

2023

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Recommended Citation

Çetin, G., & Eren, A. (2023). “To Be or Not To Be Neglected”: Latent Profile Analysis of Null Curriculum Concerning 21st-Century Skills in Teacher Education. *Australian Journal of Teacher Education*, 48(9). <https://doi.org/10.14221/1835-517X.6213>

This Journal Article is posted at Research Online.
<https://ro.ecu.edu.au/ajte/vol48/iss9/1>

“To Be or Not To Be Neglected”: Latent Profile Analysis of Null Curriculum Concerning 21st-Century Skills in Teacher Education

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Abstract: Using a cross-sectional survey research design, this study explored the latent profiles of 247 in-service and 459 pre-service teachers' perceptions of the omitted or neglected parts of teacher education programs in Türkiye regarding 21st-century skills, with the intention of examining whether these profiles substantially differed between the in-service and pre-service teacher samples. Both groups were asked to respond to a null curriculum questionnaire for 21st-century skills. Preliminary analyses revealed that the factor structure of the questionnaire had a good fit for both in-service and pre-service teachers' data and was invariant across samples and gender. Based on the results of the latent profile analyses, three profiles (the fully omitted/neglected 21st-century skills profile, the moderately omitted/neglected 21st-century skills profile, and the well-captured 21st-century skills profile) were identified among in-service teachers. Conversely, four profiles were identified among pre-service teachers (the highly omitted/neglected 21st-century skills profile, the fully omitted/neglected 21st-century skills profile, the moderately captured 21st-century skills profile, and the fully captured 21st-century skills profile). The results showed that, with one exception (i.e., the fully omitted/neglected 21st-century skills profiles), the characteristics of these profiles were not comparable across the two samples.

Keywords: Null curriculum; 21st-century skills; teacher education; latent profile analysis; teachers

Introduction

Current scientific and technological advances affect almost all aspects of human life, necessitating individuals to acquire sophisticated information and create comprehensive knowledge to elucidate complex individual, social, and global problems, such as ecological issues (e.g., Chu et al., 2017). These demands increasingly lead individuals to cultivate a wide variety of skills, including creativity and innovation, in accordance with the characteristics of the 21st century (Voogt & Roblin, 2012).

Developing such skills, often referred to as ‘21st-century skills’ (Chalkiadaki, 2018; Scott, 2015; Voogt & Roblin, 2012), in students is a prominent educational concern in many countries around the globe (Care et al., 2016; Reimers, 2021; Rotherham & Willingham, 2009; Scott, 2015). Therefore, current education systems in general, and school programs in particular, strive to better address the complex nature of 21st-century skills and respond to the diverse learning needs of students accordingly (Dishon & Gilead, 2020). This inevitably

requires policymakers and curriculum specialists to consider and reconsider the objectives and content of educational programs at different stages.

Despite these attempts, integrating 21st-century skills into actual classroom practices has progressed at a remarkably slow pace globally in many countries around the globe, such as Australia, the Netherlands, Singapore, and the United States (Ab Kadir, 2019; Anderson-Levitt, 2021; Kunhi et al., 2020; Volman et al., 2020). For example, Care et al. (2016) examined the level of integration of 21st-century skills within the national education systems of 102 countries worldwide and found that although most countries recognized 21st-century skills as part of their broader educational goals, fewer countries provided evidence of their practical integration into the curriculum (Joynes et al., 2019). This slow progress can be attributed partly to teachers' lack of time (Care et al., 2019; González-Salamanca et al., 2020), their attitudes toward pedagogical innovations (O'Bryan, 2019), and their experience in teaching 21st-century skills (Urbani et al., 2017; Varas et al., 2023). Accordingly, it can be argued that additional support and comprehensive efforts, such as providing professional development opportunities, making curriculum adjustments, and implementing policies that encourage and sustain innovative teaching practices among teachers, are needed to facilitate effective implementation.

These efforts could be particularly important given the crucial roles of teachers in implementing the curriculum in general (Dede, 2010), and their expected ability to integrate 21st-century skills into their pedagogical practices in particular (Voogt et al., 2013). For instance, Australia's national curriculum specifies seven general capabilities that align with 21st-century skills, which teachers are required to integrate into their teaching across all subjects (Care et al., 2017). However, integrating 21st-century skills into pedagogical practices is not straightforward; rather, it necessitates teachers to have sufficient experience to teach and assess them effectively (Rotherham & Willingham, 2009; Saavedra & Opfer, 2012).

Recent research has shown that both in-service teachers (henceforth referred to as 'teachers' only, unless specified otherwise) and pre-service teachers (PTs) lack the in-depth experience to incorporate 21st-century skills into their teaching (e.g., Urbani et al., 2017; Varas et al., 2023). In this regard, the roles of initial teacher education programs in gaining these experiences become crucial because PTs learn to know, think, feel, and act like a teacher during teacher education (Feiman-Nemser, 2008), suggesting that initial teacher education programs should provide a solid basis for PTs to gain in-depth experiences in teaching 21st-century skills (Valtonen et al., 2021). As such, teacher education programs could better support the integration of 21st-century skills within classroom practices (Häkkinen et al., 2017).

It should be noted that neither integrating 21st-century skills into teacher education programs nor enabling PTs to gain in-depth experience in teaching these skills guarantees that they will be taught effectively because 21st-century skills are mostly perceived as challenging due to their complex nature (Saavedra & Opfer, 2012; Volman et al., 2020). Therefore, developing teacher education programs that include competencies for 21st-century skills requires curriculum specialists not only to holistically consider relevant teaching methods, materials, activities, and assessment procedures (e.g., the revision of textbooks, the development of teaching guides, and criteria for assessment) (Joynes et al., 2019; Kim & Care, 2018; Voogt & Roblin, 2012) but also to take into account the perceptions of teachers and PTs regarding such programs.

These explanations clearly underscore the importance of addressing the perceived discrepancies between what initial teacher education programs aim to develop in terms of 21st-century skills among teachers and PTs, and whether these programs are actually considered as important by teachers and PTs as intended. Although the mentioned

discrepancy has not been examined in a single study to date within the scope of teachers' and PTs' perceptions of 21st-century skills, how and why teachers deliberately or inadvertently ignored or omitted some parts of a curriculum has long been examined based on the concept of null curriculum (Eisner, 1985; Noddings, 2012). This suggests that teachers' and PTs' perceptions of the omitted or neglected parts of teacher education programs concerning 21st-century skills could be examined using the concept of null curriculum.

Supporting this argument, relevant research shows that 21st-century skills are rarely systematically taught in schools (Anderson-Levitt, 2021; Care et al., 2016; Volman et al., 2020), indicating that the null curriculum is indeed a crucial concern for the development of these skills in students. The origin of this concern could be traced back to both pre-service and in-service teacher education programs, given the significant roles of teachers in teaching 21st-century skills (Voogt et al., 2013), and also considering the crucial role of initial teacher education programs in teachers' professional development (Darling-Hammond, 2013). On one hand, examining the null curriculum in teacher education within the scope of 21st-century skills could reveal why these skills tended to be rarely taught in schools by teachers. On the other hand, it could uncover the factors influencing the initial aspects of this negligence during the pre-service teacher education process through the perceptions of PTs regarding these factors.

Although there appears to be a large body of research on attitudes, beliefs, and competencies of teachers and PTs within the scope of 21st-century skills (e.g., Haug & Mork, 2021; Urbani et al., 2017; Valtonen et al., 2021; Yoo & Kang, 2021), these studies do not provide clear evidence regarding the extent to which teachers' and PTs' perceived 21st-century skills are incorporated into teacher education programs. Furthermore, previous studies have mostly examined either PTs' (Urbani et al., 2017; Yoo & Kang, 2021) or teachers' (Haug & Mork, 2021; Varas et al., 2023) attitudes, beliefs, and competencies regarding 21st-century skills, signifying that these studies do not also provide clear evidence regarding the discrepancies and/or similarities between their attitudes, beliefs, and/or competencies in terms of 21st-century skills.

However, conducting a comparative analysis of teachers' and PTs' perceptions regarding the integration of 21st-century skills into teacher education programs could provide valuable insights for policymakers, teacher education program developers, and teacher educators, enabling them to better identify the obstacles hindering the teaching of these skills in educational settings. This, in turn, could inform more effective strategies for incorporating 21st-century skills into teacher education programs, aligning with current educational and curricular initiatives (Schleicher, 2012; Care et al., 2016; Reimers, 2021; Scott, 2015).

