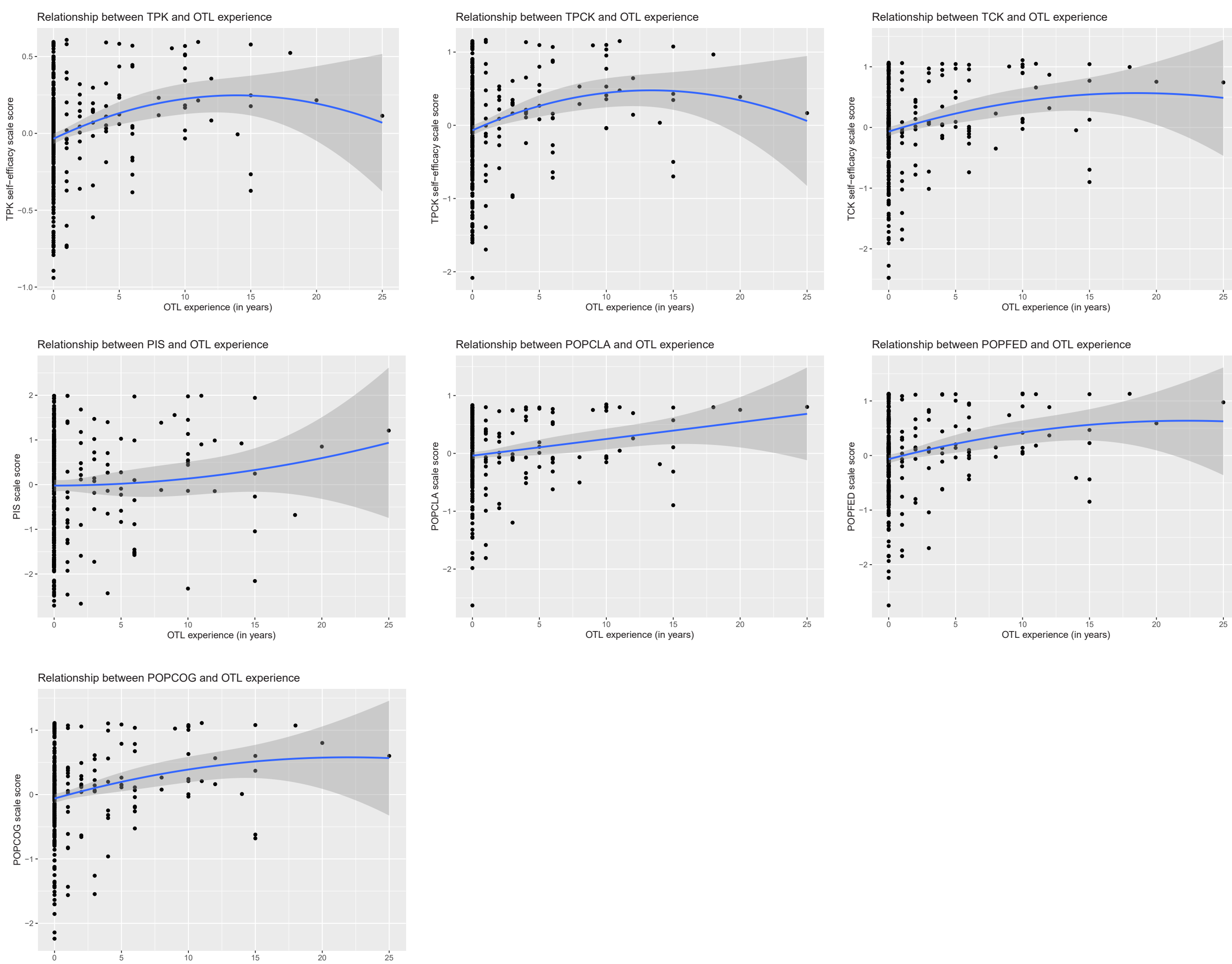

Fig. 5. Relations between the Readiness Dimensions and the Years of OTL Experience
Note. OTL = Online teaching and learning, PIS = Perceived institutional support, TCK = Technological content knowledge, TPK = Technological pedagogical knowledge, TPCK = Technological pedagogical and content knowledge, POPCOG = Perceived online presence: Cognitive activation, POPCLA = Perceived online presence: Clarity of instruction, POPFED = Perceived online presence: Feedback. TPACK self-report measures represent teachers' self-efficacy. The years of experience variables were standardized. The readiness dimensions were represented by their factor scores.

