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The design and operationalization of the teacher competence management framework: The method and practical tools to identify and close teacher competence gaps for the teaching of 21st century skills

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ABSTRACT

The aim of the Framework for Teacher Competence Management is to provide school leadership with an empirically tested protocol on how to determine teachers' professional development needs for teaching 21st century skills. Both quantitative and qualitative research methods were applied to collect and analyze data through three cycles of design-based implementation research over a period of three years, from 2017 to 2019, and by collaborating with staff from 15 schools. The Framework for Teacher Competence Management was developed through adapting a competence management model from the business environment to the school setting. The framework includes three steps: Competence identification, assessment and development; school developmental goals and education reform priorities; and the action and information flows between teachers and school leadership team members. The Framework for Teacher Competence Management has been operationalized through the design and validation of a method to identify teachers' professional development needs and competence assessment tools, such as performance level descriptors, knowledge tests, and self-assessment questionnaires. The research outlines significant differences in teacher performance within a single school, emphasizing the necessity of gathering school-based evidence for planning more personalized professional development solutions to address professional development needs for different teacher groups.

Contribution/Originality: This study contributes to ensuring effective and high-quality lifelong learning for teachers in Latvia. It focuses on the development and implementation of a method to identify gaps in teacher competence. It also explores how the method is put into practice, including the challenges associated with the teachers' professional development in Latvia.

1. INTRODUCTION

Successfully managing teacher competence at the school level can enhance overall school effectiveness (Scheerens, 2016). Traditionally, professional development courses and workshops chosen by school leaders or teachers themselves, based on available options, intuition, and personal interests, are considered a simple solution for

handling and improving teacher competence. However, the process of managing teacher competence at the school level is complex and is influenced by various factors. Professional development programs from different institutions may be too general and may not suit all teachers simultaneously (Poole & Li, 2023). Importantly, teachers differ in proficiency levels (OECD, 2019; Owen, Palekahelu, Sumakul, Sekiyono, & White, 2018), hindering their professional development and the attainment of educational goals for the school. Additionally, teachers' self-assessment of their professional development needs may not always be reliable, leading to potential inaccuracies in understanding their proficiency level and identifying competence gaps (Desimone, Smith, & Frisvold, 2010; Segal, 2024). In the last two decades, global educational reforms have become a new reality for schools. Changes in the curriculum require new competences for teachers to adopt innovative learning and teaching approaches (Muir, Livy, Herbert, & Callingham, 2018; Wang, Olivier, & Chen, 2023). In the context of the Latvian educational system, the main goal of transforming the national curriculum is to provide teaching that supports the acquisition of 21st century skills.

Despite the recent growth in the body of literature that recognizes the importance of improving teacher competence through evidence-based and teacher-needs-based professional development (Popova, Evans, Breeding, & Arancibia, 2022), there is a knowledge gap on how this process can be managed effectively at the school level (Jentsch & König, 2022). This gap raises questions such as "How can teachers' competence management be conceptualized in the school environment?", "What are the data and tools that can be combined to create a method to determine teachers' professional development needs for teaching 21st century skills?" and "How can teachers be grouped based on their professional development needs in a school setting?" This paper explores how to support schools in these efforts and focuses on the development of a data-driven teacher competence management model at the school level to promote teaching that supports students' 21st century skills. Our approach to answering these questions is based on three assumptions: (1) Schools share common characteristics with business enterprises, and staff competence management models used in business can be adapted for the school environment; (2) teacher profiles created from the data on classroom activities, attitudes, and beliefs can identify competence gaps relevant for determining professional development needs; and (3) the educational goals of the school serve as the starting point to operate the teacher competence management model at the school level.

1.1. Background and Rationale of the Research

1.1.1. Competence Management in Business Environment

School and business environments share common operational characteristics, such as budget, staff, capital, and organization. They have become more similar over time, yet they differ in goals and outcomes (Scott & Davis, 2007) leading to the idea that competence management can be built in the school environment using a strategic human resource management approach (Wright & McMahan, 1992) commonly employed in the business setting (Smylie, Miretzky, & Konkol, 2004). Competence management in a business environment encompasses defining an organization's competence requirements, identifying competence gaps (disparities between required and actual competences), acquiring the necessary competences, fostering competence development through training and coaching, and assigning personnel to projects (Baladi, 1999; Lindgren, Henfridsson, & Schultze, 2004). Staff competence management is vital for achieving business goals and increasing the effectiveness of the organization (Butkēviča, Zandbergs, Namsone, & Briķe, 2019).

There are several competence frameworks or competence models (two similar concepts, often used as synonyms) that encapsulate the concept of competence in the business environment (Chursin & Tyulin, 2018). A competence model is a set of competencies that include the key behaviors required for effective performance in a particular role (Cernuşca & Dima, 2007). Typically, competence models include a list of required competences and are developed for job roles, positions in an organization, or certain tasks, for example, for medical personnel (Martin-Sanchez, Rowlands, Schaper, & Hansen, 2017) or information technology (IT) professionals (Ho & Frampton, 2010). To diminish the ambiguity caused by the competence models' terminology, to add objectivity to the identification of the

model's elements, and to support the use of IT tools for the management of competences, scholars have proposed the use of an ontological approach (Gruber, 1995) for developing competence models (Draganidis, Chamopoulou, & Mentzas, 2006; Schmidt & Kunzmann, 2006). Ontology-based competence models (Miranda, Orciuoli, Loia, & Sampson, 2017; Zandbergs, Grundspeņķis, Judrups, & Briķe, 2019) define relationships between various concepts of competence management, describe the parts and properties of competences, and describe how they are related to an organization, an employee, and their goals.

Within organizational studies, the competence management process is explained through three key concepts: (1) Competence is articulated through a competence title, competence description, and competence level (Draganidis et al., 2006; Schmidt & Kunzmann, 2006); (2) the competence level represents a specific degree of competence, signifying employee behavior associated with that degree; and (3) competence profiles comprise acquired and required competences (De Coi et al., 2011; Rážewski & Małachowski, 2012), where the acquired profile outlines competences gained through studies and professional experience, while the required profile lists competences necessary for employees mandated by the organization. A competence profile may also involve outcome measures that describe behavioral indicators and several levels of performance (Gilis, Clement, Laga, & Pauwels, 2008). The main purpose of a competence profile is to compare the required and acquired competence levels and identify gaps.

