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Predicting profiles of early-career teachers' readiness for online teaching in primary and secondary Education

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ABSTRACT

This study examined the readiness of early-career teachers for online teaching in primary and secondary education during the COVID-19 pandemic. It aimed to generate new insights into the associations between online teaching readiness and teacher-related and contextual characteristics. Using latent profile analysis, we identified four distinct profiles of 965 early-career teachers, based on their technology integration self-efficacy, perceived support, and perceptions of online teaching practice. These profiles demonstrated patterns of consistently high or low readiness, low school support, or inconsistent readiness, highlighting the heterogeneity of early-career teachers. Three-step multinomial logistic regression revealed that teachers categorised in the high-readiness profile reported significantly higher self-efficacy, greater work engagement, a lower resignation tendency, and reduced emotional exhaustion than those in the low-readiness profile. The study's added value lies in its context-sensitive approach, which examines school types while accounting for relevant predictors and participant diversity using longitudinal panel data.

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Distance education; online teaching; early-career teachers; teacher self-efficacy; emotional exhaustion

Introduction

The shift from face-to-face to online teaching during the COVID-19 pandemic marked a critical juncture in educational practice, providing an ideal scenario for examining teachers' preparedness for online instruction (Howard et al. 2021; Johnson et al. 2023). While initially a response to the crisis, this transition has cemented the role of online learning in contemporary educational practice. As hybrid and digital teaching formats become increasingly prevalent in everyday school practice, understanding the factors that enhance teachers' preparedness for online instruction is crucial – a concern that extends well beyond the pandemic context (Tondeur et al. 2023).

Online teaching requires different skills and techniques from those used in face-to-face instruction (Pulham and Graham 2018); despite their familiarity with digital tools, even young educators have struggled with the transition (Moorhouse 2021). Empirical findings demonstrate substantial variation in teachers' preparedness for online

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instruction, reflecting a broad spectrum of readiness levels (Howard et al. 2021; Huang, Lazarides, and Richter 2023). These individual differences are expected, given that teachers' perceived readiness for online teaching encompasses multiple dimensions, including institutional support, online teaching practice, and self-beliefs (Howard et al. 2021; Scherer et al. 2021).

The body of research on online teaching in primary and secondary education has increased considerably in recent years, with numerous studies highlighting the challenges encountered by teachers during the transition to digital learning environments (Chou and Chou 2021; Huang, Lazarides, and Richter 2023; Johnson et al. 2023). Despite these insights, the empirical evidence regarding the factors that explain the variation in teachers' perceived readiness for online instruction remains limited, and few studies have addressed differences between primary and secondary education (Martin et al. 2021). Understanding this variation, however, is essential for providing targeted support to teachers across diverse educational contexts.

This study addresses these gaps by focusing on two primary aims: (i) to use latent profile analysis (LPA) to identify distinct profiles among early-career teachers (ECTs) in primary and secondary education based on key readiness variables, and (ii) to elucidate the factors influencing profile membership, considering individual teacher characteristics and contextual factors during pandemic distance education. This research contributes to the literature by identifying groups of ECTs in primary and secondary education who exhibit similar patterns of readiness-related characteristics, and by demonstrating how these profiles differ with respect to teachers' gender, school type, the subject taught, self-efficacy, digital literacy, emotional exhaustion, and occupational coping skills.

Transition to online teaching during school closures

During the pandemic, schools implemented online learning and teaching methods, presenting teachers with an entirely new instructional challenge (e.g. Burke, Schuck, and Kearney 2023). Several studies have investigated the effects of these changes on teachers' emotional exhaustion and well-being, with results consistently revealing elevated levels of stress among educators (e.g. Kim, Oxley, and Asbury 2022; Klusmann et al. 2023; Ma et al. 2022; Voss et al. 2023). Ma et al'.s (2022) meta-analysis revealed a high prevalence of COVID-19 pandemic-related anxiety, stress, and depression among teachers. In line with the job demands – resources model (Demerouti et al. 2001), these studies also identified job resources, such as social support and coping strategies, that mitigated negative psychological impacts (Kim, Oxley, and Asbury 2022; Klusmann et al. 2023; Ma et al. 2022).

Considering the significant obstacles encountered by teachers during pandemic-related teaching, instructional quality may have been affected by individual teachers' dispositions and their abilities to cope with this critical situation and the disruption of their usual work practices (Huang, Lazarides, and Richter 2023; Klusmann et al. 2023; Wong et al. 2021). As teaching began to increasingly rely on digital tools (Burke, Schuck, and Kearney 2023), it is feasible that teachers' perceived preparedness for online instruction, along with their perceptions of available support, played a critical role in shaping their instructional practices. Therefore, investigating how teachers differ in their

preparedness for online instruction is essential for understanding the conditions that hinder or facilitate effective instruction in digital learning environments.

Perceived preparedness refers to teachers' subjective evaluations of their readiness to engage in instructional activities (Brown, Lee, and Collins 2015). In the context of online teaching, the term 'readiness' is often used more broadly and is conceptualised as a multidimensional construct (Cutri and Mena 2020). We adopt this broader understanding of online teaching readiness in the present study to capture the complex set of factors affecting teachers' ability to teach effectively in digital environments.

Concept of teachers' readiness for online teaching

Pre-pandemic, the concept of online teaching readiness was predominantly applied within the context of higher education, generally defined as the 'state of faculty preparedness for online teaching' (Martin, Budhrani, and Wang 2019, 97). This concept was expanded to the school context following the pandemic-driven school closures (Howard et al. 2021).