Table 2
MIMIC model parameters describing the relationship between teacher experience and readiness for OTL.

Readiness Dimension	Linear effect			Quadratic effect			R^2
	B	*SE*	*p*-value	*B*	*SE*	*p*-value	
Years of experience with OTL							
PIS	0.003	0.121	0.983	0.025	0.390	0.983	0.005
TCK	0.241	0.064	<.001	0.014	0.139	0.001	0.061
TPK	0.161	0.057	0.005	0.009	0.017	0.007	0.094
TPCK	0.279	0.067	<.001	0.014	0.001	<.001	0.049
POPCLA	0.067	0.056	0.232	0.012	0.582	0.270	0.023
POPFED	0.247	0.071	0.001	0.019	0.158	0.001	0.051
POPCOG	0.191	0.060	0.001	0.013	0.281	0.003	0.052
Years of general teaching experience							
PIS	−0.078	0.063	0.216	0.053	0.397	0.378	0.007
TCK	−0.136	0.044	0.002	0.036	0.477	0.015	0.038
TPK	−0.039	0.024	0.102	0.021	0.305	0.237	0.018
TPCK	−0.099	0.042	0.018	0.036	0.425	0.061	0.025
POPCLA	−0.037	0.037	0.316	0.032	0.423	0.442	0.006
POPFED	−0.011	0.045	0.809	0.035	0.741	0.809	0.001
POPCOG	−0.011	0.040	0.787	0.033	0.857	0.809	<.001

Note. OTL = Online teaching and learning, PIS = Perceived institutional support, TCK = Technological content knowledge, TPK = Technological pedagogical knowledge, TPCK = Technological pedagogical and content knowledge, POPCOG = Perceived online presence: Cognitive activation, POPCLA = Perceived online presence: Clarity of instruction, POPFED = Perceived online presence: Feedback. R^2 represents the variance explanation of the model with the linear and the quadratic term. TPACK self-report measures represent teachers' self-efficacy. The years of experience variables were standardized.

4.3. Relations between readiness and experience at the indicator level (RQ2)

As a next step, we estimated the experience-readiness relations at the level of indicators via MIMIC-DIF modeling (RQ2). Table 3 shows the main results of this step, and Supplementary Material S3 and S4 contain the respective model parameters. For OTL experience, five readiness indicators were initially flagged with linear or quadratic differential item functioning effects (i.e., TPCK1, POTP3, POTP4, POTP6, and PIS2; see Supplementary Material S2 for the item wordings). After the Benjamini-Hochberg adjustment, only item POTP3 (i.e., *providing clear instructions on how to participate in course learning activities*) exhibited DIF and an inverted U-shaped relation to OTL experience. This DIF effect suggested that the probabilities of responding to this item increased with OTL experience up to a certain point and decreased with even more OTL experience. None of the readiness indicators showed DIF in relation to general teaching experience.

In sum, OTL experience was related to teachers' responses to one readiness indicator above and beyond the readiness constructs. Hence, this indicator exhibited quadratic DIF and functioned differently for teachers of different OTL experience levels.

4.4. Robustness checks and sensitivity analyses

To further check the robustness of the curvilinear experience-readiness relationship, we studied the extent to which the MIMIC model parameters may be sensitive to gender differences, outliers in the reported OTL experience, subject domains, and possible confounding by teachers' age or the days they were given to prepare for OTL. Supplementary Material S5-S6 contain the detailed model parameters, analytic output, and statistical tests of these checks.