In a business environment, the competence management process consists of three phases. First, the organization must determine its existing competences at both individual and organizational levels. More importantly, it needs to identify the competences required to enhance organizational performance and achieve goals (Corallo, Lazoi, Margherita, & Scalvenzi, 2010). Competence identification should align with the organization's values and goals, and they should be precise, measurable, and clear to ensure universal understanding within the organization (Langdon & Whiteside, 2004). Second, the organization should assess the competence levels (knowledge, skills, and attitudes) of their staff for the specific competences that are included in the competence profiles (Lichtenberg et al., 2007). Typically, a specific competence assessment method is selected, and various competence assessment tools and assessors (e.g., individuals who participate in competence assessment) can be involved. The results of the competence assessment are viewed as levels of acquired competence and gaps that could serve as a foundation for further decision making. Third, the organization needs to decide on the development of competences for individual employees, groups, or the entire staff. Competence development involves recognizing the areas where improvement is needed, taking into account information regarding competence gaps and implementing various activities to enhance the competence of employees (Wallo, Kock, Lundqvist, & Coetzer, 2020). These activities encompass formal training and development (Salas, Tannenbaum, Kraiger, & Smith-Jentsch, 2012) as well as initiatives aimed at changing the work structure to encourage informal learning on the job (Eilström & Kock, 2008).

1.1.2. The Importance and Context of Competence Management in School Setting

Competence models designed for business environments may not be directly suitable for the school setting. To create a model that effectively oversees teaching quality in schools, it is important to incorporate concepts related to instructional quality (e.g., teaching methods that support students' 21st century skills) and roles specific to the school environment. This integration results in a competence model tailored to the management of teaching quality.

In educational studies, teacher competence is understood as a complex and multi-dimensional concept (Kaiser et al., 2017; Kunter et al., 2013) consisting of knowledge, skills, and beliefs that are mutually integrated and manifest in action (Helmke, 2009; Taconis*, Van Der Plas, & Van der Sanden, 2004), that is, observable on-the-job behavior (Kunter et al., 2013). Instructional quality is positively related to students' learning outcomes (Fauth, Decristan, Rieser, Klieme, & Büttner, 2014; Good, Wiley, & Florez, 2009) and can be measured based on variables involving instruction clarity, cognitive activation, classroom management, and a supportive atmosphere (Bloemeke, Nilsen, & Gustafsson, 2016).

A teacher competence profile (Holzberger, Maurer, Kunina-Habenicht, & Kunter, 2021) serves as a starting point to identify what competences are essential for reaching school goals. School goals are, in turn, directly related to the priorities of the national education policy; in this context, it is the implementation of curriculum reform in general education. Furthermore, teacher competence profiles help in the planning of further professional development (Gilis et al., 2008). The authors used the term "teachers' professional development" instead of "teachers' professional learning," thus emphasizing the perspective of an organization and its agency in achieving its goals. Teacher competence development starts with the identification of professional development (PD) needs by defining the competence gap, i.e., the difference between required and actual competences. Information on PD needs is obtained through multi-source and multi-informant types of data (Hirsch, Ely, Lloyd, & Isley, 2018) such as observation notes on a teacher's activities and interviews (Zein, 2017), and it defines teachers' PD needs to overcome the identified competence gap and enhance their professional work.

An important concept of competence management in a school setting is data-driven decision making based on the premise that teachers' competence in teaching (instructional quality) must be managed using data on personalized solutions for improvement. In formal education, the key aim of teachers' competence management is to improve students' learning quality in accordance with school goals (Mandinach & Gummer, 2013).

1.1.3. Teacher Competence Assessment

In the examined competence management models, the competence assessment phase stands out as particularly crucial as it enables the identification of competence gaps based on actual and required competence profiles and is essential for finding personalized solutions for the staff. Competence assessment in a business environment is based on the competence model used by the organization and the description of the levels of competence necessary for a particular job (Campion et al., 2011). Holistic Kaiser et al. (2017) and situation-based approaches have been used in business environments to assess staff competence. Assessment reflects real-life work situations and is multi-dimensional as it is performed using a variety of assessment tools, instruments, and data sources (Kaiser et al., 2017; Tschannen-Moran, Hoy, & Hoy, 1998). This also applies to competence assessment in the educational sciences (Westera, 2010) and reflects the conceptual construct of competence in the workplace. To adapt this approach to the school environment, the determination of the actual competence profile is viewed as a teaching quality assessment, and competence gaps are viewed as teachers' professional development needs.

Past research indicates that the complexity of competence assessment requires evaluating a person from multiple perspectives and measuring various aspects of competence (McClelland, 1973). This means assessing not only knowledge but also other factors, such as behavior. This has led to the adaptation of universal assessment methods, such as observations and interviews conducted by more than one expert, including human resource management experts and employees' supervisors (Drisko, 2014).

Various comprehensive frameworks and systems exist to assess teaching (Danielson, 2013; Roelofs & Sanders, 2007). To evaluate and draw conclusions about observed competence, teacher competence frameworks frequently include performance-level descriptors and indicators for various progression levels (Blömeke, Gustafsson, & Shavelson, 2015; Shavelson, 2010). Tools used in teacher assessment include self-assessment tools, such as questionnaires (Bakx, Baartman, & Van Schilt-Mol, 2014; Kunter et al., 2013; Malva, Leijen, & Baucal, 2020; Tondeur, Van Braak, Ertmer, & Ottenbreit-Leftwich, 2017), scenarios where teachers have to answer open-ended questions (Klug, Bruder, Kelava, Spiel, & Schmitz, 2013), video-based assessments (König, 2015; Roelofs & Sanders, 2007), lesson observation, which is the most widely used tool (Zohar & Schwartzer, 2005), and a clear set of standards against which to benchmark teacher performance (for a review, see Hallinger, Heck, and Murphy (2014)).

Overall, assessment can serve two different purposes for system improvement: professional development and accountability (Danielson & McGreal, 2000; Roegman, Reagan, Goodwin, & Yu, 2016), both of which are difficult to

combine within a single approach. From the perspective of this study, competence assessment methods in the educational environment should cover the following principles:

(1) Clearly define the required competence

(2) Assess all components of competence

(3) Design a framework to assess the necessary competences in accordance with the goals (the new education reforms in the country)

(4) Combine formative and summative assessments

(5) Design and use reliable assessment tools that consider on-the-job performance by combining various tools,

(6) Design a framework and tools that allow the assessment of competence development and progress (Kaiser & König, 2019; Kaslow et al., 2007; Tondeur et al., 2017).

1.1.4. Teacher Competence Management Framework for Teaching 21ˢᵗ Century Skills

The context of this research is the curriculum reform in general education in Latvia and introduces 21st century skills, also called transversal competences. Helping students develop 21st century skills requires changes across many elements of the education system, including curriculum, instruction, assessment, teacher education, and professional development (Griffin & Care, 2015; Pellegrino, 2017). As part of the curriculum reform in general education in Latvia, the following skills are set in the revised curriculum as the necessary transversal skills for students: Critical thinking and problem solving, creativity and entrepreneurship, self-directed learning, collaboration, civic participation, and digital literacy (Cabinet of Ministers of the Republic of Latvia, 2018). This largely corresponds with the findings on transversal or 21st century skills in the literature (Martin, 2018; National Research Council, 2012; World Economic Forum, 2015).