Additionally, attitudes, beliefs, and competencies of both teachers and PTs regarding 21st-century skills have predominantly been examined in previous studies through qualitative analyses (e.g., Haug & Mork, 2021) or, to a lesser extent, variable-centered quantitative analyses (e.g., Urbani et al., 2017). This signifies that the comprehensive understanding of teachers' and PTs' attitudes, beliefs, and competencies regarding 21st-century skills could not be fully captured from the results of these studies. This is because the results of qualitative studies cannot be generalized to larger samples of teachers or PTs, while variable-centered analyses only offer a general overview of the relationships between the variables of interest (Laursen & Hoff, 2006). In contrast, person-centered quantitative analyses enable researchers to describe both common and different characteristics of individuals based on diverse or similar combinations of the research variables (i.e., profiles) simultaneously (Laursen & Hoff, 2006). This approach facilitates researchers to compare these characteristics across groups in a detailed manner, allowing for a nuanced understanding of differences and similarities embedded in the research variables (Lohbeck & Frenzel, 2022). Therefore, in this study, a novel and robust approach for person-centered analysis, namely Latent Profile

Analysis (LPA; see the section entitled ‘data analysis’), was conducted to uncover the profiles of teachers and PTs grounded in their perceptions of the degree to which teacher education programs embrace 21st-century skills.

The aforementioned explanations clearly indicate that it is not only reasonable but also important to examine teachers’ and PTs’ perceptions of the extent to which teacher education programs encompass 21st-century skills. Consequently, this study aimed to explore the latent profiles of teachers’ and PTs’ perceptions of the omitted or neglected parts of teacher education programs in relation to 21st-century skills, with the ultimate intention of uncovering whether the characteristics of these profiles substantially differed across the samples of teachers and PTs. Two overarching research questions were formulated as follows: (1) What are the profiles of teachers’ and PTs’ perceptions regarding the omitted or neglected parts of teacher education programs in relation to 21st-century skills? (2) Do the characteristics of these profiles substantially differ across the samples of teachers and PTs? Specific hypotheses were not formulated because of the exploratory nature of the study (Fraenkel et al., 2012).

Conceptual Framework

Null Curriculum

Null curriculum, also known as excluded or absent curriculum, refers to “the options students are not afforded, the perspectives they may never know about, much less be able to use, the concepts and skills that are not part of their intellectual repertoire” (Eisner, 1985, p. 107). It is a multidimensional concept that consists of emphasized, yet disregarded, intellectual processes along with excluded or neglected content due to political and/or cultural reasons (Eisner, 1985). The term ‘intellectual processes’ denotes a large set of knowledge, skills, values, attitudes, and emotions (Cahapay, 2020; Flinders et al., 1986). The content dimension, however, occurs in a hierarchy, extending from the exclusion of entire disciplines to the omission of particular bits of information (Flinders et al., 1986). Thus, null content could take many forms, some of which denote the exclusion of certain disciplines and sub-fields within a particular discipline, while others point to the omission of specific topics, facts, and histories of populations or cultures (Cahapay, 2020).

These forms and their extent could vary from one school to another due to the educational policies of countries in general, and the interests and capabilities of curriculum specialists and/or teacher values in particular (Gholami et al., 2016). For example, in some countries, religion and/or sex-related topics are deliberately neglected in school curricula due to political reasons (Assemi & Sheikzade, 2013). Whether done deliberately or not, such neglect has crucial consequences for student learning, as it gives an implicit message that these and similar topics (e.g., sexist language in books) are unimportant (Milner IV, 2017). Therefore, a critical analysis of null curriculum paves the way for a broader understanding of what is not offered to students, as well as reveals the consequences and effects of such neglect (Quinn, 2010).

Previous studies, though limited in number, provided evidence showing where curriculum omissions arise and how these omissions bias student thinking (Boateng et al., 2023; Chowdhury & Siddique, 2017; Sanjakdar et al., 2015; Tatar & Adıgüzel, 2019; Yonas et al., 2024). For example, Sanjakdar et al. (2015) demonstrated that the content of many school-based sexuality education programs and associated teacher pedagogies in Australia and New Zealand failed to address variability in the sexual health status along with behaviors of ethnic young people, despite growing cultural and ethnic diversification in these schools. Chowdhury and Siddique (2017) showed that teachers in Bangladesh ignored the information

about genitals, physical and psychological changes during puberty, pregnancy, and evolution because of their socio-cultural and religious beliefs, which negatively affected student achievement regarding scientific literacy. Likewise, Tatar and Adıgüzel (2019) revealed that controversial issues (e.g., human rights, evolution) were either inadequately included or entirely neglected in primary and secondary school programs in Türkiye. Boateng et al. (2023) indicated that inadequate resources, problematic nature of particular topics, insufficient time, and inadequate knowledge and skills prompted teachers to omit specific topics, experiences, or subjects from the implemented curriculum in the Ghanaian basic education system. More recently, Yonas et al. (2024) demonstrated that states with legislative mandates requiring genocide education in the United States often omit acts of genocide, refrain from using this term, and frame genocides as less important than the Holocaust, perpetuating the null curriculum of genocides.

Research on null curriculum in teacher education is even more limited, despite its crucial significance for teacher education programs. For instance, Borek (2012) revealed that music teacher education programs in the United States, specifically in the state of Massachusetts, mostly emphasized knowledge and performance-oriented skills regarding Western art music, while neglecting other types of music from non-Western countries.

Recently, Kazemi et al. (2020) developed a questionnaire titled ‘The Questionnaire for Null Curriculum in English Language Teaching: Focusing on 21st Century Skills (QNCES)’ to examine the null curriculum of 21st-century skills in the English as a Foreign Language Teaching (EFL) context. The questionnaire was administered to university instructors teaching English to EFL undergraduate students in Iran. The results showed that the null curriculum in the EFL teaching context could be reliably examined based on a diverse range of 21st-century skills, such as global and local connection skills. In a subsequent study, Kazemi et al. (2023) also noted that, except for communication skills, all other 21st-century skills were regarded as aspects of the null curriculum in the English Language Teaching (ELT) context at the bachelor’s degree level in Iranian universities. The framework of Kazemi et al. (2020, 2023) is notable as it captures the comprehensive and interconnected nature of 21st-century skills. This framework also provides a robust theoretical foundation for investigating teachers’ and PTs’ perceptions regarding the extent to which teacher education programs incorporate 21st-century skills. Hence, the framework of Kazemi et al. (2020, 2023) was adopted in this study.

21st-Century Skills

While there is no completely agreed-upon definition of ‘21st-century skills’, the term generally denotes a distinct set of competencies, attributes, and abilities essential for navigating the demands of contemporary life (Joynes et al., 2019). 21st-century skills are described as multifaceted and interconnected attributes rather than isolated and independent concepts (Chalkiadaki, 2018; Voogt & Roblin, 2012). Specifically, these skills have predominantly been explored through various professional attributes, including communication skills, collaborative abilities, individual learning approaches such as critical thinking and autonomy, flexibility, as well as ICT and digital literacy, encompassing the use of technology for learning, communication, and collaboration (Joynes et al., 2019). Particular knowledge domains, such as literacy, numeracy, and STEM-related fields, along with additional personal attributes, including social and emotional skills and social citizenship, are also considered integral to the concept of 21st-century skills (Joynes et al., 2019). This consideration serves to highlight the interdisciplinary nature of contemporary knowledge domains (Kennedy & Sundberg, 2020) and emphasizes the connection between higher-order

skills and behaviours necessary for addressing complex problems and unpredictable situations (Voogt & Roblin, 2012).

Although many of these skills (e.g., communication skills) and knowledge domains (e.g., literacy) are not unique to the 21st century, they have become more complex due to rapid scientific and technological developments (Silva, 2009). Hence, these skills have been recently expanded by practitioners, educators, and international organizations in response to compelling economic, social, and educational demands (Chu et al., 2017; Saavedra & Opfer, 2012), leading to the development of more inclusive frameworks for 21st-century skills. These frameworks include, among others, the Asia-Pacific Economic Cooperation (APEC), the Partnership for 21st Century Learning (P21 Framework), Assessment and Teaching of 21st Century Skills (ATC21S), and National Educational Technology Standards (NETS), as well as EnGauge, 21st Century Skills and Competences for New Millennium Learners, Key Competences for Lifelong Learning, and ICT Competency Framework for Teachers (for comprehensive reviews, see Binkley et al., 2012; Chu et al., 2017; Dede, 2010; Scott, 2015).