The concept of online teaching readiness encompasses a complex interplay of skills, knowledge, beliefs, and conducive contextual factors (Cutri and Mena 2020; Scherer et al. 2023a). Scherer et al'.s (2023a) systematic review of research assessing teachers' readiness for online teaching concluded that most studies used a multidimensional definition of the construct, including several factors such as teachers' confidence in utilising technology for teaching, the support they perceive from their environment, and their presence within the teaching process. Empirical studies have also confirmed these distinct readiness dimensions (Chou et al. 2020, Hung 2016; Scherer et al. 2021).

Recent studies based on the TPACK (technological pedagogical content knowledge) framework have conceptualised the first dimension of the readiness construct – teachers' self-efficacy in teaching online (Howard et al. 2020; Scherer et al. 2021, 2023a).

The second dimension of the readiness construct – online teaching presence – is considered a fundamental aspect of high-quality online teaching (Howard et al. 2020; Scherer et al. 2021). Teachers' evaluations of their online teaching presence encompass various teaching practices (Gurley 2018, Howard et al. 2020; Scherer et al. 2021).

Institutional support has been widely recognised as another pivotal factor in teachers' readiness for online teaching (e.g. Howard et al. 2021; Scherer et al. 2021, 2023a, 2023b). Institutional support has become especially pertinent given the swift transition to online learning engendered by the COVID-19 pandemic, as the abrupt school closures thrust teachers into an entirely novel teaching environment (Burke, Schuck, and Kearney 2023; Huber and Helm 2020).

To summarise, existing research views teachers' online teaching readiness as a multifaceted concept. Researchers have primarily examined these facets using self-report measures assessing three indicators: (i) self-efficacy in teaching with technology, (ii) perceptions of online teaching (specifically during the pandemic), and (iii) perceptions of institutional support. Based on these indicators, Scherer et al. (2021) identified three teacher profiles within higher education: low readiness, inconsistent readiness, and high readiness. Using the same indicators, Howard et al. (2021) identified four teacher profiles in secondary education, classifying them as 'high',

'medium', 'low', and 'mixed' readiness. We extended this line of research in the present study by focusing on ECTs in both primary and secondary education and examining how individual and contextual factors relate to readiness profile membership, using a conceptualisation of readiness consistent with that used in prior studies.

Factors related to teachers' readiness for online teaching

Empirical research in the field of higher education has demonstrated that gender, scientific disciplines, and former online teaching practice are significant predictors of teachers' readiness for online teaching (Martin, Budhrani, and Wang 2019; Scherer et al. 2021, 2023a, 2023b).

Other research, focusing more generally on predictors of the successful adoption of distance learning, identified information and communication technology (ICT) skills, previous teaching experiences, job resources, and psychological distress as significant predictors (Hershkovitz et al. 2023; Huang, Lazarides, and Richter 2023; König, Jäger-Biela, and Glutsch 2020; Wong et al. 2021). Specifically, König, Jäger-Biela, and Glutsch (2020) found that teachers' self-efficacy and technological pedagogical knowledge were positively associated with the frequency of reported online teaching activities. Huang, Lazarides, and Richter (2023) identified collaboration, professional training in ICT, and ICT self-efficacy as significant predictors of primary and secondary teachers' perceived preparedness for distance education. Hershkovitz et al. (2023) found that experience in teaching with technology was positively associated with teachers' adoption of online teaching, and emotional difficulties were negatively associated. Similarly, Wong et al. (2021) found negative correlations between stress, anxiety, and depression and secondary teachers' online teaching proficiency. Furthermore, recent research suggests that teachers' sensory preferences may be related to their willingness to engage with new teaching technologies (Majewska 2020).

In summary, empirical results indicate that individual resources, such as high self-efficacy and prior experience with online teaching, are positively associated with teachers' online teaching preparedness, whereas psychological distress is negatively associated. However, there is a lack of research systematically examining how individual and contextual factors jointly predict teachers' readiness – understood as a multidimensional construct – across primary and secondary education.

Present study

The aims of the present study were to extend the current literature by (i) using LPA to identify profiles of readiness in primary and secondary ECTs and (ii) investigating the factors associated with profile membership, taking into account ECT characteristics and contextual factors.

To understand the profiles more comprehensively, it is crucial to determine the factors contributing to an individual having a particular profile, especially given the considerable challenges teachers encountered when transitioning to online teaching during the pandemic. These challenges highlight the importance of acknowledging individual differences in coping with the situation (Klusmann et al. 2023; Voss et al. 2023; Wong et al.

2021). Currently, there is limited evidence available regarding these differences among primary and secondary teachers.

The predictors in this study encompass teachers' backgrounds (e.g. gender, teacher self-efficacy [TSE]) and contextual factors (type of school, school subjects). To predict profile membership, we considered both teacher resources (e.g. TSE and work engagement) and potential risk or stress factors (e.g. resignation tendencies and emotional exhaustion) in our analysis. We sought to address the following research questions:

(1) What ECT profiles can be detected based on their technology integration self-efficacy, the support they perceived from colleagues and principals, and their experiences with online teaching during the pandemic-driven school closures?
(2) Are there associations between profile affiliation and gender, school type, school subjects, TSE, ICT literacy, emotional exhaustion, and occupational coping skills?

We formulated the following hypotheses:

H1. There is a higher proportion of STEM teachers affiliated with profiles that are characterised by high online teaching readiness (HR).

H2. Teachers in HR profiles have higher ICT literacy than those in other profiles.

H3. Teachers in HR profiles have higher teacher self-efficacy than those in other profiles.

H4. Teachers in HR profiles have more occupational coping skills than those in other profiles.