To operationalize the reform goals down to school and classroom levels, the authors have designed and field-tested a Framework to Support Teaching 21st Century Skills (FST21CS; Bertule, Dudareva, Namsone, Cakane, and Butkevica (2019)) (see Table 1). The FST21CS is based on the analysis of policy documents on education reforms for teaching 21st century skills and literature studies on teacher competence frameworks (Caena & Redecker, 2019; Danielson, 2013), and it was further developed during the research described in this article. The framework uses two teacher competence categories (IA and IB) and their criteria (1.1.–6.2.), which are further expressed in a rubric describing the performance levels for each criterion. Additionally, three domains of teaching practice – planning, teaching, and management of the classroom environment – structure the information in the framework.

Table 1. Framework to support teaching 21ˢᵗ century skills (FST21CS).

Category		II-1 Planning	II-2 Teaching	II-3 Classroom environment
IA-1	Student self-directed learning	1.1. Learning goals	1.2. Metacognitive skills	Not applicable
IA-2	Student cognitive activation	2.1. Learning tasks for cognitive depth	2.2. Classroom discourse	Not applicable
IA-3	Student collaboration	3.1. Learning tasks for collaboration	3.2. Student collaboration	Not applicable
IA-4	Digital competence	4.1. Information and communication technology tools	4.2. Meaningful ICT usage	Not applicable
IB-5 IB-6	Teacher techniques and basic skills	5.1. Lesson design	5.2. Teaching techniques	5.3. Differentiation and support
		6.1. Curriculum	6.2. Feedback to students	Not applicable

Note: IA-1 to IB-6 correspond to teacher competence categories and respective subcategories; II-1 to II-3 correspond to three domains of teaching practice: Planning, teaching, and classroom environment.

The selection of these exact categories for the framework is based on several rationales. Categories IA-1 "student self-directed learning," IA-3 "student collaboration", and IA4 "digital competence" come directly from various 21st century skill frameworks (Caena & Redecker, 2019; Danielson, 2013; Martin, 2018). The category IA-2 "student cognitive activation" reflects the goals of the Latvian education reform (promotion of student higher order thinking skills). The category IB "teacher techniques and basic skills" was created as part of this research, and it covers the basics of teaching practices and allows comparison of teacher performance.

It must be emphasized that the *required teacher competence* is understood in the context of the necessary staff competence for the implementation of the current educational reform, i.e., curriculum reform in general education that introduces the teaching of 21st century skills.

1.1.5. The Rationale of the Study and Research Gap

Competence models are descriptive tools that identify competences needed to perform effectively in an organization (Chung-Herrera, Enz, & Lankau, 2003; Hecklau, Galeitzke, Flachs, & Kohl, 2016), and they are also important for integrating education and training. Today, almost every organization uses some form of competence management (Škrinjarić, 2022). Although several important competence management models have emerged for this purpose in the last few decades (Miranda et al., 2017; Rauner et al., 2013), there is still a knowledge gap regarding the competence management of teaching staff in a school environment (Jentsch & König, 2022). Creating a teacher competence management model tailored for schools can help address persistent issues highlighted in prior studies and international comparisons (OECD, 2019). These studies have identified significant variations in teachers' performance levels, hindering their professional development and impacting school progress (Owen et al., 2018). Given the inevitability of gaps in teacher competence, especially when introducing new teaching innovations, it's unrealistic to expect teachers to seamlessly implement high-quality practices in their daily routines when trying them for the first time. The disparities in teaching quality are not confined to Latvia; they appear to be increasing across education systems worldwide (Bae, Hayes, & DeBusk-Lane, 2020).

This study aims to fill a gap by outlining a method for identifying the professional development needs of in-service teachers at the school level. The goal is to enhance teaching that fosters the development of 21st century skills among students. Drawing on previous studies (De Vries, Dimosthenous, Schildkamp, & Visscher, 2023; Dervenis, Fitsilis, & Iatrellis, 2022), we posit that managing teacher competence should involve tools for assessing competence, exploring practices related to managing teacher competence, examining practices for developing teacher competence, and defining teacher competence profiles. Our approach to managing teacher competence in schools relies on using assessment tools designed to identify gaps in competence (Ranjan & Tripathi, 2011; Tripathi & Ranjan, 2013) as a starting point to create personalized professional development solutions tailored to teachers' needs.

We believe that a clear method with specific steps and tools can help tackle gaps in teacher competence. This approach can aid schools in adopting a more data-driven competence management strategy and assist teachers in progressing from their current competence level, particularly as expectations for teaching quality continue to rise.

2. MATERIALS AND METHODS

To answer the research questions, a design-based implementation research (DBIR) was applied that focuses on the development and adoption of innovations (Fishman, Penuel, Allen, Cheng, & Sabelli, 2013). Recently, DBIR has been used in educational research to develop and implement teaching practices (LeMahieu, Nordstrum, & Potvin, 2017), curricula (Underwood & Kararo, 2021), and school-wide innovations (Anderson et al., 2018). DBIR can be characterized as "a systematically forged partnership between researchers and practitioners that is egalitarian and thoughtful" (LeMahieu et al., 2017) and follows four guiding principles:

1) Focuses on persistent problems of practice in education systems from multiple stakeholders' perspectives
2) Commits to the iterative and collaborative design of change interventions to achieve desired outcomes

3) Develops theory, knowledge, and practice-based expertise related to both implementation processes and outcomes through systematic inquiry

4) Develop organizational capacity for sustaining change improvements in systems (Penuel & Fishman, 2012).

In the current research, all four principles have been applied by analyzing, designing, and refining the conceptual framework for competence management in school settings in partnership with school leadership (principle 1); conducting three cycles of design-based research to design and field-test both the framework and competence management tools (principle 2); conducting research on the implementation of the designed framework and tools in two school samples (principle 3); and conducting research, networking, and capacity-building events for schools participating in the research (principle 4). The processes of the design, refinement, and implementation of the framework and tools occur simultaneously and cyclically and cannot be viewed in isolation.

Both quantitative and qualitative methods were used to collect and analyze data throughout the DBIR process to develop a framework and tools for competence management in the school setting. Detailed information is provided in the following sections.

2.1. Three Cycles of the Design-Based Implementation Research

The DBIR process consisted of three cycles from April 2017 to December 2019. The first research cycle focused on the initial design of the Framework for Teacher Competence Management (FTCM), the second research cycle focused on the redesign of the FTCM and the initial design and first validation of the competence assessment tools according to the FTCM, and the third research cycle focused on piloting the redesigned framework and the continued validation of the tools.