In fact, the P21 framework is widely used because it is more detailed and comprehensive (Chu et al., 2017; Dede, 2010; Voogt & Roblin, 2012), clearly delineating the skills, knowledge, and expertise that students need to effectively enter today's workforce. Within this framework, K-12 students are expected to master nine major subjects (e.g., mathematics), learn about five interdisciplinary themes (e.g., civic literacy), and develop three categories of skills (e.g., learning and thinking skills) (see, for more information, Partnership for 21st-century Learning-P21, 2019). Considerable research examined teachers' and PTs' attitudes, beliefs, and competencies regarding 21st-century skills within the P21 framework (e.g., Anagün, 2018; Kazemi et al., 2020; Urbani et al., 2017). For example, Anagün (2018) found that teachers perceived problem-solving, critical thinking, cooperation, communication, and creativity as prominent aspects of 21st-century skills. Similarly, Urbani et al. (2017) demonstrated that PTs learned better from coursework and fieldwork when 21st-century skills were intrinsically linked to the content, enabling them to integrate these skills into their teaching practices more effectively.

The results of these and similar studies (e.g., Yoo & Kang, 2021) suggest that the P21 is a reliable and comprehensive framework that enables exploration of the cross-cutting, multidimensional, and extensive characteristics of 21st-century skills within the realm of teaching and teacher education. Likewise, the framework proposed by Kazemi et al. (2020, 2023) was derived from the P21 framework, indicating that the 21st-century skills outlined by Kazemi et al. (2020, 2023) could be reasonably applied to the context of teaching and teacher education as delineated by the P21 framework. Thus, in this study, the P21 framework was used to investigate the extent to which 21st-century skills are perceived by teachers and PTs to be incorporated into teacher education programs.

Method

A cross-sectional survey research design (Fraenkel et al., 2012; Gay et al., 2014) was adopted to examine the perceptions of teachers and PTs regarding the omitted or neglected components of teacher education programs concerning 21st-century skills.

Context and Participants

In Türkiye, faculties of education have been offering teacher education through four-year bachelor's degree programs since the establishment of the Council of Higher Education

(CoHE) in 1981. The CoHE bears full responsibility for accrediting and standardizing teacher education programs. Recently, education faculties have also offered one-year Teaching Certificate programs for final-year undergraduate or graduate students from other faculties (e.g., economics and administrative sciences). Due to the highly centralized nature of teacher education programs in Türkiye, all PTs are required to take field-specific courses (e.g., calculus), pedagogical courses (e.g., classroom management), and teaching practicum courses, regardless of the duration and types of these programs (CoHE, 2018).

This study was conducted with PTs enrolled in four-year bachelor's degree programs and teachers who graduated from both four-year bachelor's degree programs and one-year Teaching Certificate programs. Specifically, 471 fourth-year PTs (360 female and 111 male), majoring in 12 diverse fields of study (e.g., special education), were conveniently sampled from the faculty of education, which consists of nearly 750 final-year PTs, at a large university in the North-West region of the Black Sea in Türkiye. The sample included only PTs in their final year of studies because, at the time of data collection, they had already completed most of the field-specific and pedagogical courses. The PTs ranged in age from 20 to 37 years ($M = 22.02$; $SD = 1.70$) (see Tab. 1).

A total of 253 teachers (174 female, 79 male), who were conveniently sampled from all geographical regions in Türkiye (e.g., the Aegean region), also constituted the sample. With a mean age of 35.31 years ($SD = 7.27$), the sample consisted of teachers from 29 diverse fields of expertise. For simplicity and clarity, these fields of expertise were classified under broader conceptual categories, as depicted in Table 1.

Research Instrument

Null Curriculum Questionnaire for 21st-Century Skills

The Questionnaire for Null Curriculum in English Language Teaching: Focusing on 21st Century Skills, originally developed by Kazemi et al. (2020, 2023), was adapted to assess teachers' and PTs' perceptions of the extent to which teacher education programs include 21st-century skills. This questionnaire comprised 42 items represented by 10 interrelated factors: critical thinking and problem-solving skills, collaboration skills, communication skills, creativity and innovation skills, self-direction skills, technological literacy, global and local connection skills, economic and financial literacy, business and entrepreneurial literacy, and media literacy.

All the items (e.g., students learn to work in groups or pairs to complete a task together) in the original questionnaire were translated into Turkish by the authors. The items were slightly modified to commence with the term 'during teacher education' to enable teachers and PTs to rate their responses with various aspects of their teacher education programs in mind (e.g., learning and teaching activities, fieldwork, laboratory studies). For example, an item was adjusted to read, 'during teacher education, pre-service teachers learn to work in groups or pairs to complete a task together'. Moreover, 10 additional items were written and included in the questionnaire to strengthen the semantic content of the factors that contained few items (e.g., business and entrepreneurial skills). The modified questionnaire was named the 'Null Curriculum Questionnaire for 21st-Century Skills (NCQ-21st)' by the authors. Accordingly, the NCQ-21st consisted of 52 items represented by 10 factors (see Tab. 2 for the subscales and sample items of the NCQ-21st). For all items, response options ranged from 1 (not at all) to 5 (to a great extent).

Characteristics		PTs	
		<i>f</i>	%
Gender	Male	111	23.57
	Female	360	76.43
Age (years)	20-25	457	97.03
	26-30	10	2.12
	31 and above	4	.85
Fields of study	Science Education	19	4.03
	Mathematics Education	48	10.19
	Social Studies Education	33	7.01
	Arts Education	16	3.40
	Music Education	14	2.97
	Preschool Education	57	12.10
	Primary School Education	67	14.23
	English Language Education	72	15.29
	Turkish Language Education	64	13.59
	Special Education	34	7.21
	Computer Ed. & Instructional Technologies	8	1.70
	Guidance & Psychological Counselling	39	8.28
Characteristics		Teachers	
		<i>f</i>	%
Gender	Male	79	31.23
	Female	174	68.77
Age (years)	20-30	68	26.88
	31-40	131	51.78
	41-50	48	18.97
Teaching experience (years)	51 and above	6	2.37
	1 or less	13	5.14
	2-5	45	17.78
	6-10	72	28.46
	11-15	53	20.95
	16-20	37	14.63
	21-25	22	8.69
	26-30	6	2.37
	31 and above	5	1.98
Level of education	Bachelor	192	75.89
	Postgraduate	61	24.11
Program duration	Four-year bachelor's degree	207	81.82
	One-year teaching certificate	46	18.19
Fields of expertise	Arts, Languages, and Letters	70	27.67
	Natural and Physical Sciences	59	23.32
	Social Sciences and Humanities	120	47.43
	Others (e.g., food and beverage services)	4	1.58
Level of teaching	Preschool	14	5.53
	Primary school	60	2.72
	Middle school	106	41.90
	High school	73	28.85
Geographical region	Marmara	38	15.02
	Aegean	17	6.72
	Mediterranean	51	20.16
	Black Sea	58	22.92
	Central Anatolia	44	17.39
	East Anatolia	13	5.14
	South-eastern Anatolia	32	12.65

Table 1: Demographic Characteristics of PTs and Teachers

Procedure

The data from teachers and PTs were gathered by the authors during the fall semester of the 2021-2022 academic year. The NCQ-21st was presented to teachers through Web 2.0 technologies, while PTs received the paper-based version during one of their regular class hours. Teachers and PTs were provided with brief explanations about the research aim and clear instructions on how to respond to the items in the questionnaire. The administration process lasted approximately 15 minutes. Ethical approval was obtained from the Institutional Review Board of the university where the study was carried out (Protocol No: 2021/402).