H5. Teachers in HR profiles report lower emotional exhaustion than those in other profiles.

Materials and methods

Sample

The data used in this study were derived from the National Educational Panel Study (NEPS): Starting Cohort First-Year Students (doi:https://doi.org/10.5157/NEPS:SC5:17.0.0; Blossfeld and Roßbach 2019). NEPS is a comprehensive nationwide random sample from Germany. The participants in this specific cohort embarked on their higher education journey during the winter term of 2010/11. Notably, students enrolled in teacher education programs were intentionally oversampled (Schaeper et al. 2023). Data collection for this study was conducted during the 17th survey wave, which occurred between November and December 2020, following the initial school closures prompted by the COVID-19 pandemic. The study encompassed 965 ECTs, comprising 75% females and 25% males, who were actively teaching during the second half of the 2019/2020 school year, coinciding with the initial wave in Germany. The maximum tenure as an in-service teacher at the time of the study was 4 years. At the onset of the school closures in March 2020, the

average age of the participating teachers was 30.25 years (SD = 2.33). Of the participants, 20% were elementary teachers, and 77% worked in secondary education. Approximately 3% of the participants either worked in other school environments or did not disclose details about their school setting.

Measures

ECTs' readiness for online teaching was measured using the following indicators: (i) teachers' technology integration self-efficacy; (ii) collegial support during school closures; (iii) principal support during school closures; (iv) teachers' perceptions of online teaching practice. These indicators were used to create the profiles. An overview of all items is provided in Supplement 1.

Technology integration self-efficacy

The technology integration self-efficacy scale was adapted from Bosse and Spörer (2014), Dinse de Salas (2019), and Schaeper and Weiß (2016) and comprised of five items (e.g. *I have the confidence to design lessons with digital media so that students use learning time effectively*), rated on a 6-point Likert scale ($\alpha = 0.78$; $\omega = 0.79$).

Perceptions of support

Support during pandemic distance teaching was measured using two single items: *During the school closure, 1) the colleagues supported each other very well, and 2) my principal was an important support for me*, rated on a 4-point Likert scale.

Perceptions of online teaching practice

To assess teachers' perceptions of online teaching practice, a three-item scale was specifically created. The items in this scale were rated on a 4-point Likert scale and included the following: *During the school closure, 1) it was easy for me to provide learning materials for homeschooling, 2) I did well in motivating the students to study at home, 3) I was well prepared for digital teaching thanks to my previous experience in teacher training and on the job*. The reliability coefficient of the scale was rather low ($\alpha = 0.58$), so each item was used as a single indicator to create the profiles.

Teacher background characteristics and predictor variables

We assessed several work-related and personal characteristics, recording teachers' personal background characteristics, age, and gender. Information about the teaching context included the type of school and the main subject taught.

Teacher self-efficacy. This instrument (Schwarzer and Schmitz 1999) comprised 10 items rated on a 4-point Likert scale. The assessment was conducted between March and August 2020 (16th wave), roughly a decade after the majority of the study participants commenced their initial teacher training ($\alpha = 0.72$; $\omega = 0.73$).

ICT literacy. The measurement of ICT literacy consisted of 36 multiple-choice items assessing technological and information-related knowledge [see Senkbeil, Ihme, and Schöber (2019) for details]. The participants took the test between May and July 2013 (wave 5), approximately 3 years after commencing their initial teacher training and 7 years prior to the onset of the COVID-19 pandemic. Competence scores were estimated as weighted maximum-likelihood estimates, and the test's IRT-based reliability was 0.72 [see Senkbeil, Ihme, and Schöber (2019)].

Emotional exhaustion. Emotional exhaustion was measured using four items rated on a 4-point Likert scale ($\alpha = 0.75$; $\omega = 0.75$), from the German Maslach Burnout Inventory (Kunter and Holzberger 2014). The construct was measured between March and August 2020 (wave 16).

Occupational self-regulation. This instrument is based on a shortened version of the Occupational Stress and Coping Inventory (Menge and Schaeper 2019). It comprises four subscales – subjective significance of work (three items), career ambitions (four items), inability to distance (three items), and resignation tendency (three items) – that were measured with a 5-point Likert scale ($\alpha = 0.81$–0.83; $\omega = 0.81$–0.84). The first two scales represent work engagement, and the second two represent resilience. Scores on the subscales representing resilience were reversed so that low values indicate high resilience. The measurement point of the construct occurred in wave 17.

Data analysis

Confirmatory factor analysis

A confirmatory factor analysis was used to evaluate the measurement model for technology integration self-efficacy. Robust maximum-likelihood (MLR) estimation was employed. The incidents of missing values on the single items were very low, with only one item having a non-response. This missing value was included using the full information maximum likelihood (FIML) estimation method (Muthen and Muthen 2017). The assessment of model fit was conducted using the goodness-of-fit index (CFI), the Tucker – Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardised root mean square residual (SRMR). A model was considered to have a very good (acceptable) fit if it met the following criteria: CFI > 0.95 (0.90), TLI > 0.95 (0.90), RMSEA < 0.05 (0.08), and SRMR < 0.05 (0.08) (Hu and Bentler 1999). Following the identification of the factor model, the factor scores were extracted (Morin and Marsh 2015) and used as manifest indicators in the LPA (Wang, Kim, and Yi 2022).