In the first cycle, we collaborated with a business management organization to review the existing literature on competence management in business and school environments, and by following the methodology described by Ravitch and Riggan (2016), we created an initial version of the FTCM, which was further implemented in the school environment. Teachers' competence was conceptualized in the context of the research, and ways to assess teachers' competence were studied from the competence management model (CMM) perspective in the business environment and the teaching quality assessment perspective in education. The implementation of the FTCM occurred through workshops, focus group discussions, and school visits (experts and school leaders) to analyze, discuss, and refine the initial FTCM and its elements.

In the second cycle, we redesigned the FTCM and described the respective terminology for competence management in school settings, for example, terms such as "teacher competence profile" and "professional development needs." The redesigned version of the FTCM was implemented in sample 1. The initial school leaders' workshops and regular meetings between the authors and school leaders were held to support the implementation of the FTCM in each school. At this stage, the competence assessment tools were designed and tested in the sample 1 schools, which comprise the initial version of performance level descriptors (PLDs or rubrics) according to the FST21CS and the initial version of the teacher tests and questionnaires (see section 2.3. for more details). The authors collaborated with experienced and nationally highly rated experts to observe, transcribe, and analyze lessons to test the PLDs. In the third cycle, the final version of the FTCM was validated, and insights into how the FTCM works in various schools (school sample 2) were obtained. In addition, teacher competence profiles were developed, and competence gaps and PD needs were identified in two sample schools. In addition, the redesigned PLDs, tests, and questionnaires were validated. As in the previous research cycles, the authors regularly visited the schools to conduct meetings, workshops, and focus group interviews with school leaders, observe teacher lessons, and make field notes about school leader actions and the implementation of the FTCM and tools in general.

2.2. Research Participants

The first research cycle included teachers and school leaders from one urban secondary school (18 subject

teachers and three school leaders). The second research cycle included the aforementioned secondary school as well as seven other schools (school sample 1: 145 teachers and 16 school leaders; to validate the competence management tools, the sample was extended to 197 teachers). The participants in the third research cycle comprised seven new schools from a single urban municipality (school sample 2: 103 teachers and 14 school leaders; to validate the competence management tools, the sample was extended to 457 teachers).

Starting from the second research cycle, the sample of participants is representative, as the school sample includes country-representative schools with different characteristics (urban/rural), different school types regarding the number of students, subject specialization, language of instruction, etc. As part of the third research cycle, all general education schools in one selected municipality were included in the sample. The teachers involved represented grades 1–12 and 18 different subjects. Schools, school leaders, and teachers voluntarily participated in this study.

The demographics of the research participants are: 93% female (N=278) and 7% male (N= 21); 7% with teaching experience of two years or less (N=21), 9% with 3 to 5 years of teaching experience (N=27), 9% with 6 to 10 years of teaching experience (N=27), 17% with 11 to 20 years of teaching experience (N=51) and 58% with 20+ years of teaching experience (N=188); 3% aged 25 years or under (N=9), 14% aged 26–35 (N=42), 22% aged 36–45 (N=66), 32% aged 46–55 (N=95), 26% aged 56–65 (N=78) and 3% aged 65+ (N=9).

In addition to the authors and school representatives, eight experts were selected to be involved in the research. They are recognized as professionals with 7–17 years of experience in designing and leading various types of teacher and school leader professional development and learning activities, as well as developing teacher support materials (Namsone & Čakāne, 2018).

2.3. Developing Teacher Competence Assessment Tools

The developed set of teacher competence assessment tools is informed by the authors' understanding of competence; that is, competence consists of knowledge, skills, and beliefs and is demonstrated in a work situation. Also, conclusions from the focus group discussions held as part of the first research cycle are considered, for example, "it is unclear why teachers act in one way or another – do they lack knowledge, do they have to enhance their skills, or is there a problem of beliefs or attitude?" Furthermore, the authors regard data triangulation principles (Fotheringham, 2010), which is the combination of different data sources and assessment tools, considering the complex structure of competence and the limitations of lesson observation, as a significant approach to data gathering.

2.3.1. Performance Level Descriptors (Rubrics)

As one of the competence assessment tools, the authors developed and validated PLDs (see Table 2) in accordance with the criteria of the FST21CS (see Table 1). Seventeen criteria of the framework were operationalized by describing teacher performance on five levels: Expert level = 3+; proficient level = 3; basic level or developing = 2; initial level or beginner = 1; not observed = 0. These performance level descriptions were based on studies of scientific literature (Caughlan & Jiang, 2014; Danielson, 2013; Kunter et al., 2013), analysis of good practice examples in the USA (Farr, 2010), Japan (Takahashi, 2011), and Switzerland (Jayaram, Moffit, & Scott, 2012), and good practice of rubrics development (Brookhart, 2013). The authors started with a description of professional (level 3) teacher performance. The initial performance (level 1) was described, and all other levels were described afterwards.

To gather data for the development of PLDs, authors and experts observed and transcribed 278 lessons and organized several expert focus groups to analyze transcriptions to identify performance descriptors for different levels. The identified descriptors were compared with the observed performance as part of the validation process of the PLDs (for more details on PLD development, see Bertule et al. (2019)). Two separate experts analyzed all lesson transcriptions. First, each expert determined the teachers' performance (levels 0 to 3+) according to the 17 criteria of the framework, and then they compared their assessment results. In the case of differences, the experts discussed the results until they reached an agreement. An inter-rater reliability of 0.80 was reached throughout the validation.

Table 2. Example of PLDs for 2.2. criterion "Classroom discourse".

IA-2 Student cognitive activation					
	0 (Not observed)	**1 (Beginner)**	**2 (Developing)**	**3 (Proficient)**	**3+ (Expert)**
2.2. Classroom discourse	The teacher introduces information and explains concepts. If questions arise, they are barely addressed. Students mainly listen, observe and take notes.	Teacher monologue dominates. However, some elements of discourse can be observed – the teacher asks questions but expects certain answers. Questions are only used for checking knowledge. If students fail to provide prompt expected answers, the teacher answers them him/herself. Students answer particular questions and/or ask very few questions.	Alongside explaining and asking questions, the teacher develops a situation where students have to pose questions on the content of the lesson. If needed, the teacher instructs students how to form questions and how to engage in conversation. The teacher tries to provide enough time for students to think over their answers, however, the time is insufficient. Students feel free to ask questions and engage in conversation.	The teacher asks various questions, including questions that lack one clear answer. The teacher asks the students for their opinions to motivate them. The teacher uses questions and different student answers to expand class or group (pairs) conversations. If needed, the teacher rephrases student questions. During conversation, the teacher allocates sufficient time for students to do their thinking. Discourse procedures are clear for students, and they know how to apply them in the abovementioned types of conversations – students know how to ask and how to answer. Students pose various questions.	The teacher uses appropriate problem questions to create situations that foster student engagement and deepen the discourse. Students ask various questions and initiate and lead discussions. They are active and fully engaged in reasoning.