Null Curriculum Questionnaire for 21st-Century Skills (NCQ-21st)	Subscale	Number of items	Sample items
During teacher education ...	critical thinking and problem-solving skills	5	... pre-service teachers learn to solve complex problems
	collaboration skills	6	... pre-service teachers learn to work in groups or pairs to complete a task together
	communication skills	5	... pre-service teachers learn to deliver an oral presentation or lecture to the class
	creativity and innovation skills	5	... pre-service teachers learn how to invent a solution to a question or a problem
	self-direction skills	5	... pre-service teachers learn to plan the steps they will take to complete a task
	technological literacy	5	... pre-service teachers' technology literacy improves
	global and local connection skills	5	... pre-service teachers learn how to make local and global connections
	economic and financial literacy	7	... pre-service teachers learn about global economic issues
	business and entrepreneurial literacy	5	... pre-service teachers learn how to do innovative projects to develop entrepreneurial mindsets
	media literacy	4	...pre-service teachers learn how to use electronic resources such as e-books or e-journals

Table 2. Subscales and Sample Items of the NCQ-21st

Data Analysis

Before addressing the research questions, a series of preliminary analyses were conducted. First, the missing data were examined. No missing values were observed in the sample of teachers because the data were obtained through Web 2.0 technologies, which did not allow teachers to skip their responses to the items, either intentionally or unintentionally. On the other hand, there were missing values for some items in the sample of PTs as they received the paper-based NCQ-21st. The proportion of missing values was extremely small (0.08%), showed no particular pattern, and was completely at random, as revealed by Little's test of missing completely at random ($\chi^2(816) = 726.83, p = .989$). As Tabachnick and Fidell (2013) stated, if only 5% or fewer data points are missing in a random pattern from a large data set, almost any procedure for handling missing values yields similar results.

Nevertheless, the mode substitution method was utilised in this study to replace missing values with the most frequently occurring non-missing values of the respective

variables. Indeed, dealing with missing values using methods appropriate for categorical or ordinal data, such as the mode substitution method, is reasonable because the overall distribution of the data remains relatively unchanged (Tabachnick & Fidell, 2013). This, in turn, helps preserve the main characteristics of the original dataset without introducing significant bias (Little & Rubin, 2019).

Second, employing the maximum likelihood method of estimation with robust standard errors (MLR), and the oblique target rotation method (Browne, 2001) from *Mplus* 8 (Muthén & Muthén, 2017), two separate exploratory structural equation modeling (ESEM; Asparouhov & Muthén, 2009) analyses were conducted to examine the factor structure of the NCQ-21st in the samples of teachers and PTs. The MLR estimator was used because the data showed significant skewness (two-sided multivariate skewness: $M = 407.61$, $SD = 4.71$, $p < .001$; two-sided multivariate kurtosis: $M = 2792.92$, $SD = 7.02$, $p < .001$).

The ESEM analyses were conducted because, unlike confirmatory factor analysis (CFA) where items are constrained to load only on their respective factors, ESEM, akin to Exploratory Factor Analysis (EFA), enables researchers to freely estimate all cross-loadings within a specified factor structure (Marsh et al., 2014). By offering a more accurate representation of the data, ESEM integrates the theory-driven approach of Confirmatory Factor Analysis (CFA) with the exploratory nature of EFA, resulting in enriched insights (Eren, 2024; Tóth-Király et al., 2017; van Zyl & Ten Klooster, 2021). As such, ESEM analysis provides less biased parameter estimates compared to traditional Structural Equation Modeling (SEM) analysis (Eren, 2024; Mai et al., 2018; Marsh et al., 2014). ESEM further enables researchers to assess the discriminant validity of factors, ensuring they are not overly similar or redundant, alongside evaluating their structural validity. Thus, the relationships among the factors of the NCQ-21st were computed as ESEM-based latent-factor correlations and examined separately in the samples of teachers and PTs.

Third, employing the closed-form algorithm for estimating single-factor loadings (Hancock & An, 2020), the internal consistencies of the factors were assessed using McDonald's coefficient omega (McDonald, 1999) as a robust measure of internal consistency (Hayes & Coutts, 2020). In addition, hierarchical omega coefficients (ω_H) were calculated separately in both samples using ESEM-based bi-factor analyses to evaluate the multidimensional reliability of the NCQ-21st.

Fourth, employing the multi-group ESEM framework, two separate measurement invariance analyses were conducted to examine whether configural invariance (i.e., both factor loadings and intercepts are estimated freely across multiple groups), metric invariance (i.e., factor loadings are constrained to be equivalent across multiple groups), and scalar invariance (i.e., both factor loadings and intercepts are constrained to be equivalent across multiple groups) were confirmed across the samples and gender (Rhudy et al., 2020). Robust fit indices, including CFI ($\geq .90$), TLI ($\geq .90$), RMSEA ($\leq .08$), and SRMR ($\leq .08$), were employed to assess data fit (Kline, 2016). Chi-square (χ^2) was not utilized for assessing data fit due to its sensitivity to sample size (Kline, 2016). Similarly, measurement invariance of the 10-factor model with 52 items (i.e., the NCQ-21st) was assessed by examining significant changes in robust fit indices (i.e., $\Delta CFI \geq .01$, $\Delta TLI \geq .01$, and $\Delta RMSEA \geq .015$, Chen, 2007; Cheung & Rensvold, 2002).

Although there is no clear consensus on the cutoff values to assess changes in these fit indices under all circumstances (Putnick & Bornstein, 2016), changes in CFI, TLI, and RMSEA equal to or greater than .01, .01, and .015 respectively can be considered significant in practice (Chen, 2007; Cheung & Rensvold, 2002). In fact, recent evidence suggests that these cutoff values can even be considered to assess measurement invariance for ESEM models with polytomous items unless strong cross-loadings between these items are observed (Jin, 2020).

To address the first research question, the %OVERALL% command in *Mplus* was employed, enabling class sizes to vary across the groups of teachers and PTs. Subsequently, two separate LPAs were conducted. LPA is a person-centered approach used to identify unobserved subgroups, or latent profiles, within a dataset based on patterns of responses to multiple variables (Ferguson et al., 2020). Unlike traditional clustering methods, LPA does not impose a priori group structures onto the data but rather allows the data to dictate the formation of profiles (Duffy et al., 2022). Therefore, in this study, focusing on determining the optimal number of latent profiles that best capture the variability in the data was deemed most appropriate. This approach aligns with the exploratory nature of the research, allowing for a nuanced understanding of the diverse characteristics present within the samples.

As the best fitting latent profile models are likely to be found by comparing one to five latent profile models (Ferguson et al., 2020; Watt et al., 2021), five separate LPAs were conducted for each sample to uncover the best-fitting latent profile models of teachers' and PTs' perceptions. The optimal number of latent profiles was determined based on both quantitative and qualitative criteria. Specifically, quantitative criteria included Bayesian Information Criterion (BIC), sample-adjusted BIC (SABIC), Akaike information criterion (AIC), entropy (*S*), Vuong-Lo-Mendell-Rubin Likelihood Ratio Test (LRT), and Lo-Mendell-Rubin adjusted Likelihood Ratio Test (ALRT). The Bootstrapped Likelihood Ratio Test (BLRT) was not considered due to its tendency to overestimate the number of profiles (Nylund et al., 2007). To control for model complexity (Lin & Dayton, 1997), the Consistent Akaike information criterion (CAIC) was also computed by adding the number of free parameters with BIC (Morin et al., 2020).

Lower values of BIC, SABIC, and CAIC indicate a better fit (Ferguson et al., 2020), while non-significant LRT and ALRT values suggest that a more parsimonious model should be retained over a less parsimonious model (Morin et al., 2020). In addition, profiles that include equal to or less than 5% of the respective samples were not considered as they are likely to be spurious (Ferguson et al., 2020). The interpretability of latent profiles was also used as a qualitative criterion. Based on the most likely class membership, a series of multivariate analyses of variance (MANOVAs), follow-up univariate analyses of variance (ANOVAs), and post-hoc comparisons for unequal variances (i.e., Games-Howell) were performed with SPSS 23 to investigate whether the latent profiles distinctly differed across the samples.

The Mahalanobis distance was used to identify multivariate outliers (Field, 2009; Tabachnick & Fidell, 2013). The results indicated that the responses of six teachers and 12 PTs could be described as outliers. These outliers represented small proportions of the PTs (2.5%) and teachers (2.3%) samples and showed no discernible patterns across the samples (Cramer's $V = .01, p = .885$) and gender ($V = .07, p = .075$). Consequently, the outliers were removed from the entire dataset, and all statistical analyses were conducted based on the remaining 706 participants (247 teachers and 459 PTs). For the second research question, the results of the LPAs for both teachers and PTs samples were compared graphically.

Results

Preliminary Analyses

The ESEM and Correlation Analyses

The results revealed that the 10-factor model with 52 items demonstrated a good fit to both teachers' ($\chi^2(844) = 1291.02$; CFI = .963; TLI = .942; RMSEA = .046, 90% CI [.041 – .051]; SRMR = .015) and PTs' data ($\chi^2(844) = 1122.31$; CFI = .981; TLI = .969; RMSEA = .027, 90% CI [.022 – .031]; SRMR = .017). With one exception (i.e., item 1 in the

communication skills subscale), items in each subscale were significantly loaded on their respective factors in both samples, with coefficients ranging in magnitude from .32 to .96 (see Tab. 3 for the summary of the ESEM analyses).