Latent profile analysis

LPA was conducted to identify different profiles using Mplus 8.7 (Muthen and Muthen 2017). The calculations were based on six indicators: (i) teachers' technology integration self-efficacy (factor scores); (ii) collegial support during school closures; (iii) principal support during school closures; (iv) provision of learning materials; (v) motivation of students; and (vi) online instruction. There were very few missing values on these indicators (max. 0.41% item non-response). They were confirmed to be missing completely at random (MCAR) by Little's test, with a calculated chi-square value of 14.47 ($df = 11$;

$p < 0.21$; Li 2013). Missing values were therefore included using the FIML estimation method. Following the three-step procedure presented by Asparouhov and Muthén (2014), the analysis was conducted stepwise to avoid local optima. We expanded the number of random starting values in the initial and subsequent steps of the optimisation to 500, and set the number of iterations in the initial optimisation step to 50.

To determine the most suitable model, we used the following statistical indicators: Akaike information criterion (AIC), Bayesian information criterion (BIC), sample-adjusted Bayesian information criterion (aBIC), entropy, Bayesian log-likelihood values, the bootstrapped likelihood ratio test (BLRT), and the adjusted Vuong – Lo – Mendell – Rubin test (VLMRT) (Weller, Bowen and Fauber 2020).

Predictors of profile membership

After determining the optimal profile solution, the model was extended by incorporating covariates that potentially predict teachers' membership in specific profiles. Missing data were encountered within the covariate variables (Table 1). To ensure the integrity of the analysis and minimise potential biases introduced by missing data, we employed an imputation technique selected based on the characteristics of the missing data and the assumptions regarding their mechanism of missingness. We applied Little's test to analyse the missing data (Li 2013), the results indicating that the mechanism of missingness was not MCAR. Due to the nature of missing values in the covariates, which could be attributed to characteristics unique to the panel study, we assumed that the data were missing at random (MAR) and that multiple imputation could be applied. We implemented multiple imputation by chained equations, generating 20 imputed datasets. The imputation model comprised the indicators for the profile and the covariates. We employed the indirect auxiliary-variables approach (R3STEP), which enabled us to examine the effects of the covariates while ensuring that the profile solution remained unbiased (Asparhouhov and Muthen 2014).

Results

Descriptive results and confirmatory factor analyses

Table 1 presents the descriptive findings, correlations, and reliability estimates for the scales. For technology integration self-efficacy, a single-factor model with five indicators was estimated and evaluated, demonstrating a good model fit ($\chi^2 = 28.122$, $df = 5$, $p < 0.001$, RMSEA = 0.069 [0.046 0.095], SRMR = 0.03, TLI = 0.95, and CFI = 0.98). We extracted the factor scores based on this measurement model.

Results of latent profile analysis

To determine the number of latent profiles, we specified and estimated a range of LPA models, varying the number of profiles from one to five. The variances for the indicator 'motivation of students' in class 1 were estimated to avoid convergence problems; the other indicator variances were held equal (default in Mplus). The resulting model fit information criteria are presented in Table 2.

Table 1. Descriptives and correlations of indicators and covariates (N = 965).

	M	*SD*	Missings	1	2	3	4	5	6	7	8	9	10	11	12
1. Technology integration self-efficacy	4.34	0.72	0												
2. Collegial support	2.73	0.86	2	.12*											
3. Principal support	2.36	0.93	4	.07	.44*										
4. Learning materials	2.79	0.76	2	.24*	.13*	.14*									
5. Motivation of students	2.37	0.70	4	.23*	.23*	.18*	.39*								
6. Online instruction	1.99	0.87	2	.35*	.13*	.20*	.28*	.29*							
7. ICT Literacy	−0.05	0.66	209	.14*	−.02	.00	−.02	.05	.04						
8. Teacher self-efficacy	3.17	0.30	143	.30*	.14*	.13*	.12*	.16*	.14*	−.04					
9. Subjective significance of work	2.42	0.88	68	.12*	.06	.11*	.04*	.16*	.08	−.01	.21*				
10. Work ambitions	3.01	0.82	68	.17*	.06	.09*	.05	.15*	.10*	−.02	.28*	.51*			
11. Inability to distance	3.26	0.86	68	−.02	−.04	−.07	−.05	−.02	−.07	.05	−.06	.30*	.18*		
12. Resignation tendency	2.96	0.82	68	−.10	−.06	−.03	−.02	−.02	−.11*	.03	−.13*	.24*	.21*	.54*	
13. Emotional exhaustion	1.84	0.51	160	−.16	−.06	−.12*	−.12*	−.08	−.10*	.00	−.32*	−.05	−.12*	.34*	.32*

Notes. *M* = mean; SD = standard deviation; *$p < 0.01$.

Table 2. Information criteria for LPA models.

#	AIC	BIC	aBIC	Entropy	LL	p_{BLRT}	p_{VLMRT}
2	13,062.09	13,159.53	13,096.01	0.55	−6511.04	< 0.001	0.020
3	12,880.06	13,011.60	12,925.85	0.69	−6413.03	< 0.001	0.066
4*	12,776.28	12,941.93	12,833.95	0.67	−6354.14	< 0.001	0.029
5	12,736.31	12,936.07	12,805.85	0.69	−6327.16	< 0.001	0.450

Notes: # = number of latent profiles; AIC = Akaike information criterion; BIC = Bayesian information criterion; aBIC = sample-adjusted BIC; BLRT = bootstrap likelihood ratio test; VLMR = adjusted Vuong – Lo – Mendell – Rubin test; LL = log-likelihood value; pBLRT = *p*-value for bootstrapped likelihood ratio test; pVLMRT = *p*-value for adjusted Lo – Mendell – Rubin test. * selected profile solution.