4.4.1. Robustness across gender

To perform the robustness checks, we extended the MIMIC models by gender as a grouping variable. The model estimating the gender-specific relations for OTL experience and assuming scalar invariance of the readiness measurement model (i.e., the equality of the factor structure, loadings, and intercepts; see Millsap, 2011) across gender showed an acceptable fit to the data, χ^2 (935) = 1305.7, $p < .001$, CFI = 0.960, RMSEA = 0.048, SRMR = 0.051. For men, the curvilinear, inverted U-shape relations of OTL experience to TPK and TPCK self-efficacy were evident, and so was the positive linear relation to POPCOG (see Fig. 6). For women, positive linear relations occurred for all TPACK self-efficacy dimensions, POPCOG, and POPFED (see Fig. 6). Perceived institutional support was not related to OTL experience for both gender groups. Up to 11% (8%) of the variation in TPACK self-efficacy could be explained by experience for women (men).

The model estimating the gender-specific relations between readiness and general teaching experience also showed an acceptable fit to the data, χ^2 (935) = 1280.9, $p < .001$, CFI = 0.960, RMSEA = 0.045, SRMR = 0.050. Neither for women nor for men were the experience-readiness relations curvilinear. Except for negative and linear relations of teaching experience to TPACK self-efficacy and perceived institutional support for men and teaching experience and TCK self-efficacy for women, all other relations were statistically insignificant, and the resultant variance explanations were less than 6.9%.

4.4.2. Sensitivity to outliers

To study outlier sensitivity, we excluded cases reporting more than 10 years of OTL experience. The overall model fit was not affected, and the curvilinear relations were evident for TPACK self-efficacy and POPFED, yet not for POPCOG. Perceived online presence concerning cognitive activation showed a linear and positive relation to the years of OTL experience. All other relations were statistically insignificant. Our findings exhibited some degree of robustness and, at the same time, some dependence on the inclusion of OTL-experienced teachers.

4.4.3. Confounding by age and the days of preparation

To rule out any confounding of the experience-readiness relationship by teachers' age, we examined the correlations among age and the two experience indicators. Indeed, age and general teaching experience were highly correlated (r = .80)—thus, the experience effects may largely represent age effects on readiness. However, age and OTL experience were weakly correlated (r = 0.09). Finally, general teaching experience and OTL experience represented two different types of experience, as their weak correlation suggested (r = 0.14). The days teachers were given to prepare for OTL were weakly correlated to the readiness dimensions (rs = 0.01-0.12), to general teaching experience (r = 0.08), and OTL experience (r = 0.07). Hence, age confounding or confounding by the days of preparing for OTL in the OTL experience-readiness relationship were unlikely.

4.4.4. Subject domain differences

Teachers' experience with and readiness for OTL may vary across subject domains due to different inherent subject cultures, teacher education programs, teaching practices, or other factors representing the domain specificity of teaching and learning (e.g., Baran, 2011; Tondeur et al., 2019). For instance, while some subjects, such as Science, may involve more frequent digital and online practices, other disciplines may not and, ultimately, provide teachers with fewer mastery experiences that could help them form positive self-perceptions profiles (Scherer et al., 2021). As a consequence, we examined the sensitivity of the experience-readiness relationship to subject domains.

First, using teachers in the Social Sciences as a reference group, we controlled for subject domains in the model describing the relations between OTL readiness and experience. This model represented the data well (χ^2 [585] = 841.7, $p < .001$, CFI = 0.972, RMSEA = 0.036, SRMR = 0.033) and showed some subject domain differences. For instance, teachers in Medicine and Health (d = 0.21, p = .001) and teachers in science (d = 0.22, p = .003) perceived the institutional support they received to be larger than teachers in the Social Sciences. Business teachers reported higher levels of TCK self-efficacy than Social Sciences

Table 3
MIMIC-DIF model parameters describing the relationship between OTL experience and readiness.

