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Improving Child Outcomes and Quality in Early Childhood Education and Care Through Implementation of Professional Development: A Meta-Systematic Literature Review of Pre- and In-Service Approaches

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ABSTRACT

This systematic literature review explores the developing landscape of Early Childhood Education and Care (ECEC), highlighting its growing significance in contemporary society. It examines the complex dimensions of ECEC quality and its impact on children, with a particular focus on the critical role of staff education and training. Additionally, it reviews various tools and methods used to measure ECEC quality, framing the analysis around enhancing quality through comprehensive professional development (PD) initiatives. By conducting a meta-systematic literature review of meta-analyses and systematic reviews, this study synthesizes the characteristics and effects of both pre-service and in-service professional development for ECEC staff. Data extraction and cross-sectional analyses aim to identify patterns and differences in findings, ultimately informing effective PD strategies. The results show promising effects of in-service PD, particularly evidence-based practices such as coaching and mentoring, in improving educator practices and benefiting children's outcomes. Pre-service PD demonstrates positive, though varied, associations between educator qualifications and child outcomes, highlighting the need for policy interventions to improve staff education programs and raise ECEC quality. However, differences in international contexts and the diverse aims of outcomes limit generalizability. Factors such as duration, intensity, and alignment with targeted outcomes remain crucial for success. Tailored, collaborative, and context-specific PD interventions are recommended to enhance ECEC practices and child outcomes. Some PD elements, both pre- and in-service, show greater impact than others, suggesting that further research is necessary to refine approaches and clarify the variability in effects.

Keywords: Structural Quality, Process Quality, Child Outcomes, Pre-Service Qualifications, In-Service Training.

INTRODUCTION

The Importance of Early Childhood Education and Care

Early Childhood Education and Care (ECEC) is increasingly vital for families and children in modern society, with most children in Western nations experiencing some form of ECEC before

starting regular school [1-2]. Originally focused on facilitating parental workforce participation, ECEC has evolved into a scientific approach centered on individual child development, addressing the needs of both children and their families [3].

National and international research has yielded promising cost-benefit analyses, demonstrating significant correlations between quality ECEC and positive life outcomes [4-6]. Participation in ECEC is associated with improved academic skills such as reading, writing, spelling, and math [7-10], as well as enhanced socio-emotional abilities that contribute to social skills and overall cognitive learning [11-14].

Children are viewed as both unique individuals and integral members of their communities, and the collaboration of families, educators, and the broader ECEC community is essential for fostering the child's holistic well-being [15-17]. Engaging in ECEC communities through play and child-oriented activities enhances social skills, learning, and overall well-being, as well as preparing the child for school-life and citizenship [18-23].

Within these contexts, children refine negotiation and communication skills, building relationships with peers and adults. Such interactions are not only engaging for children but also serve as pivotal learning experiences across various international ECEC traditions [19-20, 22, 24-25]. The interactions between teachers and children in ECEC are frequently cited as critical for quality child development, learning, and well-being, leading to a focus on the skills and qualifications of ECEC staff [21, 26-28]. Thus, the proficiency and preparedness of ECEC staff are critical factors influencing the outcomes for children in ECEC programs. This underscores the need for extensive research to identify effective methods for staff development and improvement, as well as to understand how these enhancements impact overall ECEC quality.

Quality in ECEC

In ECEC, ensuring quality is a primary concern of governments and leadership [29-31]. However, the endeavor to define and achieve quality is complex and multifaceted. While many acknowledge its importance, the exact parameters of quality can be difficult to establish, and therefore, caution is advised when aiming to achieve quality in ECEC, as it is influenced by various contextual factors and encompasses multiple dimensions [21-22, 32-34]. Many research reports and studies on ECEC quality construct comprehensive lists of distinct categories and elements of quality to improve - making education, training and professional development of staff only one point of improvement among many others [20, 31, 35-39]. Considering this, it is imperative to identify the most effective practices and development interventions for ECEC staff. Doing so could offer valuable insights for administrators and leadership when allocating resources for quality improvements across the spectrum of ECEC.