Factor	CTPS	COLS	COMS	CRIS	SEDS	TECS	GLCS	ECFS	BUES	MEDS
CTPS	.43-.76/ .38-.67	-.04-.17/ -.01-.10	-.01-.07/ -.07-.23	-.09-.19/ -.04-.17	.05-.15/ .01-.11	-.07-.11/ -.14-.15	-.04-.15/ -.09-.11	-.09-.08/ -.02-.08	-.02-.09/ -.02-.06	-.02-.10/ -.01-.04
COLS	-.03-.12/ -.04-.07	.51-.85/ .32-.73	-.05-.38/ -.03-.32	-.01-.19/ -.07-.09	-.02-.09/ -.02-.16	-.01-.05/ -.01-.15	-.06-.07/ -.04-.05	-.08-.08/ -.11-.06	-.06-.14/ .01-.09	-.03-.07/ -.08-.07
COMS	-.07-.14/ .00-.05	-.03-.26/ -.03-.34	.24-.91/ .23-.93	-.07-.14/ .00-.13	-.02-.19/ .00-.08	-.01-.14/ -.05-.07	-.04-.11/ -.00-.07	-.08-.09/ -.05-.05	.01-.06/ -.00-.08	-.01-.04/ -.05-.10
CRIS	.04-.07/ -.01-.17	-.05-.14/ -.05-.21	-.09-.25/ -.01-.07	.43-.71/ .33-.69	-.04-.23/ .05-.20	-.00-.10/ -.04-.06	-.00-.18/ .01-.10	-.01-.14/ -.08-.15	-.01-.14/ -.05-.11	-.07-.09/ -.02-.15
SEDS	-.10-.17/ -.06-.13	-.02-.06/ -.03-.15	-.03-.09/ -.12-.15	-.03-.25/ -.01-.14	.43-.62/ .36-.59	-.02-.13/ -.00-.12	-.06-.18/ -.06-.12	-.06-.04/ -.16-.06	-.00-.07/ -.08-.11	.01-.10/ -.05-.11
TECS	-.06-.10/ -.06-.06	-.01-.14/ -.02-.13	-.04-.32/ -.06-.24	-.10-.19/ -.02-.07	-.03-.11/ -.01-.10	.49-.77/ .59-.86	-.03-.12/ -.05-.09	-.01-.12/ -.01-.11	-.01-.12/ -.05-.14	.01-.14/ -.02-.09
GLCS	-.08-.13/ -.02-.06	-.05-.14/ -.16-.18	-.18-.19/ -.05-.18	.00-.12/ -.01-.14	-.08-.17/ -.05-.08	-.01-.13/ -.10-.10	.52-.75/ .54-.80	-.08-.19/ -.05-.06	-.01-.11/ -.03-.12	-.02-.17/ -.03-.13
ECFS	-.01-.22/ -.07-.08	-.14-.16/ -.06-.12	-.06-.04/ -.03-.08	-.00-.11/ -.03-.14	-.13-.13/ -.10-.10	.05-.12/ -.02-.11	.06-.16/ -.11-.13	.60-.86/ .56-.96	-.09-.18/ .01-.21	-.02-.12/ .01-.05
BUES	-.05-.12/ -.12-.17	-.11-.14/ -.04-.13	-.10-.15/ -.09-.05	-.01-.17/ -.04-.08	-.11-.19/ -.12-.09	-.01-.06/ -.10-.12	-.01-.10/ -.05-.17	-.04-.20/ -.11-.26	.57-.78/ .59-.77	.01-.19/ .03-.17
MEDS	-.08-.11/ -.06-.15	-.15-.14/ -.07-.07	-.08-.14/ -.04-.12	-.01-.14/ .03-.11	-.02-.10/ -.04-.16	-.01-.15/ -.02-.13	.01-.09/ -.02-.09	-.09-.15/ -.11-.14	.01-.14/ -.02-.15	.52-.71/ .50-.80

Note: CTPS: Critical thinking and problem-solving skills; COLS: Collaboration skills; COMS: Communication skills; CRIS: Creativity and innovation skills; SEDS: Self-direction skills; TECS: Technological literacy; GLCS: Global and local connection skills; ECFS: Economic and financial literacy; BUES: Business and entrepreneurial literacy; MEDS: Media literacy. For the samples of teachers (before the slash) and PTs (after the slash), only the ranges of standardized factor loadings of the items on their respective (highlighted in bold font) and other factors were shown in the Table to enhance presentation clarity.

Table 3: Summary of the Exploratory Structural Equation Modelling Analyses

Specifically, item 1 in the communication skills subscale [i.e., during teacher education, pre-service teachers' communication skills (e.g., confidence, open-mindedness, respect, empathy, listening) are developed] was strongly loaded ($\beta > .30$) on the collaboration skills subscale in the samples of teachers ($\beta = .38$) and PTs ($\beta = .32$). This item was also strongly loaded on the technological literacy subscale in the sample of teachers ($\beta = .32$). The cross-loadings of this item could be dependent on its content, as the development of communication skills of PTs during teacher education is intertwined with their collaboration skills, which also incorporate technological aspects (Ong & Annamalai, 2024). Likewise, these skills are established not only during face-to-face interactions with others but also in online environments, reflecting the demands of the current era. No other strong cross-loadings were observed.

Consequently, item 1 was removed from the communication skills subscale, and ESEM analyses were re-conducted. The results demonstrated that the 10-factor model with 51 items also had a good fit to both teachers' [$\chi^2(803) = 1189.76$; CFI = .967; TLI = .948; RMSEA = .044, 90% CI [.039 – .049]; SRMR = .014] and PTs' data [$\chi^2(803) = 1068.64$; CFI = .981; TLI = .970; RMSEA = .027, 90% CI [.022 – .031]; SRMR = .017]. Furthermore, none of the changes in robust fit indices were significant across the samples of teachers ($\Delta\text{CFI} = .004$; $\Delta\text{TLI} = .006$; $\Delta\text{RMSEA} = .002$) and PTs ($\Delta\text{CFI} = .000$; $\Delta\text{TLI} = .001$;

$\Delta\text{RMSEA} = .000$). Hence, subsequent statistical analyses were conducted based on the 10-factor model with 51 items.

The results of the correlation analysis indicated that the relationships among the subscales of the NCQ-21st were all positive and significant across the samples (see Tab. 4 for descriptive statistics, internal consistencies, and latent-factor correlations). Notably, the correlational patterns between the subscales in the sample of teachers exhibited differences in magnitude compared to those in the sample of PTs, signifying the importance of examining the profiles of teachers' and PTs' perceptions separately. Finally, the results also demonstrated high coefficients of McDonald's omega for single-factor ($\omega > .80$) and general-factor structures in the samples of PTs ($\omega_H = .93$) and teachers ($\omega_H = .95$).

Variable	M(SD)	CTPS	COLS	COMS	CRIS	SEDS	TECS	GLCS	ECFS	BUES	MEDS
CTPS	19.07(3.58)	(.92/.83)	.54	.49	.60	.50	.40	.46	.37	.38	.37
COLS	23.47(4.45)	.63	(.93/.85)	.54	.55	.58	.51	.41	.33	.29	.46
COMS	15.69(3.10)	.55	.66	(.91/.84)	.52	.54	.45	.46	.27	.26	.38
CRIS	18.28(4.05)	.66	.65	.59	(.93/.88)	.60	.43	.58	.41	.42	.47
SEDS	19.32(3.79)	.52	.60	.56	.63	(.93/.87)	.56	.57	.41	.29	.56
TECS	18.76(4.18)	.47	.49	.49	.54	.46	(.95/.89)	.52	.46	.33	.56
GLCS	17.09(4.48)	.44	.37	.44	.56	.48	.57	(.96/.90)	.65	.53	.47
ECFS	21.38(7.65)	.36	.26	.31	.48	.35	.57	.68	(.97/.94)	.53	.42
BUES	15.36(5.27)	.38	.32	.38	.50	.38	.52	.63	.77	(.97/.94)	.37
MEDS	14.93(3.51)	.42	.46	.53	.49	.47	.66	.55	.54	.56	(.94/.89)

Note: All the correlation coefficients were significant at $p < .001$ level of significance. CTPS: Critical thinking and problem-solving skills; COLS: Collaboration skills; COMS: Communication skills; CRIS: Creativity and innovation skills; SEDS: Self-direction skills; TECS: Technological literacy; GLCS: Global and local connection skills; ECFS: Economic and financial literacy; BUES: Business and entrepreneurial literacy; MEDS: Media literacy. The correlation coefficients regarding the sample of teachers were shown below the diagonal whereas the correlation coefficients regarding the sample of PTs were shown above the diagonal. For the samples of teachers (before the slash) and PTs (after the slash), internal consistencies for each subscale were depicted along the diagonal in parentheses and highlighted in bold font.