2.3.2. Knowledge Test and Self-assessment Questionnaire

Based on the FST21CS and further developed PLDs, the authors developed a test and a questionnaire in which questions were grouped according to the FST21CS categories and reflected situations from the lessons in accordance with the developed PLDs. By completing the test, the teachers demonstrate their knowledge of the most desirable behavior in a classroom situation, and by filling out the questionnaire, the teachers note their own most typical behavior in a classroom situation (self-assessment) (for more details on test and questionnaire development, see Dudareva, Namsone, Butkevica, and Cakane (2019)). See Table 3 for an example of a test question.

Table 3. Example of a knowledge test item.

Item code	Question type	Question	Assessment	Max. points
D-Z-8	Yes/No	Does the teacher effectively engage students in thinking? Please select which statements you agree or disagree with.	1 point for: A – no B – no C – yes D – yes	4
		A – Teacher poses a question and allows students to respond if they wish. If students do not answer at once, the teacher answers the question. B – The teacher asks a question and asks a specific student to answer it. C – The teacher uses various questions and student answers to drive the conversation and deepen it. D – The teacher proposes a situation where students ask each other questions and discuss the answers.		

Note: D-Z-8 corresponds to item's code in the respective questionnaire.

Each test participant (extended samples 1 and 2; N=654) was assigned a code, and test access was granted for a limited time. This allowed us to track each teacher's test results and compare them with the results obtained from

lesson observations. A validation instruction that regulated the duration and completion of the test was developed. The instructions (stated in the test) were strictly followed, and answers were collected after the allotted period of time. To validate the knowledge test, two major classical test theory attributes were analyzed (difficulty and discrimination indexes). The datasets were analyzed using SPSS software to determine the internal consistency of the tool (Dudareva et al., 2019). The improvement of the test consisted of various actions. For example, when assessing the test item, the easiest and most difficult questions were replaced.

The developed test and questionnaire provide an opportunity to triangulate the data gathered through lesson observations and/or other data sources on teacher competence, and they can be used as separate tools to create teacher competence profiles and determine teachers' PD needs and solutions.

3. RESULTS

The key results of this research are the developed and tested framework of teacher competence management (FTCM) and the developed and tested method for identifying the PD needs of in-service teachers. The framework and method ensure the identification of teachers' PD needs with the use of various tools, such as teacher competence profiles, PLDs, teacher knowledge tests, and self-assessment questionnaires.

3.1. Description of the Framework of Teacher Competence Management

The teacher competence management framework (see Figure 1) was developed by adapting the CMM from the business environment and further developing and testing it through DBIR. The developed framework allows the identification of teacher competence gaps, which, in turn, allows the identification of teachers' PD needs and the design of appropriate PD solutions. This can be achieved in three successive phases: Teacher competence identification, competence assessment, and competence development. In the competence identification phase, teacher competence profiles are created in accordance with the school's development goals; in the competence assessment phase, competence gaps are identified through analysis of classroom instruction in the context of teaching 21st century skills; and in the competence development phase, teachers' PD needs are identified and described.
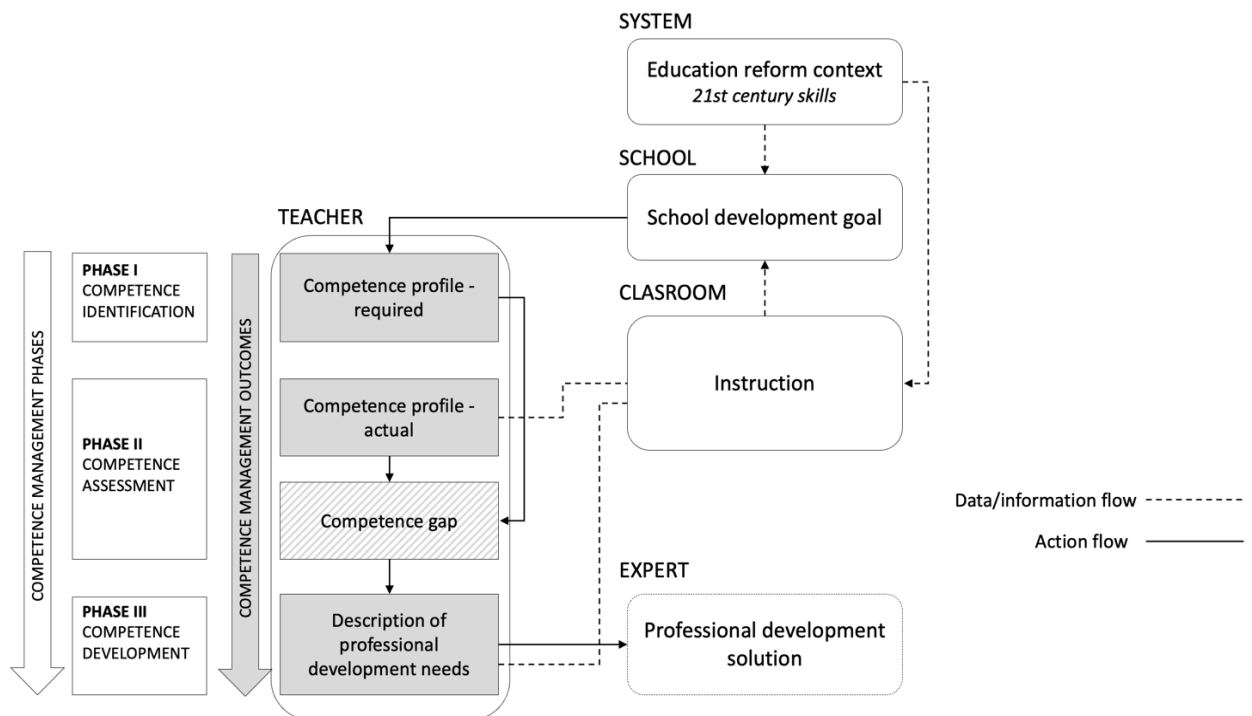

Figure 1. The framework of teacher competence management (FTCM).

The framework enables an in-depth analysis of innovations needed for teaching 21st century skills in classrooms and schools through the involvement of teachers, school leaders, and external experts.