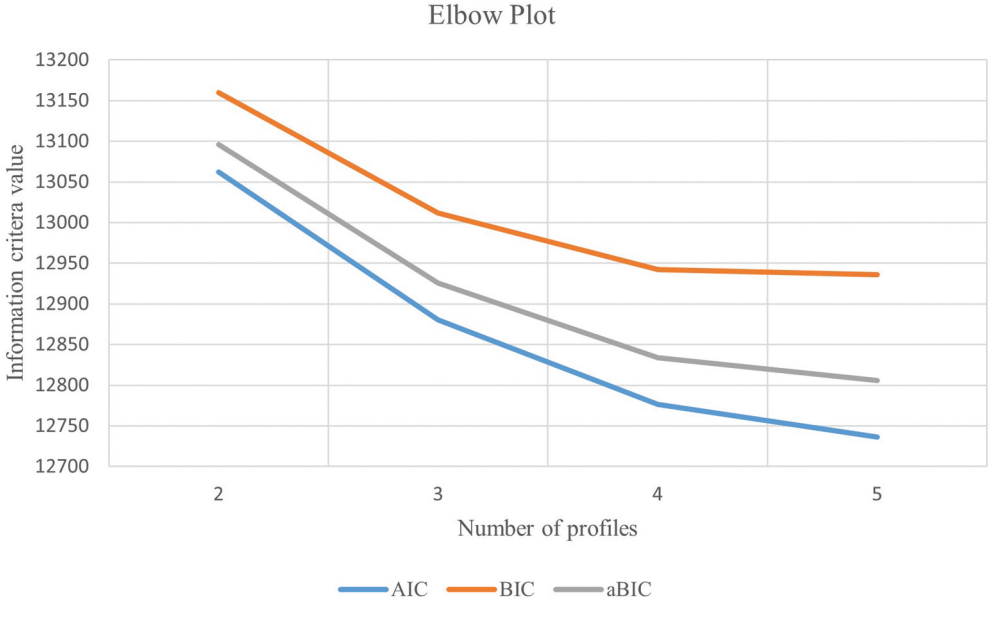

Figure 1. Elbow plot of selected fit indices for the LPA.

Models with three and five profiles had the highest levels of entropy, with the four-profile model ranking next. The elbow plot displayed a noticeable bend, suggesting a choice between a three- or four-profile solution (Figure 1). LPA models with five profiles included one small profile (8.9%). Given these findings, we ultimately selected the four-profile model as the final choice. We conducted a multivariate analysis of variance (MANOVA) to confirm the selection of profiles and substantiate the differences among the four profiles in terms of indicators. There were statistically significant differences between the profiles on the combined dependent variables, as evidenced by Pillai's trace ($V = 1.29$, $F(18, 2856) = 120.176$, $p < 0.001$, partial $\eta^2 = 0.431$). Post hoc tests with Bonferroni correction revealed significant differences between profiles for all indicators (see Supplement 2), with the exceptions of the difference in motivating students between profiles 1 and 3 and the difference in support between profiles 1 and 2.

Figure 2 illustrates the four latent profiles. Profile 3, comprising 519 individuals, was the most prevalent, followed by profile 1 with 171 individuals, profile 2 with 164 individuals, and finally profile 4—the smallest group – comprising only 111 teachers. Profile 1 (low school support) represents teachers who consistently registered low

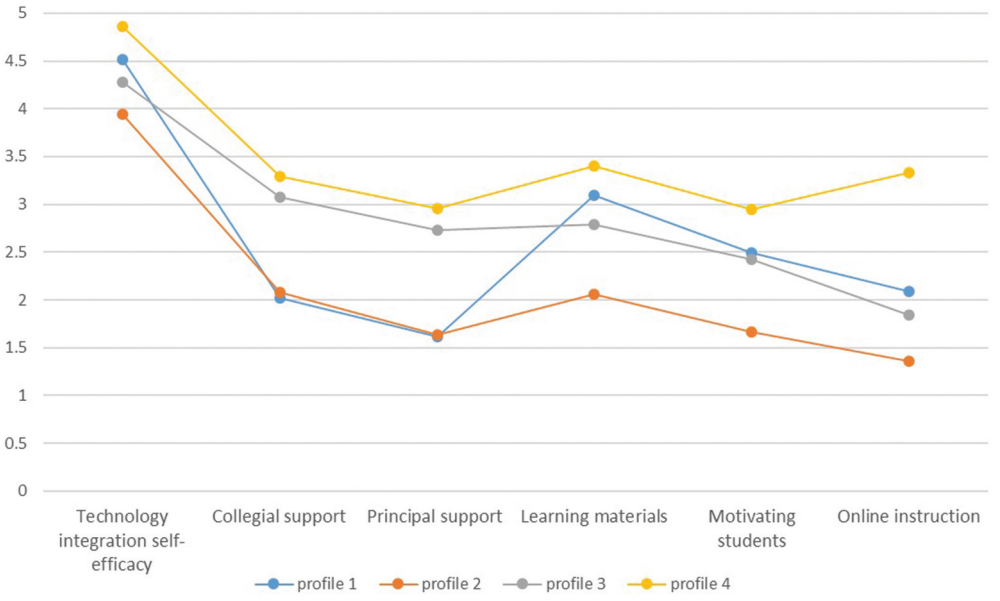

Figure 2. Mean values of the profile indicators of the four profiles.

values in terms of both collegial support ($M = 2.03$, $SE = 0.24$) and principal support ($M = 1.62$, $SE = 0.10$). They also exhibited medium to high ratings in other areas, such as teachers' technology integration self-efficacy ($M = 4.51$, $SE = 0.11$), provision of learning materials ($M = 3.10$, $SE = 0.10$), motivation of students ($M = 2.49$, $SE = 0.13$), and online instruction ($M = 2.09$, $SE = 0.22$). Despite feeling individually prepared for online teaching and learning, this group of teachers expressed a lack of institutional readiness, citing the insufficient support provided by the school.