Table 4: Descriptive Statistics, Internal Consistencies, and ESEM-based Latent-Factor Correlations

Measurement invariance analyses

The results indicated that configural, metric, and scalar models had a good fit to the data across the samples and gender (see Tab. 5 for the summary of the measurement invariance analyses). Additionally, the differences between configural, metric, and scalar models were found to be non-significant in terms of the changes in robust fit indices, suggesting that the 10-factor model with 51 items was invariant across the samples and gender.

Variable Model	$\chi^2(df)$	CFI	TLI	RMSEA(90% CI)	SRMR	Comp.	ΔCFI	ΔTLI	$\Delta RMSEA$
Sample									
1. Configural	2262.16(1606)	.975	.960	.034(.031-.037)	.016	-	-	-	-
2. Metric	2769.29(2016)	.971	.963	.033(.029-.035)	.029	1 vs. 2	.004	.003	.001
3. Scalar	2881.53(2057)	.968	.960	.034(.031-.037)	.031	1 vs. 3	.007	.000	.000
						2 vs. 3	.003	.003	.001
Gender									
1. Configural	2382.98(1608)	.971	.954	.037(.034-.040)	.016	-	-	-	-
2. Metric	2912.14(2018)	.967	.958	.035(.033-.038)	.026	1 vs. 2	.004	.004	.002
3. Scalar	2965.33(2059)	.966	.958	.035(.032-.038)	.026	1 vs. 3	.005	.004	.002
						2 vs. 3	.001	.000	.000

Table 5: Summary of the Measurement Invariance Analyses

Latent Profile Analyses

In relation to the sample of teachers (Tab. 6), the results showed that Model 4 had a better fit to the data than the other models in terms of AIC, CAIC, BIC, and SABIC. With one exception (i.e., Model 5), Model 4 exhibited lower values for each criterion. All models demonstrated high entropy values ($> .80$) (Muthén & Muthén, 2017), indicating they were considerably discerning in the sample of teachers.

Group	Model	AIC	CAIC	BIC	SABIC	S	SC	LRT	ALRT	LRT _{comp.}
Teachers	1	14202.56	14292.75	14272.75	14209.35	-	-	-	-	-
	2	12982.69	13122.48	13091.48	12993.21	.94	41	-7081.28 ^b	1221.71 ^b	2 > 1
	3	12435.36	12624.75	12582.75	12449.61	.96	10	-6460.35 ^c	560.09 ^c	3 > 2
	4	12267.34	12506.34	12453.34	12285.33	.95	6	-6175.68 ^a	186.93 ^a	4 > 3
	5	12092.03	12380.63	12316.63	12113.75	.95	7	-6080.67	194.11	5 < 4
PTs	1	25792.87	25895.45	25875.45	25811.98	-	-	-	-	-
	2	23953.33	24112.33	24081.33	23982.95	.90	45	-12876.44 ^c	1834.33 ^c	2 > 1
	3	23359.18	23574.60	23532.60	23399.30	.89	17	-11945.67	607.15	3 < 2
	4	23067.38	23339.22	23286.22	23118.01	.89	9	-11637.59 ^b	309.21 ^b	4 > 3
	5	22961.55	23289.81	23225.81	23022.69	.88	9	-11480.69	125.96	5 < 4

^a $p < .05$; ^b $p < .01$; ^c $p < .001$

Note: AIC = Akaike Information Criterion; CAIC = Consistent Akaike Information Criterion; BIC = Bayesian Information Criterion; SABIC = Sample Size Adjusted BIC; S = Entropy; SC = proportion of the smallest class; LRT = Vuong-Lo-Mendell-Rubin Likelihood Ratio Test; ALRT = Lo-Mendell-Rubin adjusted LRT.

Table 6: Summary of the Model Fit for Latent Profiles

Although the results also demonstrated that the values of AIC, CAIC, BIC, and SABIC were lower for Model 5 than for Model 4, the LRT and ALRT values for Model 5 were non-significant. These results suggest that retaining Model 4 (i.e., the more parsimonious model) could be more accurate than retaining Model 5 (i.e., the less parsimonious model). However, the proportion of the smallest profile for Model 4 was barely above the recommended threshold (i.e., 5%, Ferguson et al., 2020), indicating that one of the profiles in Model 4 was likely to be spurious. Thus, profiles of teachers' perceptions were described based on Model 3, which included at least 10% ($n = 25$) of the sample.

The results of the LPAs regarding the sample of PTs (Tab. 2) showed that Model 2 had a better fit to the data than Model 3, while Model 4 had a better fit than both Model 3 and Model 5. However, upon examining the values of AIC, CAIC, BIC, and SABIC, it was observed that these fit indices were lower for Model 4 than for Models 1, 2, and 3. Additionally, all models exhibited high entropy values.

An alternative model (Model 6) was also examined to determine whether the confusing results regarding the latent profiles of PTs were due to the inflated number of classes. The results indicated that this was not the case (Model 5 vs. Model 6: LRT = -11416.78, $p = .600$; ALRT = 118.45, $p = .603$). Therefore, profiles of PTs' perceptions were described based on Model 4, consisting of at least 9% ($n = 41$) of the sample. Table 7 displays the descriptive statistics for Model 3, while Table 8 presents the statistics for Model 4.

Variable	Profile 1 M(SD) ($n = 25$)	Profile 2 M(SD) ($n = 107$)	Profile 3 M(SD) ($n = 115$)
CTPS	11.49(2.58)	16.32(2.58)	19.80(2.58)
COLS	13.73(3.41)	20.15(3.41)	23.94(3.41)
COMS	8.71(2.02)	13.34(2.02)	16.44(2.02)
CRIS	10.35(2.33)	15.38(2.33)	20.02(2.33)
SEDS	10.59(2.26)	16.59(2.26)	20.39(2.26)
TECS	9.52(2.61)	15.23(2.61)	20.21(2.61)
GLCS	7.59(2.71)	14.25(2.71)	19.26(2.71)
ECFS	9.46(4.89)	16.72(4.89)	26.14(4.89)
BUES	6.62(3.05)	12.08(3.05)	18.30(3.05)
MEDS	7.41(2.03)	12.07(2.03)	15.99(2.03)

Note: CTPS: Critical thinking and problem-solving skills; COLS: Collaboration skills; COMS: Communication skills; CRIS: Creativity and innovation skills; SEDS: Self-direction skills; TECS: Technological literacy; GLCS: Global and local connection skills; ECFS: Economic and financial literacy; BUES: Business and entrepreneurial literacy; MEDS: Media literacy. Unstandardized means were presented in the Table. The same standard deviations were reported for variables across the profiles because standard deviations were automatically constrained to be equal in *Mplus* (Muthén & Muthén, 2017).