3.2. The Identification Method of Teachers' PD Needs

As a result of the research, we not only developed the framework but also produced a method for teacher competence management in the school environment. We determined a sequence of key steps to operationalize the framework and arrive at teachers' PD needs and solutions. Figure 2 shows the main steps and the key tools that characterize the method developed by the authors when deploying FTCM in schools.
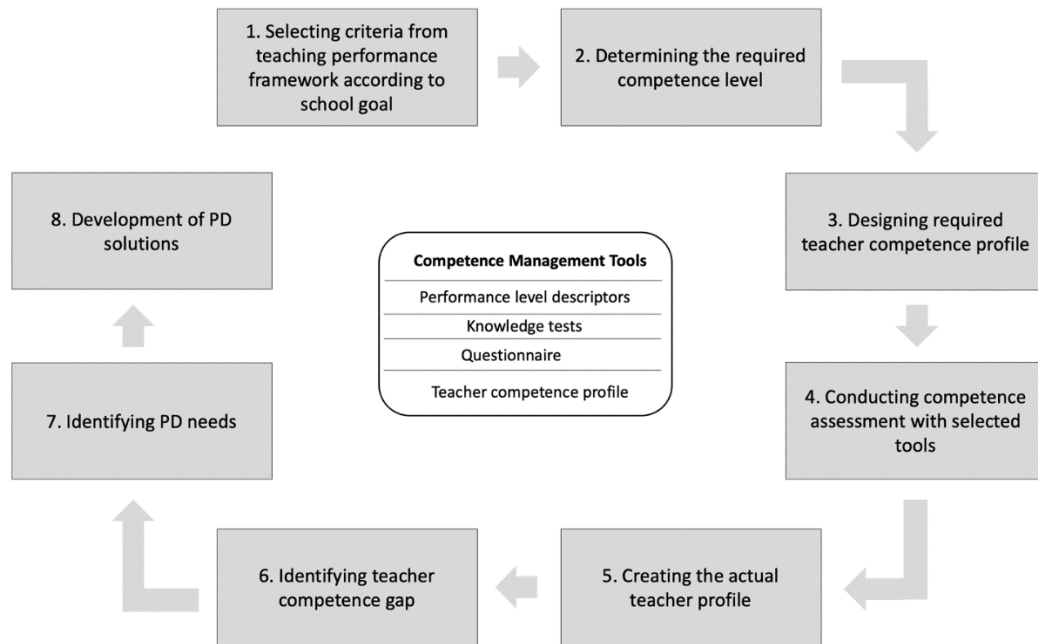

Figure 2. The method for identification of teacher PD needs.

Steps 1, 2, and 3 of the method demonstrate teacher competence identification, and the required teacher competence profile is informed by the FST21CS criteria and the accompanying PLDs selected to correspond with the school development goal.

As part of step 2, the required teacher competence level for each of the chosen criteria is determined, and as part of step 3, all required teacher competence levels to form a teacher competence profile are collected. Steps 4, 5, and 6 describe the teacher competence assessment phase. In Step 4, teacher competence assessment is managed by collecting data through lesson observations, knowledge tests, and teacher self-assessment questionnaires. In Step 5, it is possible to create an actual teacher competence profile. The actual and required teacher competence profiles are compared in Step 6 to identify competence gaps and PD needs in Step 7. Currently, the linkage between the identified PD needs and the appropriate PD solutions (Step 8) is beyond the scope of this study and is a relevant topic for future research.

3.3. Teacher Competence Profile and PD Needs Identification

To demonstrate the practical application of the developed method and its steps, the authors selected one school (urban gymnasium) from sample 2, with the code "GM" to show an example of designing a teacher competence profile and identifying PD needs. A teacher competence profile is created by combining two parts in relation to the FST21CS: a constant part (IB category "Basics of Instruction") and a part where criteria are chosen according to the school goal. In collaboration with school leaders, criteria corresponding to both parts were agreed (the constant and the variable) along with the required competence level. The constant part covers the basics of teaching practices and provides an

opportunity to compare teacher competence across schools in various subjects.

School GM development goals include an emphasis on student cognitive activation in lessons; therefore, category IA "student cognitive activation" with corresponding criteria 2.1. "Learning tasks for cognitive depth" and 2.2. "Classroom discourse" was selected from the FST21CS. To create the required teacher competence profile, the authors and school leaders agreed that performance level descriptors corresponding to level 3 appropriately describe the school's goal.
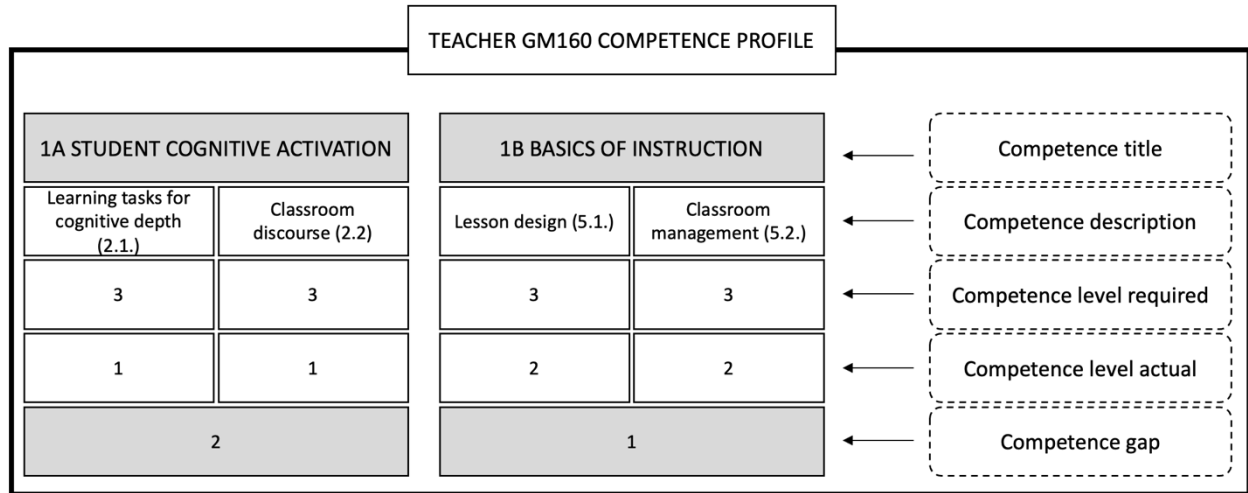

Figure 3. Identification of teachers' GM_160 competence gap.

Figure 3 displays the outcome of the competence assessment process for one particular teacher – the school's GM teacher with a code "GM_160," i.e., an example of the identification of the required and actual teacher competence profiles and the competence gap following the categories and criteria in the FST21CS and the steps to operationalize the FTCM. As demonstrated in Figure 3, teacher GM_160 must overcome the two-level competence gap between the two criteria (2.1. and 2.2.) with regard to competence category IA "student cognitive activation" and a single-level competence gap in the criteria (5.1. and 5.2.) with regard to competence category IB "basics of instruction."

To illustrate the competence development phase, an example of the identification of teachers' PD needs is provided (see Table 4). As displayed in Table 4, teachers' GM_160 PD needs are conceptualized as the necessary actions that teachers should implement in their classrooms to reach the next level of performance, as described in the PLDs (rubric) accompanying the FST21CS. Table 4 focuses on actions for the necessary improvement in Section 2.2., the criterion of the FST21CS "classroom discourse."