Readiness Indicator	Linear effect			Quadratic effect			Model comparison			
	B	*SE*	*p-value*	*B*	*SE*	*p-value*	χ^2	*df*	*p-value*	p_{BH}
TPACK self-efficacy										
TCK1	−0.037	0.049	0.447	0.003	0.010	0.761	1.734	2	0.420	0.710
TCK2	0.064	0.046	0.164	−0.009	0.010	0.347	3.973	2	0.137	0.387
TPK1	−0.022	0.061	0.715	0.006	0.013	0.623	0.270	2	0.874	0.960
TPK2	−0.028	0.081	0.732	0.011	0.020	0.578	0.416	2	0.812	0.957
TPK3	0.089	0.065	0.170	−0.025	0.019	0.199	1.891	2	0.389	0.709
TPK4	−0.087	0.063	0.168	0.018	0.016	0.257	2.175	2	0.337	0.674
TPCK1	0.140	0.080	0.081	−0.038	0.019	0.044	4.089	2	0.129	0.387
TPCK2	−0.069	0.101	0.491	−0.006	0.030	0.849	3.208	2	0.201	0.520
TPCK3	−0.004	0.076	0.959	0.012	0.020	0.559	1.449	2	0.485	0.715
TPCK4	−0.053	0.079	0.500	0.026	0.019	0.170	2.792	2	0.248	0.566
Perceived online teaching presence										
POTP1	−0.068	0.059	0.249	0.017	0.014	0.214	4.452	2	0.108	0.372
POTP2	0.066	0.044	0.132	−0.016	0.010	0.122	8.932	2	0.011	0.119
POTP3	0.083	0.035	0.016	−0.014	0.007	0.053	12.764	2	0.002	0.052
POTP4	−0.077	0.030	0.010	0.010	0.006	0.103	9.283	2	0.010	0.119
POTP5	0.007	0.049	0.882	−0.006	0.011	0.607	0.513	2	0.774	0.957
POTP6	−0.108	0.050	0.029	0.024	0.009	0.008	6.419	2	0.040	0.313
POTP7	0.015	0.061	0.804	−0.001	0.014	0.938	0.215	2	0.898	0.960
POTP8	0.045	0.048	0.345	−0.024	0.012	0.051	5.673	2	0.059	0.364
POTP9	−0.035	0.060	0.565	0.001	0.014	0.944	1.656	2	0.437	0.710
POTP10	−0.029	0.057	0.609	0.019	0.012	0.112	4.548	2	0.103	0.372
POTP11	0.037	0.047	0.435	0.004	0.010	0.692	5.134	2	0.077	0.372
POTP12	0.030	0.057	0.603	−0.006	0.011	0.562	0.400	2	0.819	0.957
POTP13	−0.029	0.056	0.605	0.006	0.011	0.562	0.400	2	0.819	0.957
Perceived institutional support										
PIS1	0.029	0.067	0.666	−0.004	0.015	0.812	0.365	2	0.833	0.957
PIS2	−0.138	0.072	0.055	0.034	0.015	0.022	4.606	2	0.100	0.372
PIS3	0.092	0.067	0.167	−0.019	0.017	0.243	1.561	2	0.458	0.710
PIS4	0.002	0.097	0.980	0.001	0.023	0.982	0.011	2	0.995	0.999
PIS5	−0.043	0.086	0.619	0.015	0.017	0.374	0.729	2	0.695	0.957
PIS6	0.058	0.094	0.534	−0.030	0.027	0.264	2.113	2	0.348	0.674
PISCO1	−0.004	0.117	0.974	0.001	0.026	0.974	0.001	2	0.999	0.999
PISCO2	−0.167	0.130	0.200	0.045	0.027	0.093	2.729	2	0.256	0.566

Note. OTL = Online teaching and learning, PIS = Perceived institutional support, TCK = Technological content knowledge, TPK = Technological pedagogical knowledge, TPCK = Technological pedagogical and content knowledge, POTP = Perceived online teaching presence, p_{BH} = *p*-value after the Benjamini-Hochberg adjustment. TPACK self-report measures represent teachers' self-efficacy. Model comparisons are based on the chi-square difference test between the MIMIC model with the linear and quadratic predictor of the latent variables and the MIMIC-DIF model with the linear and quadratic predictor of the latent variables and one indicator. The years of experience variables were standardized.

teachers ($d = 0.21, p = .004$). However, these differences were small and unsystematic, that is, without a consistent pattern across subject domains or readiness dimensions. In fact, controlling for subject domain differences in readiness did not change the key parameters describing the experience-readiness relationship (see Supplementary Material S6).