Profile 2 (low readiness) characterises teachers who consistently registered low values across all profile indicators, including teachers' technology integration self-efficacy ($M = 3.94$, $SE = 0.08$) collegial support ($M = 2.07$, $SE = 0.17$), principal support ($M = 1.64$, $SE = 0.11$), provision of learning materials ($M = 2.06$, $SE = 0.20$), motivation of students ($M = 1.67$, $SE = 0.09$), and online instruction ($M = 1.36$, $SE = 0.06$). This group of teachers expressed that they were either not prepared or minimally prepared for online teaching.

Profile 3 (limited readiness) characterises teachers with medium ratings across teachers' technology integration self-efficacy ($M = 4.28$, $SE = 0.04$), providing of learning materials ($M = 2.79$, $SE = 0.05$), motivation of students ($M = 2.42$, $SE = 0.05$), and online instruction ($M = 1.85$, $SE = 0.08$). The difference between teachers in profiles 3 and 1 lies in their ratings of perceived support. Individuals in profile 3 perceive collegial support ($M = 3.08$, $SE = 0.05$) and principal support ($M = 2.73$, $SE = 0.14$) as high. However, their evaluations of teaching presence are notably lower compared to those in profile 4. Therefore, this group is characterised by their high self-assessed abilities and support, but provides a less favourable assessment of teaching presence. Hence, it can be concluded that these ECTs demonstrate a relatively low level of readiness in terms of performance.

Table 3. Early-career teachers' characteristics separated by profiles.

	Profile 1 ($n = 171$)	Profile 2 ($n = 164$)	Profile 3 ($n = 519$)	Profile 4 ($n = 111$)
Age	29.95 (1.51)	30.65 (2.95)	30.24 (2.33)	30.16 (2.22)
Sex				
Women	73.68%	76.83%	76.88%	66.67%
Men	26.32%	23.17%	23.12%	33.33%
Type of school				
Primary	14%	14%	26%	12%
Other	85%	86%	74%	77%
Missing	1%	0%	< 1%	0%
Subject				
Language	42%	45%	49%	41%
STEM	40%	33%	30%	38%
Social sciences and economics	11%	9%	9%	13%
Other	6%	13%	11%	8%
Missing	1%	0%	< 1%	0%

Profile 4 (high readiness) characterises teachers who consistently registered high ratings across all profile indicators, including teachers' technology integration self-efficacy ($M = 4.86$, $SE = 0.08$), collegial support ($M = 3.30$, $SE = 0.11$), principal support ($M = 2.95$, $SE = 0.14$), provision of learning materials ($M = 3.40$, $SE = 0.12$), motivation of students ($M = 2.95$, $SE = 0.08$), and online instruction ($M = 3.33$, $SE = 0.11$). These teachers expressed that they were well prepared for online teaching, not only in terms of their own abilities but also due to their confidence in the adequacy of institutional support.

Table 3 presents the teacher characteristics, categorised into the four profiles. Overall, disparities are evident among the profiles regarding the teacher's background characteristics. To investigate these distinctions among teachers across profiles and ascertain which features can predict profile membership, the LPA model was augmented with explanatory variables at the teacher level.

Table 4. Results of multinominal logistic regression.

	Profile 4 vs. 2				Profile 4 vs. 1				Profile 4 vs. 3			
	B	*SE*	*OR*	*p*	*B*	*SE*	*OR*	*p*	*B*	*SE*	*OR*	*p*
Age	−0.059	0.078	0.943	0.450	0.110	0.098	1.116	0.264	−0.007	0.077	1.007	0.927
Primary school	−0.020	0.596	0.980	0.973	−0.280	0.578	0.756	0.629	−1.258	0.475	0.284	0.008
ICT literacy	0.174	0.293	1.190	0.553	0.133	0.280	1.142	0.636	0.145	0.247	1.156	0.557
Female	−0.338	0.425	0.713	0.426	−0.346	0.410	0.708	0.399	−0.384	0.358	0.681	0.284
Language[a]	−0.197	0.423	0.821	0.641	0.137	0.397	1.147	0.730	−0.156	0.365	0.855	0.284
Social sciences and economics[a]	0.296	0.584	1.344	0.612	0.098	0.548	1.103	0.858	−0.085	0.476	0.919	0.858
Other subject[a]	−0.565	0.604	0.569	0.349	0.494	0.733	1.639	0.501	−0.630	0.557	0.533	0.258
Teacher self-efficacy	2.907	0.718	18.296	0.000	1.551	0.714	4.717	0.030	1.569	0.588	4.801	0.008
Subjective significance of work	0.573	0.276	1.774	0.038	0.410	0.228	1.507	0.072	0.178	0.210	1.194	0.397
Work ambitions	0.635	0.280	1.886	0.023	−0.106	0.260	0.899	0.684	0.239	0.220	1.271	0.276
Inability to distance	−0.197	0.255	0.821	0.439	0.131	0.270	1.140	0.674	0.289	0.225	1.335	0.199
Resignation tendency	−0.547	0.278	0.579	0.049	−0.114	0.270	0.892	0.674	−0.411	0.225	0.663	0.067
Emotional exhaustion	−0.845	0.420	0.429	0.044	−0.315	0.431	0.729	0.464	−0.623	0.375	0.536	0.097

Note. [a]subject with reference STEM.