Table 4. Descriptions of actual and required competence levels and professional development needs in the case of teacher GM160.

FST21CS criterion	Required competence level	Actual competence level	Professional development needs
Classroom discourse (2.2.)	The teacher asks various questions. The teacher asks for students' opinions and justifications. The teacher uses questions and student answers to deepen the conversation. The teacher provides the necessary thinking time. (Level 3 from the PLDs)	Teacher monologue dominates. The teacher asks few questions and accepts only desired answers. If the students don't provide the desired answers quickly, the teacher answers him/herself. (Level 1 from the PLDs)	Implement situations where students have to ask questions on the lesson topic. If needed, teach students how to ask good questions and how to converse. Give the students enough time to think and state answers. (Level 2 from the PLDs)

3.4. Clustering Teachers' PD Needs

Apart from describing the step-by-step process for the identification of the PD needs of individual teachers, the

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PD needs of all teachers at a particular school were clustered. Table 5 shows an example from the school GM, where 22 teachers participated in the study. The table shows the distribution of the actual teacher competence levels in selected categories of the FST21CS, and the actual competence level distribution of school GM teachers was compared to the actual competence level distribution of teachers representing school samples 1 and 2.

Table 5. Comparison between the actual competence levels of teachers from school GM and all teachers in the research sample.

Category	1A student cognitive activation		1B basics of instruction	
	Samples 1 & 2 (N=248 teachers)	School GM (N=22 teachers)	Samples 1 & 2 (N=248 teachers)	School GM (N=22 teachers)
Level				
0	27%	14%	9%	5%
1	52%	54%	34%	18%
2	13%	27%	33%	36%
3	5%	5%	23%	41%
3+	0%	0%	1%	0%

The comparison displayed in Table 5 indicates that each school has a different proportion of actual teacher competence levels, according to the performance levels and categories of the FST21CS. This also implies that it is possible to divide teachers into groups based on their actual competence levels. The data from the knowledge test and self-assessment questionnaire was used to determine the variations in the competence gap to clarify more nuanced PD needs; thus, individual competence gap combinations could be identified and subsequently clustered. As part of this research, teacher clusters were created for all schools based on their specific PD needs. The identified competence gaps, PD needs, and clusters of teachers with similar PD needs of school GM teachers are represented in Table 6, which indicates that there are four groups of teachers with different PD needs: A group that needs to reach expert level performance (level 3+), a group that needs to reach proficient performance (level 3) and prioritize criteria in category 1B, a group that needs to reach the "developing" level (level 2) and prioritize criteria in category 1B, and a group that needs to reach the "beginner" level (level 1) and prioritize criteria in category 1B.

Table 6. Clustering of school GM teachers according to the identified PD needs.

Competence gap against each category		No. of teachers	Actual competence level	Description of professional development needs
IA	IB			
0	0	1	Level 3 (IA and IB)	To reach level 3+
1	0	4	Level 2 (IA and IB) or Level 3 (IA or IB)	To reach level 3, priority is IB
0	1	-		
1	1	1		
2	0	3	Level 1 (IA and/or IB)	To reach level 2, priority is IB
0	2	-		
2	1	6		
1	2	1		
2	2	3		
3	0	1	Level 0 (IA and/or IB)	To reach level 1, priority is IB
3	1	1		
3	3	1		

Table 6 illustrates a common situation in both research sample schools. Although teachers should achieve the same school development goal, their PD needs are scattered, and only some teachers meet the required competence level (level 3).

4. DISCUSSION

This section focuses on theoretical and practical implications, a comparison of the findings with other studies,

the limitations of the research, and future research prospects.

4.1. Implications and Suggestions: Theoretical Implications

As a result of the research, the ontology-based competence management model (CMM), a general model of staff competence management in business environments (Zandbergs et al. 2019), has been transferred and adapted to school settings, further developed and field-tested, resulting in a framework for teacher competence management (FTCM). The developed FTCM was tested in the context of identifying teachers' PD needs for teaching 21st century skills in accordance with the school's stated development goal.

The main difference between the CMM and the FTCM is the central role of classroom instruction in competence identification, assessment, and development. The actual teacher competence profile assessed through observations of classroom instruction can be used to identify teacher competence gaps, and further observations of classroom instruction can produce insights for competence managers (school leadership) on whether current PD solutions are working as intended.

Overall, when adapting the CMM to the school environment, its elements have been preserved and transferred, adapting the model to the school context and focusing on teacher competence in classroom instruction. The use of an ontology-based model provides an opportunity to precisely define the elements of the model and their interrelations, making a terminological contribution to the further development of the concept of school effectiveness. It also serves as a basis for creating digitized solutions for competence management in the future (Zandbergs, Judrups, Plane, & Uscins, 2021), thus expanding its availability.

In addition to the framework, we have also described an eight-step method to identify teachers' PD needs that operationalizes the developed FTCM and uses a set of practical tools for competence assessment. Considering that the context of the research is curriculum reform in general education, the FTCM and its accompanying method, as well as the set of tools, contribute to the monitoring of the implementation of the reform. Furthermore, the FTCM can be adapted in the context of other educational reforms.

The eight-step method can also be used independently by teachers who want to identify their PD needs. For this purpose, the authors created a self-assessment rubric based on the categories, criteria, and corresponding PLDs of the FST21CS. However, a self-assessment of teachers' PD needs can only be successful if teachers' reflection skills are appropriate. In cases where teachers cannot identify their competence gaps, support from school leadership or teacher educators is required.

The identification of teacher competence gaps and PD needs is conceptualized from the perspective of the school as an organization, thus, designing tools is essential for school leadership to gather the necessary data on the competencies of the staff and provide insights for needs-based PD solutions.

The designed teacher competence profile differs from the competence profiles created for a business environment (Kregel, Ogonek, & Matthies, 2019) as it includes variable and constant parts. The variable part reveals the context of a particular educational reform, i.e., curriculum reform in general education, and the constant part is designed to see individual teachers' potential in instructional design and classroom management required for teaching 21st century skills. The framework of a competence profile can be used as a foundation for implementing research methodology in relation to other changes in education.

4.2. Implications and Suggestions: Practical Implications

The FTCM was field-tested in a school setting, with the participation of teachers and school leadership. The practical application of the FTCM as part of design-based implementation research provided an opportunity to improve it, as well as to indicate the limitations associated with its use.

The competence assessment tools designed and tested in the research sample schools enabled school leadership to make data-driven decisions regarding the identification of teacher competence gaps and PD needs, as well as PD

solutions. Thus, the FTCM, the eight-step method to operationalize the developed FTCM, as well as the set of practical tools for competence assessment, have the potential to help schools and teacher educators move toward evidence-based PD and be responsive to teachers' PD needs (Darling-Hammond, Hyer, & Gardner, 2017).