Second, we examined the extent to which the experience-readiness relationship may be moderated by subject domains. Only eighteen of 112 possible interaction terms with OTL experience and thirteen interaction terms with general teaching experience of 112 possible interaction terms were statistically significantly different from zero, suggesting that a moderation effect may exist. Again, these effects did not show a systematic pattern across subject domains or readiness dimensions and were small (see Supplementary Material S6). Hence, the influence of the subject domains on the main results was marginal.

5. Discussion

5.1. Summary of key findings

Examining the relationship between experience and readiness for OTL in a sample of higher-education teachers, we found that:

- The experience-readiness relationship was curvilinear for teachers' OTL experience in the dimensions of TPACK self-efficacy, POPFED, and POPCOG;
- The experience-readiness relationship existed not only at the construct level but also at the indicator level, suggesting measurement non-invariance of at least one indicator;
- The curvilinear relationship to general teaching experience held only for TCK and TPCK self-efficacy;
- The nature, strength, and direction of the experience-readiness relationship varied across gender;
- The nature, strength, and direction of the experience-readiness relationship was largely robust against outliers in teacher experience; confounding by age or the days of OTL preparation was not evident.

5.2. Debunking the linearity assumption on the experience-readiness relationship

The educational disruptions during the COVID-19 pandemic have forced teachers around the world to transition to OTL and have shown that many educational systems were not as resilient as expected to facilitate this transition (Meinck, Fraillon, & Strietholt, 2022). The "Great Online Transition" has also shown that teachers' readiness for OTL varies across educational systems and their individual backgrounds (Scherer et al., 2021). By focusing on core dimensions of teacher readiness in higher education, our study was aimed at giving teachers a voice, uncovering their specific needs in the context of OTL, and putting to test the assumption that experienced teachers consider themselves