Table 7: Descriptive Statistics for Model 3: Teacher Sample

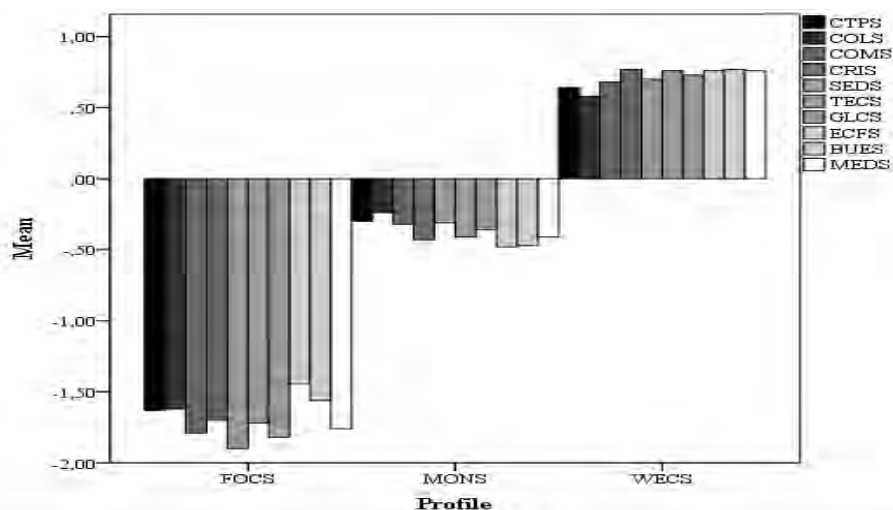
Variable	Profile 1 M(SD) ($n = 140$)	Profile 2 M(SD) ($n = 102$)	Profile 3 M(SD) ($n = 41$)	Profile 4 M(SD) ($n = 176$)
CTPS	18.01(2.28)	23.24(2.28)	15.98(2.28)	20.51(2.28)
COLS	22.18(2.69)	28.25(2.69)	19.57(2.69)	25.80(2.69)
COMS	15.00(1.99)	18.90(1.99)	12.01(1.99)	17.22(1.99)
CRIS	16.39(2.05)	23.47(2.05)	11.99(2.05)	20.03(2.05)
SEDS	18.32(1.98)	23.98(1.98)	13.58(1.98)	21.00(1.98)
TECS	17.89(2.63)	23.34(2.63)	13.94(2.63)	20.48(2.63)
GLCS	15.41(2.79)	22.07(2.79)	10.72(2.79)	18.73(2.79)
ECFS	17.38(5.70)	29.45(5.70)	13.81(5.70)	23.17(5.70)
BUES	12.69(3.68)	21.56(3.68)	9.00(3.68)	16.72(3.68)
MEDS	14.03(2.12)	19.00(2.12)	10.18(2.12)	16.54(2.12)

Note: CTPS: Critical thinking and problem-solving skills; COLS: Collaboration skills; COMS: Communication skills; CRIS: Creativity and innovation skills; SEDS: Self-direction skills; TECS: Technological literacy; GLCS: Global and local connection skills; ECFS: Economic and financial literacy; BUES: Business and entrepreneurial literacy; MEDS: Media literacy. Unstandardized means were presented in the Table. The same standard deviations are reported for variables across the profiles because standard deviations were automatically constrained to be equal in *Mplus* (Muthén & Muthén, 2017).

Table 8: Descriptive Statistics for Model 4: Pre-Service Teacher Sample

In the sample of teachers, the results of the MANOVA revealed significant differences among the profiles based on the variables used to generate them (see Tab. 7) (Wilks' Λ (20,470) = .16, $p < .001$, partial eta-squared- η^2_p = .61). Subsequent follow-up ANOVAs and post-hoc comparisons confirmed the distinctiveness of the profiles from each other ($p < .001$). Similar findings were observed in the sample of PTs. Specifically, the MANOVA results indicated significant differences among the profiles based on the variables used to generate them (see Tab. 8) (Wilks' Λ (30,1309) = .09, $p < .001$, η^2_p = .55). The results of the follow-up ANOVAs and post hoc comparisons confirmed the significant differences among the profiles ($p < .01$).

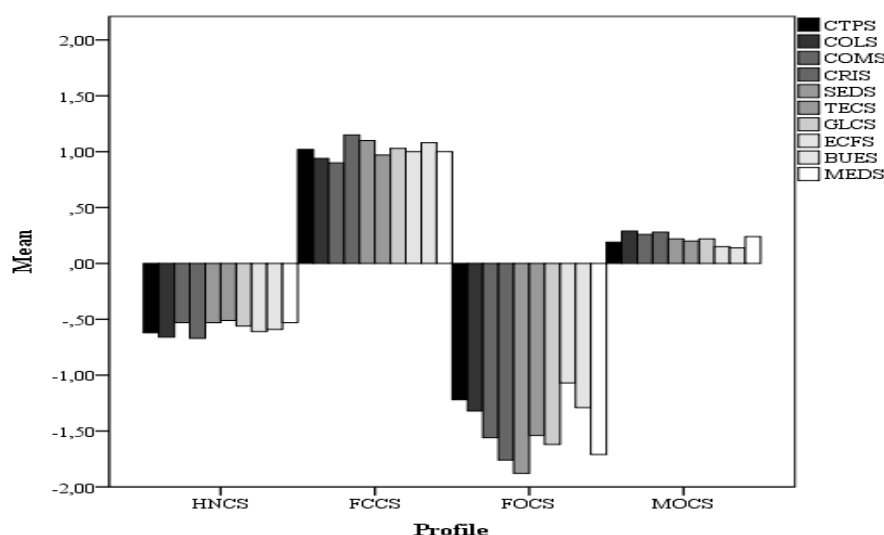
Consequently, concerning the sample of teachers, the first, second, and third profiles were labeled as the fully omitted/neglected 21st-century skills profile, the moderately omitted/neglected 21st-century skills profile, and the well-captured 21st-century skills profile, respectively. Teachers in the fully omitted/neglected 21st-century skills profile believed that 21st-century skills were entirely omitted or neglected in teacher education programs, while those in the moderately omitted/neglected 21st-century skills profile believed that these skills were only moderately omitted or neglected (Fig. 1). Conversely, teachers in the well-captured 21st-century skills profile believed that 21st-century skills were highly integrated into teacher education programs (Fig. 1).



Note. FOCS: fully omitted/neglected 21st-century skills profile; MONS: moderately omitted/neglected 21st-century skills profile; WECS: well-captured 21st-century skills profile. CTPS: Critical thinking and problem-solving skills; COLS: Collaboration skills; COMS: Communication skills; CRIS: Creativity and innovation skills; SEDS: Self-direction skills; TECS: Technological literacy; GLCS: Global and local connection skills; ECFS: Economic and financial literacy; BUFS: Business and entrepreneurial literacy; MEDS: Media literacy.

Figure 1: Standardized Means of the Latent Profiles Regarding Teacher Sample

In the sample of PTs, the first, second, third, and fourth profiles were respectively labelled as follows: the highly omitted/neglected 21st-century skills profile, the fully captured 21st-century skills profile, the fully omitted/neglected 21st-century skills profile, and the moderately captured 21st-century skills profile. PTs in the highly omitted/neglected 21st-century skills profile believed that 21st-century skills were significantly neglected in teacher education programs. Conversely, PTs in the fully captured 21st-century skills profile believed that these skills were comprehensively integrated into such programs. PTs in the fully omitted/neglected 21st-century skills profile believed that these skills were entirely ignored, while those in the moderately captured 21st-century skills profile perceived some level of inclusion of these skills in teacher education programs (Fig. 2).



Note. HNCS: Highly omitted/neglected 21st-century skills profile; FCCS: fully captured 21st-century skills profile; FOCS: fully omitted/neglected 21st-century skills profile; MOCS: moderately captured 21st-century skills profile. CTPS: Critical thinking and problem-solving skills; COLS: Collaboration skills; COMS: Communication skills; CRIS: Creativity and innovation skills; SEDS: Self-direction skills; TECS: Technological literacy; GLCS: Global and local connection skills; ECFS: Economic and financial literacy; BUES: Business and entrepreneurial literacy; MEDS: Media literacy.

Figure 2: Standardized Means of the Latent Profiles Regarding PTs Sample

When comparing the characteristics of the latent profiles of teachers (Fig. 1) to those of PTs (Fig. 2), it became evident that, apart from the fully omitted/neglected 21st-century skills profiles, all the profiles showed significant differences across the samples. Specifically, the results revealed that the fully omitted/neglected 21st-century skills profiles were highly consistent across both groups, comprising teachers and PTs who believed that 21st-century skills were entirely omitted or neglected in teacher education programs.

In order to assess whether these profiles significantly differed from one another across the samples of teachers ($n = 25$) and PTs ($n = 41$), a summary t -test for independent samples was conducted based on the overall standardized means of the variables [$M_{\text{Teachers}} (SD = 1.35) = -1.69$; $M_{\text{PTs}} (SD = .26) = -1.50$] used to generate these profiles. The results demonstrated that the fully omitted/neglected 21st-century skills profiles did not significantly differ from one another across the samples ($t(64) = -.879, p = .383$, Cohen's $d = .20$).