Furthermore, the results suggest that the PD process should be organized so that teachers with similar PD needs are grouped together (Ball & Cohen, 1999). The study identified four to five teacher groups with similar competence gaps and PD needs in each of the sample schools. The authors recommend clustering teachers in groups with similar PD needs according to the appropriate category of the FST21CS, which corresponds with the school's development goals. At the school level, teacher clustering was performed according to the size of competence gaps to be overcome in each of the FST21CS categories, defining gap limits as 0–1 and 2–3; afterwards, PD needs were identified for each group. The authors also anticipate automating the algorithms for identifying PD needs and clustering teachers with similar PD needs to ease the work of school leadership teams.

It is evident that teachers tend to highlight aspects of their work that they think are important but that do not reflect the reality of their teaching. To solve this issue, one of the practical implications emerging from the present research is understanding the critical contributions of external experts. The identification and assessment of teacher competences were conducted by experts and involving school leadership. The involvement of experts was important to identify the differences between the teachers' self-assessment and the assessment of teacher performance by external experts, thus allowing the identification of competence gaps in real-life situations and practice.

The research also provides insights into various types of teacher competence gaps. If there is a difference between an expert's assessment based on lesson observation and the teacher's own assessment by providing answers to the knowledge test, it is possible to mark this as a "knowledge gap", also known as the "knowing-doing gap" (Read & Landon-Hays, 2013). For example, teachers can demonstrate excellent knowledge of teaching in the test (no gaps identified) but insufficient performance in their lesson (level 2–3 gaps identified), or a teacher can select a classroom action as typical to them and corresponding to level 3, but in practice, a level 2–3 gap is identified.

In one of the sample schools, school GM, distinct self-assessment gaps regarding students' cognitive activation were identified. This indicates the need for teachers to deepen their understanding of the instructional area. Furthermore, in the knowledge test and the self-assessment questionnaire, teachers marked the desired answers or items instead of the items that apply to their actual practice, which is in line with the social desirability bias prevalent in survey research (Bradburn, Sudman, & Wansink, 2004).

4.3. Comparison of the Findings with Other Studies

A review of literature related to teacher competence management revealed several trends—the development of competence assessment instruments, research on teacher competence management practices, research on teacher competence development practices, and determination of teacher competence profiles (Dervenis et al., 2022). The FTCM developed in this study follows these trends and proposes a method to manage teachers' competence through the identification, assessment, and development of the competence, including concrete steps and information and action flows. Previously, Ranjan and Tripathi (2011) and Tripathi and Ranjan (2013) proposed a similar approach for teacher competence management, "The User-Based Competence Management and Performance Assessment Architecture", which also includes competence identification, competence assessment, competence gap analysis, and training needs identification. However, the approach proposed by Ranjan and Tripathi does not include concrete, empirically grounded steps and does not conceptualize how the general competence management steps are related to processes that are typical for schools (for instance, instructions in lessons).

During the research, we gained valuable information regarding the needs for teachers' professional development and teacher competence profiles, and this can be compared with the findings from other studies.

Our approach for determining teacher professional development needs – the competence gap approach – has been used previously in the professional development of medical personnel (Chauvin, Anderson, & Bowdish, 2001). Recent

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studies on teacher education have utilized two different approaches: Self-reported professional development needs (Karlberg & Bezzina, 2022; Van Der Lans et al., 2024) and professional development needs determined through knowledge questionnaires (De Vries et al., 2023).

There are also several recent studies that focus on teacher competence profiles (Bae et al., 2020; Jang, Yoo, & Rubadeau, 2023; Özdemir, Kılınç, Polatcan, Turan, & Bellibaş, 2023). Almost all studies, including this paper, identified teachers who struggle with classroom instruction and teachers who are proficient. In addition to these two competence profiles, each study indicates several others that differ according to research scope, context, and methodology.

4.4. Limitations

Several limitations were identified during the field testing of the FTCM and competence assessment tools.

From a school perspective, one of the main challenges in the implementation of competence management processes is that, as a rule, they are based on experts' implicit knowledge, which limits the possibility of transferring existing knowledge about competence from one organization to another.

Furthermore, the practical usability of the FTCM in school settings is limited by the insufficient feasibility of school leadership to independently identify and assess teacher competence. It should be noted that when testing the FTCM in practice, difficulties defining school development goals by school leadership were identified. This can create complications during the competence identification phase.

From a teacher's perspective, the authors identified limitations related to their beliefs regarding their own competence, performance, and PD needs. Thus, it is necessary to develop an evidence-based teacher self-assessment process. Furthermore, the authors and experts frequently encountered stress among teachers when meeting with people observing their lesson, as teacher assessment is not a daily practice in Latvia. The stress experienced by teachers further emphasizes the importance of effectively communicating the collected data to both teachers and school leaders.

Regarding the research limitations, the study only focuses on the school level and has a specific focus on teacher competence management. The sample is based on the self-recruitment of schools and teachers, which may imply that all participating schools may have similar values, such as openness to learning, feedback, and changes, and this may impact the results. Another limitation is that the current set of items in the knowledge test and questionnaire do not cover all the criteria of the FST21CS; thus, further improvements are needed, including adding new items to cover all criteria.

4.5. Further Research

The research data showed significant differences in the performance of teachers within a single school. Thus, the need for personalized PD solutions becomes critical because one size does not fit all (Bae et al., 2020). For further PD to be effective, it is crucial to choose an appropriate solution that can have the greatest impact on teaching practice (Guskey, 2002; Lipowsky & Rzejak, 2012). Thus, the key area for further research is the link between identified PD needs and suitable PD measures for individual teachers or teacher groups within a school.

5. CONCLUSIONS

A competence management model from the business environment was transferred and adapted to the school setting to develop a framework for teacher competence management, allowing the determination of teachers' professional development needs and tailoring professional development solutions to their specific needs. The context of the relevance and use of the framework is curriculum reform in general education, with an emphasis on teaching 21st century skills.

The Framework of Teacher Competence Management to determine teacher professional development requires

three phases: Competence identification, competence assessment, and competence development. The competence identification phase serves as a reference point for schools to set their developmental goals. The key outcome of this phase was the required teacher competence profile. The competence assessment phase consists of teacher competence assessment and the design of the actual teacher competence profile, the identification of the teacher competence gap, and the comparison between the actual and the required competence profile. In the competence development phase, teachers' professional development needs were identified, setting the foundation for the design of professional development solutions. All three phases were divided into smaller steps for the implementation of the competence assessment tools created for the research.

The research outlines significant differences in teacher performance within a single school, thus emphasizing the necessity to gather school-based evidence to plan more personalized professional development solutions to address professional development needs for different teacher groups. The authors suggest clustering teachers into groups by identifying similar competence gaps for each individual teacher and priorities regarding strengthening certain areas of their expertise.

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