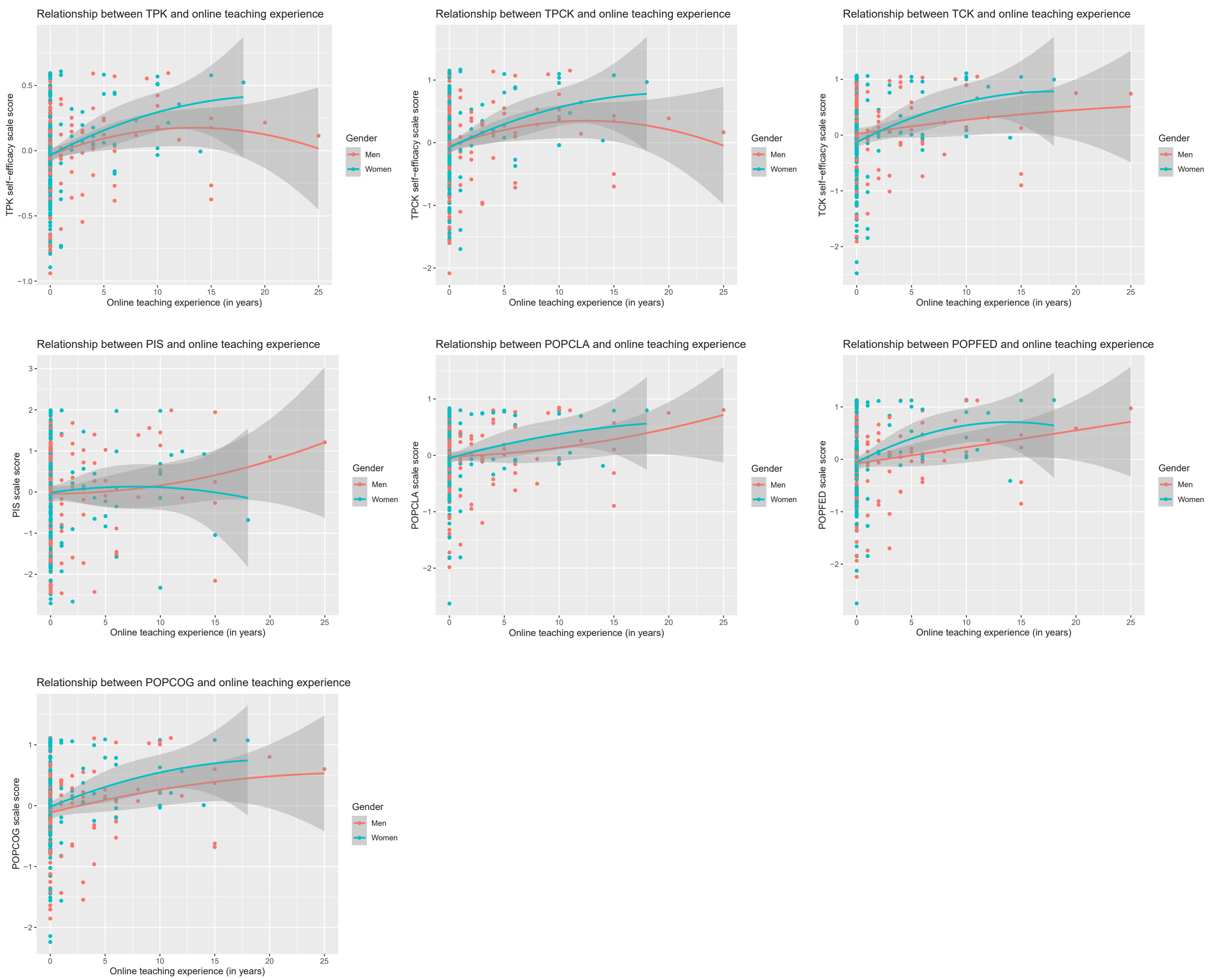

Fig. 6. Relations between the Readiness Dimensions and Years of Experience with OTL across Gender
Note. OTL = Online teaching and learning, TCK = Technological content knowledge, TPK = Technological pedagogical knowledge, POPCOG = Perceived online presence: Cognitive activation, POPFED = Perceived online presence: Feedback. TPACK self-report measures represent teachers' self-efficacy. The years of experience variables were standardized. The readiness dimensions were represented by their factor scores.

well-prepared for OTL during these disruptive times.

As the results of our study suggest, these needs, however, are neither uniformly nor linearly distributed across the levels of teacher experience and can therefore not be met by "one-size-fits-all" support activities. Specifically, the curvilinear relationship between teacher experience with OTL and their readiness implied that (a) the levels of readiness vary across the experience spectrum; (b) more experience is not necessarily associated with higher readiness; and (c) both novice and experienced teachers could benefit from readiness interventions and support. Concerning (a), irrespective of the direction, the extant literature supports the variation of readiness dimensions across teacher experience (e.g., Cutri et al., 2020; Eslaminejad, Masood, & Ngah, 2010). This variation may have several reasons, such as the extent to which teachers have experienced mastery during OTL in previous teaching situations—such mastery experiences can increase teachers' self-efficacy in OTL which is a core readiness dimension (Martin, Wang, et al., 2019; Scherer et al., 2021). This variation also indicates that teachers may have different needs for support at different experience stages. Hence, professional development and educational programs that are aimed at increasing higher-education teachers' readiness for OTL should provide differentiated learning opportunities depending on the level of experience (e.g., Collinson et al., 2009). Besides, our results point to differential relations across gender and show that the nature, strength, and direction of the experience-readiness relationship can vary. It is thus important to consider construct-relevant sub-groups of teachers when exploring this relationship further (e.g., Scherer, Siddiq, Tondeur, & Howard, 2022).