Factors predicting profile membership

A multinomial logistic regression was employed using an indirect auxiliary-variables approach and imputed data to examine which teacher-level variables could elucidate membership of a profile. In profiles demonstrating high readiness, we expected a higher proportion of STEM teachers (H1), higher ICT literacy (H2), higher TSE (H3), higher occupational coping skills (H4), and lower emotional exhaustion (H5) compared to the other profiles. Table 4 presents the (non-standardised) regression coefficients, their standard errors, and the odds ratios. To test the hypotheses, we compared profile 4 (high readiness) with profiles 2 (low readiness), 3 (limited readiness), and 1 (low school support).

Profile 4 compared to profile 2

The results revealed no significant association between a teacher's main subject taught or their ICT literacy and their categorisation into profile 4 versus profile 2. Teachers with higher TSE and higher work engagement (i.e. subjective significance of work and career ambitions) were more likely to be placed in profile 4, while teachers who reported higher resignation tendency and higher emotional exhaustion exhibited a decreased probability of being categorised into this profile. However, we did not find an effect for teachers' inability to distance. The teacher background variables of age, type of school, and gender were not significantly related to profile affiliation.

Profile 4 compared to profile 1

The results show no significant association between a teacher's main subject taught or their ICT literacy and their categorisation into profile 4 versus profile 1. Teachers with higher TSE were more likely to be placed into profile 4. Subjective significance of the work just missed the level of significance, and there were no effects for inability to distance, resignation tendency, emotional exhaustion, or the teacher background variables.

Profile 4 compared to profile 3

The results revealed no significant association between a teacher's main subject taught or their ICT literacy and their categorisation into profile 4 versus profile 3. ECTs with higher TSE were more likely to be placed into profile 4. Resignation tendency and emotional exhaustion showed marginal negative effects. However, work engagement and the inability to distance did not affect profile membership. From the teacher background variables, the type of school showed a significant negative effect, i.e. primary teachers were less likely to be categorised into profile 4 than into profile 3.

Discussion

The primary aim of this study was to identify the online teaching readiness profiles of primary and secondary ECTs during the COVID-19 pandemic. Based on previous research, profiles were created using various key indicators of readiness. We also investigated factors that predict profile membership, including teacher characteristics and contextual variables.

Identified teacher profiles

Our LPA yielded a solution with four profiles, consistent with the findings of Howard et al. (2021), who also identified four profiles for secondary school teachers. Profile 1 (low school support) comprises teachers (17.7%) reporting weak institutional support but medium to high self-efficacy in technology integration and perceived teaching presence. This suggests that self-evaluations of teaching practice within this group were unaffected by the level of support. It is possible that this group effectively utilised additional resources beyond support to navigate the challenges associated with the sudden transition to distance teaching, given the constraints of limited institutional assistance (e.g. Burke, Schuck, and Kearney 2023; Huber and Helm 2020). This result contradicts the findings of Howard et al. (2021), who identified only one group with low support as well as low scores on other indicators. Profile 2 (low readiness) comprises teachers (17.0%) with low values across all profile indicators, who are similar to those in profile 1 in terms of weak institutional support, but exhibit low technology integration, self-efficacy and low online presence. This result aligns with that of Howard et al. (2021), who found 16.7% of the teachers in the low-readiness group. Profile 3 (limited readiness) is the most prevalent (53.8%), characterised by teachers with medium to high self-assessed abilities and institutional support but with less favourable evaluations of teaching presence. This suggests that these teachers were unable to translate their perceived abilities into high performance in their teaching practice despite perceived support. Profile 4 (high readiness) is characterised by high scores on all indicators, with teachers rating their abilities and institutional support during pandemic-induced distance learning highly, and reporting high values in terms of their teaching practices. However, this group constitutes the smallest group of teachers (11.5%), consistent with the findings of Scherer et al. (2021) and Howard et al. (2021), who also reported that the group of teachers with high readiness represented the smallest group. Furthermore, these findings align with previous research indicating that younger teachers did not exhibit an advantage in pandemic online teaching compared to their older counterparts (e.g. König, Jäger-Biela, and Glutsch 2020; Ma et al. 2022). Ma et al. (2022) posited that older, experienced teachers with limited technological knowledge and interest might experience higher levels of techno-stress when required to employ technology for online teaching. Simultaneously, less teaching experience and fewer teaching routines exacerbate the challenges faced by beginner teachers (cf. König, Jäger-Biela, and Glutsch 2020; Paetsch, Franz, and Wolter 2023).

Predictors of profile membership

This study also examined the factors that predict teachers' profile membership. Based on theoretical assumptions and previous empirical findings, it was assumed that teachers in profiles with high online teaching readiness differ from those in other profiles in terms of the proportion of STEM teachers, their ICT literacy, their TSE, their occupational coping skills, and their emotional exhaustion. The results reveal that teachers in the high-readiness profile were characterised by significantly higher TSE, higher work engagement, lower resignation tendency, and lower

emotional exhaustion than teachers in the low-readiness profile. Furthermore, teachers in the high-readiness profile differ from those in both the low-support and limited-readiness profiles in terms of their TSE. The limited-readiness group also exhibited lower resignation tendency and emotional exhaustion than the high-readiness group. For ICT literacy and STEM, no differences were found in the assignment probabilities for the high-readiness profile.

The overall effects for TSE align with previous research showing that teachers' TSE is associated with their behavioural intentions to use ICT (Joo, Park, and Lim 2018), their frequency of reported activities during pandemic distance teaching (König, Jäger-Biela, and Glutsch 2020), and their teaching quality (Zee and Koomen 2016).