Discussion and Implications

This study aimed to explore the latent profiles of teachers' and PTs' perceptions of the omitted or neglected parts of teacher education programs concerning 21st-century skills, with the ultimate intention of examining whether the characteristics of these profiles significantly differ between the samples of teachers and PTs. To the best of the researchers' knowledge, this aim has not been addressed in any single study to date. Thus, before discussing the results of the study, it is worthwhile to focus on the results of the preliminary analyses to better understand the basis of these results regarding teachers' and PTs' perceptions of the omitted or neglected parts of teacher education programs in relation to 21st-century skills.

The results of the study demonstrated that the NCQ-21st is a reliable and comprehensive research instrument for assessing both teachers' and PTs' perceptions of the extent to which teacher education programs encompass 21st-century skills. Indeed, these results were not unexpected, given the strong theoretical foundations of the NCQ-21st

(Kazemi et al., 2020, 2023; P21, 2019). Nonetheless, in addition to confirming the results of previous studies (e.g., Kazemi et al., 2020, 2023; P21, 2019), this study offered a nuanced understanding of 21st-century skills in teacher education. Specifically, it revealed a dynamic, cross-cutting, and multifaceted perspective on these skills and provided a comprehensive theoretical framework for examining the null curriculum in teacher education, drawing on a wide range of 21st-century skills.

Therefore, the NCQ-21st could empower policymakers, teacher education program developers, and teacher educators to more effectively address the neglected or omitted aspects of teacher education programs, which may have adverse effects on teacher training, professional development, and teaching practices (Adamson & Darling-Hammond, 2015). By highlighting the deficiencies in teacher education programs concerning 21st-century skills, the NCQ-21st facilitates targeted improvements aimed at enhancing teacher preparation for contemporary educational needs. The NCQ-21st could additionally enable policymakers and teacher educators to more accurately identify the experiential needs of teachers and PTs concerning 21st-century skills. This, in turn, could establish a robust foundation for the development of teacher education programs that are better aligned with the professional development needs and aspirations of teachers and PTs. Thus, the NCQ-21st has the potential to make significant contributions to global educational and curricular reforms aimed at enhancing teacher effectiveness (Care et al., 2016; Reimers, 2021; Scott, 2015).

The results of the preliminary analyses also showed that the factor structure of the NCQ-21st remained consistent across the samples of teachers and PTs, as well as genders. This indicates that both female and male teachers and PTs had similar understandings of the items in the NCQ-21st. These results are essential for consistently outlining the latent profiles of teachers and PTs and for accurately interpreting the differences in their characteristics (Rhudy et al., 2020).

The main results of the study (i.e., LPAs) indicated that three latent profiles emerged from teachers' perceptions, whereas four latent profiles emerged from PTs' perceptions. Considering that PTs were more likely to be familiar with the content of teacher education programs as they were in their final year of studies at the time of data collection, it is understandable why PTs' perceptions were represented by a slightly larger number of profiles than teachers' perceptions. Following this line of reasoning, it can also be understood why the characteristics of the latent profiles of teachers and PTs were distinctly different from each other, with only one exception (i.e., fully omitted/neglected 21st-century skills profiles).

The overlap between the profiles of fully omitted/neglected 21st-century skills across the samples may be due to the fact that both teachers and PTs lack actual teaching experiences to integrate 21st-century skills into their teaching. Indeed, this is highly likely because, akin to teachers' pedagogical beliefs (Powell, 1992), PTs' pedagogical beliefs are also shaped by three diverse yet interconnected sets of experiences: "personal experience, experience with schooling and instruction, and experience with formal knowledge" (Richardson, 1996, p. 108).

Accordingly, if teacher education programs fail to provide the experiences and knowledge necessary for PTs to integrate 21st-century skills into their future teaching practices, it is likely that the perceptions of both teachers and PTs regarding the extent to which these programs incorporate 21st-century skills could significantly converge. Consistent with this argument, the results of the LPAs also revealed that the majority of teachers and PTs held similar perceptions regarding the neglect or partial integration of 21st-century skills within teacher education programs.

These results and related explanations align with recent evidence showing that numerous teacher education programs inadequately incorporate 21st-century skills and that many teacher educators lack the necessary experience or knowledge to integrate these skills

into their teaching (Alahmad et al., 2021). Consequently, it is important that 21st-century skills are not only conceptually included in teacher education programs but also thoroughly and practically integrated, considering their explicit and/or potential connections with diverse intellectual processes, educational contents, and teaching practices (Dede, 2010). Moreover, it is essential that teacher educators should be thoroughly informed about 21st-century skills to enable them to comprehensively integrate these skills into their teaching. This is crucial because teacher educators play a pivotal role in preparing PTs to effectively teach 21st-century skills in educational settings (Mestrinho & Cavadas, 2018), serving as role models and providing practical examples of how such skills are effectively integrated into teaching practices (Lunenberg et al., 2007).

Therefore, teacher educators should consider incorporating methods into their teaching, such as reinforcing the teaching and learning of 21st-century skills through assignments involving lesson planning, instructional delivery, or assessment. They should also model these approaches and adopt more effective strategies for peer teaching and teaching practicum accordingly. These and similar initiatives could enable PTs to effectively integrate 21st-century skills into their future teaching practices, thereby facilitating a smoother transition to in-service teaching (Yoo & Kang, 2021).

Limitations and Directions for Further Studies

This study has several limitations that necessitate further research. First, the cross-sectional survey research design of the study precluded causal interpretations of the relationships between teachers' and PTs' perceptions regarding the extent to which teacher education programs encompass 21st-century skills. Longitudinal studies, which examine whether PTs' perceptions significantly correlate with their perceptions when they become teachers, could enable researchers to infer causality regarding the relationships between the current profiles.

Second, the potential effects of the current profiles on teachers' and PTs' teaching practices were not examined in the study. Given the strong link between teacher beliefs and practices (Fang, 1996), experimental research investigating how in-service and pre-service teacher education programs, in which 21st-century skills are comprehensively integrated, affect teachers' and PTs' teaching practices could yield more comprehensive results.

Finally, the current results may be specific to the cultural characteristics of the samples, although teacher education programs in Türkiye are not distinctly different from those in other member countries of the OECD (CoHE, 2018). Thus, cross-cultural studies are necessary to explore potential cultural influences on the profiles of teachers' and PTs' perceptions regarding the omitted or neglected aspects of teacher education programs related to 21st-century skills. Unlike this study, researchers could employ multilevel LPAs (see Mäkikangas et al., 2018) in future studies, where teachers' and PTs' perceptions regarding the integration of 21st-century skills in teacher education programs are nested within various cultural contexts. This approach allows researchers to comprehensively address the cultural characteristics of the samples and explore how these characteristics influence the emergence of latent profiles.

Conclusion

Three important conclusions can be drawn from the results of this study. First, the NCQ-21st could provide a robust and holistic framework for evaluating omitted or neglected aspects of teacher education programs concerning 21st-century skills. Therefore, by employing the NCQ-21st, policymakers, teacher education program developers, and teacher educators can reliably identify specific strengths and weaknesses within teacher education programs, facilitating targeted interventions to better align these programs with the evolving needs of teacher education.

Second, the neglected or omitted components of teacher education programs concerning 21st-century skills could be consistently elucidated through meaningful and diverse profiles derived from teachers' and PTs' perceptions regarding the extent to which these skills are integrated into teacher education programs. As such, this approach enables a comprehensive exploration of how teachers and PTs perceive the incorporation of 21st-century skills, offering valuable insights into areas where improvements may be needed, and thereby facilitating targeted efforts to enhance teacher education programs.

Third, the latent profiles generated from teachers' and PTs' perceptions regarding the inclusion of 21st-century skills in teacher education programs can be utilized to examine both the alignment and discrepancies between their perceptions. These profiles potentially offer a nuanced understanding of how teachers and PTs perceive the extent to which these skills are integrated into teacher education programs. Thus, by analyzing the similarities and differences across their perceptions, policymakers, teacher education program developers, and teacher educators could gain greater insights into the obstacles that potentially prevent teachers and PTs from incorporating activities aimed at enhancing 21st-century skills in their students during their teaching practices.

Overall, the results of this study provide valuable insights for policymakers, teacher education program developers, and teacher educators, illuminating the specific curricular requirements of both teachers and PTs in the context of 21st-century skills. Consequently, stakeholders are prompted to carefully examine the null curriculum related to 21st-century skills in teacher education, aiming to enhance teacher effectiveness and teaching quality more effectively and comprehensively. Such an informed approach could potentially lead to targeted interventions that address the educational needs of teachers and PTs, ultimately ensuring that teacher education programs are better aligned with the ever-changing demands of teaching and teacher education.

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