Concerning (b), the curvilinear nature of the experience-readiness relationship does not support the common assumption of "the more experienced teachers are, the better prepared they are". While most studies we have reviewed as part of this paper were based on this assumption and examined linear effects of experience on readiness (see Supplementary Material S1), some studies questioned this assumption and identified deviations from linearity (e.g., Cutri et al., 2020; Hung, 2016)—in this sense, our study supports these deviations and specifies them further. The curvilinear nature of the experience-readiness relationship in the form of an inverse U shape has several implications: First, it implies that there is indeed an increase in the readiness dimensions with more experience, up until an optimum. This interval may show an increase because teachers are gaining mastery experience during this period. Such an explanation aligns with teacher self-efficacy research which shows that these experiences are key for novice teachers (e.g., Faez & Valeo, 2012; Ismayilova & Klassen, 2019; Tschannen-Moran & Woolfolk Hoy, 2007). Second, readiness decreases with more experience beyond the optimum. One possible explanation for this decrease may be that mastery experience can no longer add to teachers' readiness levels, so that other factors may play a more important role. These factors could include teachers' mindsets and perceptions of the usefulness of technology (Rolley, 2020; Scherer & Teo, 2019) or their openness and willingness to change (Gratz & Looney, 2020). At this point, our study does not shed light on the mechanisms and explanations empirically, and we encourage future research to trace the development of teacher readiness over time and in relation to individual and contextual characteristics (Ismayilova & Klassen, 2019; Rapanta et al., 2020).

Notably, we have also observed that the curvilinear relation to OTL experience was more pronounced for the self-efficacy dimensions than for the other readiness dimensions and even existed for general teaching experience. In fact, such a relationship has been reported for general and domain-specific teaching self-efficacy (Klassen & Chiu, 2010; Nixon, Smith, & Sudweeks, 2019), and our findings align with these reports. To our best knowledge, the curvilinear relations to online teaching presence have not yet been reported in the extant literature, and we still need to identify explanations for their nature. A more detailed measurement of further aspects of the construct, including dimensions of digital teaching quality, could help identify which aspects of the construct may or may not exhibit a curvilinear relation.

Concerning (c), we argue that both novice and experienced teachers are in need of professional development and educational programs that strengthen their self-efficacy, improve their online teaching practices, and provide the technological as well as pedagogical support at their institutions (Baran & Correia, 2014; Corry & Stella, 2018). Assuming that experienced teachers in higher education are optimally prepared for OTL may exclude them for the support and educational opportunities they actually need.

Despite the robust evidence, we noticed that the curvilinear relationship held across most readiness constructs for OTL experience (i.e., TPACK self-efficacy and two dimensions of perceived online teaching presence), yet only for TCK and TPCK self-efficacy in the case of general teaching experience. Similarly, some studies we have reviewed reported relations between measures of readiness and general teaching experience, and these relations tended to be weak (Adnan, 2017; Eslaminejad et al., 2010). However, other studies utilized teachers' prior OTL experience and found significant correlations (Martin, Wang, et al., 2019; Scherer et al., 2021). These findings imply that researchers need to specify the type of experience when describing the experience-readiness relationship. It needs to be further examined if the specificity and alignment of the experience measures with the readiness measures (e.g., the common context of OTL) may be an explanation of the dependency on the type of experience. Moreover, teachers' age is often confounded with general teaching experience (Klassen & Chiu, 2010), yet not with specific OTL experience. In this sense, age-related traits (e.g., openness, cognitive flexibility) could play a more important role for the relation to general teaching experience, while specific mastery experiences may be more important for specific OTL practices.

Finally, as the experience-readiness relationship existed at both the construct and the indicator level for OTL experience, we argue that readiness measures may be prone to measurement non-invariance or, in other words, bias. In our study, only one teaching presence indicator exhibited differential item functioning and was thus not considered a fair indicator of readiness across OTL experience levels. Identifying such non-invariant indicators is key to crafting a validity argument for the readiness scores and to ensure the fairness of the underlying assessments (AERA et al., 2014).

Overall, we argue that readiness research should (a) debunk the linearity assumption and explore curvilinear experience-readiness relations; (b) consider multiple dimensions of readiness and specify clearly the type of experience; and (c) take a measurement perspective and perform invariance and robustness checks to craft a validity argument and to provide reliable conclusions. In our study, we have proven the curvilinear relationship between OTL experience and readiness; yet, it needs to be further explored and replicated in future research.