The finding that teachers with better coping strategies and lower emotional exhaustion are more likely to be categorised in the high-readiness profile aligns with the findings of Wong et al. (2021), who demonstrated a significant relationship between stress and online teaching proficiency among secondary teachers. Additionally, these findings corroborate those of Klusmann et al. (2023), who found a negative relationship between emotional exhaustion and social support, as well as those of Huang, Nalipay, and Wang (2024), who demonstrated an association between occupational well-being and teaching quality. While we observed differences among the profiles in terms of teachers' work engagement and resignation tendencies, the inability to distance oneself, another aspect of occupational self-regulation, did not emerge as a significant predictor of profile membership. This suggests that the extent to which teachers addressed work-related challenges during their leisure time was less influential in the context of pandemic-driven online teaching.

Our study found that teachers' ICT literacy was not a predictor of high-readiness profile membership, which contradicts the work of Huang, Lazarides, and Richter (2023), who found that professional training in ICT was a significant predictor of teachers' perceived preparedness for distance education, as well as that of Rohatgi, Scherer, and Hatlevik (2016), who identified associations between ICT literacy and domain-specific self-efficacy. A possible explanation for this is that the measurement of ICT literacy was not valid because the measurement point occurred approximately 7 years prior to the start of the pandemic.

Finally, we discuss the results for the contextual factors of subject and school type. Our study reveals that primary teachers were more likely to be assigned to the limited-readiness profile than to the high-readiness or low-readiness profiles. This suggests a performance issue and indicates that there may be additional factors within primary schools that hinder the implementation of online teaching. For instance, the heterogeneity of students, their lower level of independence, and their relative lack of ICT skills could all contribute to this challenge (cf. Jung, Cho, and Lim 2019). Additionally, subject disciplines did not explain differences in the profile membership probability assignments, indicating that STEM teachers did not have any advantages in online teaching. Scherer et al. (2021) argued that differences in academic disciplines may be mediated by other factors associated with academic cultures. Considering the findings from Ma et al. (2022), whose meta-analysis demonstrated lower stress levels in teachers from science and technology disciplines, emotional exhaustion may mediate the differences in profile membership between-subject disciplines in our study.

Limitations and future research

The current study has several limitations. First, the indicators used to assess online teaching readiness provide only a partial picture of this complex construct. Future research should consider extending the measures to include other relevant aspects (cf. Scherer et al. 2021), such as TPACK or collaboration with colleagues.

Another limitation relates to the measurement of technology integration self-efficacy. The scale we used included items that assessed general aspects of ICT integration rather than specifically targeting online teaching. This could limit the validity of the instrument and impact the LPA results.

Furthermore, the assessment of teaching practice relied on three single-item indicators rather than scales. This approach may have resulted in the inadequate capture of important aspects of the construct.

Despite deriving data from a comprehensive panel study, the research design lacked a longitudinal dimension, limiting the opportunity to observe changes in variables over time. This omission means that it is not possible to establish causality from the findings. Further research is needed to assess the effectiveness of targeted interventions tailored to specific readiness profiles.

Although the sample of ECTs in our study was relatively large, the proportion of primary teachers was rather small. Therefore, differences between primary and secondary school teachers could not be examined in detail, and the profiles that we identified may not be fully applicable to both groups. Future studies with a larger sample of primary school teachers should investigate the similarity of latent profiles across primary and secondary education (Morin, Meyer, and Biétry 2015). Furthermore, the observed differences across educational contexts highlight the need for more comparative and context-sensitive research across different school types. Future studies should more thoroughly examine the influence of structural and demographic variables to better understand how these factors shape teacher profiles and impact teaching practices. For example, this could involve investigating the effects of school locations (urban, rural, suburban), student backgrounds, and teachers' levels of experience and training.

Another limitation is the use of measures of ICT literacy gathered several years before the onset of the pandemic. This may have resulted in inaccurate estimates of ICT literacy, potentially explaining the lack of significant effects observed in this study.

Finally, we observed a notable amount of missing values in the covariates. Acknowledging the impact of missing data is crucial because it can introduce bias and affect the broader applicability of the research results. However, efforts were made to address this limitation by employing appropriate statistical techniques to manage missing data. Nonetheless, due to panel attrition, the results may still be affected by selective dropout, which could compromise representativeness (Zinn et al. 2018).

Conclusions and implications

This study revealed systematic differences in ECTs' online teaching readiness, indicating that support strategies and training initiatives should be tailored rather than uniformly applied to meet the specific needs of different teacher groups. Additionally, the identified profiles demonstrate that personal and contextual readiness can diverge, highlighting not

only the value of viewing online teaching readiness as a multidimensional construct (cf. Cutri and Mena 2020) but also the necessity for teacher education programs to address multiple aspects of readiness beyond ICT competencies alone (Johnson et al. 2023). Our findings in primary and secondary education differ from those in higher education, suggesting distinct challenges across educational levels. Given that primary teachers were overrepresented in the limited-readiness profile, targeted strategies are especially needed at the primary level, where digital instruction may involve unique pedagogical demands. Our study demonstrates that teachers with high online teaching readiness exhibit high levels of TSE, strong work engagement, reduced resignation tendency, and lower emotional exhaustion, emphasising the importance of promoting teacher well-being through targeted interventions and integrating such support into systemic professional development structures (e.g. Voss et al. 2023). Given the continued expansion of online and hybrid instruction (Tondeur et al. 2023), these findings underscore the need to adequately prepare even ECTs for the demands of digital teaching environments.

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Data availability statement

This study utilises data from the National Educational Panel Study (NEPS): Starting Cohort First-Year Students, available at doi:10.5157/NEPS:SC5:17.0.0

Disclosure statement

No potential conflict of interest was reported by the author(s).

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