5.3. Limitations and future directions

The present study has several limitations: First, despite the new evidence on the curvilinear experience-readiness relationship, this evidence does not uncover what characterizes "an optimal level of experience" and what are the factors determining whether teachers may reach this level. In-depth qualitative studies could shed further light on which types of experiences (e.g., mastery experiences; Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998) and conditions contribute to teachers' readiness for online teaching. As noted earlier, such conditions may include teachers' level of digital (teaching) competence as an informant of their self-reported readiness ("Dunning-Kruger Effect"; e.g., Schmid et al., 2021). Second, the relations among readiness constructs and indicators may evolve over time as teachers gain more experience with OTL. Hence, possible longitudinal extensions of our study, with both long-term and fine-grained day-to-day designs, tracing teachers' experiences with online teaching could make visible developmental patterns of the readiness construct. Third, the robustness of the curvilinear experience-readiness relationship needs to be further tested across different teacher samples, background characteristics, and contexts outside of the context of the COVID-19 pandemic in which teachers were almost "forced" to move to OTL. For instance, we found evidence for small and unsystematic subject differences in teachers' OTL readiness and the experience-readiness relationship which needs to be further substantiated with larger teacher samples that are representative of key subject domains. Moreover, information about the time and resources teachers had to spent to prepare for OTL, either as part of professional development activities or in their leisure, could describe the context of teachers' experience in greater detail. Fourth, our assessment of readiness was focused on teachers' perceptions of their capacities for OTL, teaching presence during OTL, and institutional support. These core perceptions do not cover all aspects of readiness and could be enhanced by measures of teacher personality (e.g., openness to change, adaptability) and cognition (e.g., cognitive flexibility; Kim, Jörg, & Klassen, 2019) in future studies. Finally, our sample was a convenience sample rather than randomly drawn and representative sample of teacher, due to the heavy survey constraints at the beginning of the first COVID-19 lockdown. Hence, the inferences draw on the readiness-experience relationship have limited generalizability and need to be further substantiated. At the same time, this sample was unique in the field because it was captured so early, that is, before teachers began to upskill and develop their digital competence.

6. Conclusion and implications

Our study showed that the relation between higher-education teachers' OTL experience and readiness is not linear but curvilinear and followed an inverted U shape for the readiness dimensions of TPACK self-efficacy and perceived online teaching presence. This finding has several implications for practice, measurement, and theory: First, both novice and expert teachers may benefit from support programs for OTL, because perceived readiness was low at both ends of the experience spectrum. Second, researchers examining the experience-readiness relationship should debunk the linearity assumption of "the more experienced, the better prepared" and, instead, explore curvilinear relations for constructs and indicators. Third, the nature of the relationship adds to the validity evidence for the non-linearity assumption and points to the need for revising existing OTL readiness theories. Given that the curvilinear relationship existed for most readiness dimensions and OTL experience, yet only for TPACK self-efficacy and general teaching experience, we further argue that the selection of experience indicators and their domain specificity are key factors informing the nature of the experience-readiness relationship. In our view, a measurement perspective is needed in OTL readiness research linking readiness constructs *and* indicators to teachers' experience. This perspective sheds light on the possible measurement bias due to measurement non-invariance across the experience spectrum and is critical for crafting a validity argument. Fourth, we consider robustness checks and replication studies of the curvilinear relationship important for establishing the transferability of our results to other teacher samples in contexts beyond the beginning of the COVID-19 pandemic. Our study has shown that the linearity assumption on the relationship between teachers' OTL experience and readiness should be challenged, laying ground for further investigations and adoption in future studies.

Credit Statement

Ronny Scherer: Conceptualization, Methodology, Software, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization; **Fazilat Siddiq**: Conceptualization, Methodology, Investigation, Resources, Writing – review & editing; **Sarah K. Howard**: Conceptualization, Methodology, Software, Investigation, Resources, Data curation, Writing – review & editing, Project administration; **Jo Tondeur**: Conceptualization, Methodology, Investigation, Resources, Data curation, Writing – review & editing, Project administration.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chb.2022.107530.

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