Emphasizing specific aspects of quality, such as the education and training of staff, holds considerable potential to enhance the overall quality of ECEC, and is commonly acknowledged as a direct means of ensuring quality standards [21, 32, 34, 40]. According to findings from a large UK study, the presence of trained staff in early childhood programs significantly impacts quality [23, 41, 42]. Within the studies, ‘educated staff’ mostly refers to individuals holding a minimum of a bachelor's degree in pedagogy or education, with an even more pronounced effect observed when the program leader also possesses a bachelor's degree. However, other

studies have shown mixed results, with little and modest results from educational attainment of staff [32, 43-44]. Additionally, it is also possible to ensure training and education of ECEC staff when they are in service, with promising results showing effects of small- and large-scale professional development programs for personnel in ECEC [45-47].

Types of Quality in ECEC: Structural and Processual Dynamics

The above-mentioned aspects are part of what is commonly referred to as *structural quality* in ECEC, but it only represents one level of quality. At a macro-level, organizational factors such as policy leadership and allocated resources shape requirements and standards in law and guidance, ultimately influencing both structural possibilities and procedural practices [32, 48-50]. While different frameworks exist, most researchers and professionals typically categorize quality into two main types: process quality and structural quality. Process quality pertains to child-staff interactions, instructional learning, and daily activities, reflecting the engagement between children and staff, whereas structural quality encompasses staff experience and education, leadership, work environment, and available resources [10, 32, 48, 51].

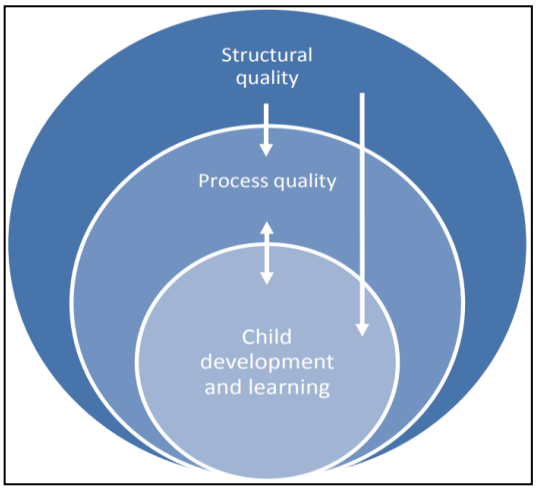

Figure 1: OECD adaption of the conceptual model of quality relationships in ECEC from Slot (2018). - (OECD, 2018)

Slot's (2018) conceptual framework, adapted by the OECD, illustrates the relationship between various levels of ECEC quality and child outcomes (see Figure 1). It emphasizes the interplay between structural and process quality, with structural factors like staff-child ratios, qualifications, and facilities underpinning improvements in process quality, such as instructional practices and teacher-child interactions. Enhancements in organizational structures, materials, and facilities foster environments that promote effective teaching and child engagement for development and learning [21, 50].

Quality in ECEC is further subdivided into specific categories, with three critical aspects of structural quality frequently highlighted: staff-to-child ratios, child group sizes, and staff qualifications. Collectively referred to as the 'iron triangle' of structural quality, these elements influence government strategies worldwide to elevate ECEC standards [10,17,52]. However, it is essential to assess whether standards can be improved more affordably through professional development, as reducing ratios and group sizes can be costly relative to their benefits [43, 53-56]. Additionally, quality elements impact each other more than the conceptual division will

imply, and researchers are trying to pinpoint the overlapping effects, as they are crucial in the analysis of cost-benefit effects [14, 21, 38, 57-58]. Some researchers advocate for more rigorous investigations into their interrelations, as findings have shown varying and ambiguous results [34, 50]. Nonetheless, these categorizations are vital for the holistic evaluation and future development of ECEC, serving as frameworks for research on ECEC effects and quality enhancement in practice [50, 58-59]. For many researchers, administrators, and professional leaders, these quality categories provide essential benchmarks for assessing overall quality and evaluating the effectiveness of initiatives and practices [48, 60].

Measurement Methods and Tools in the ECEC Research Landscape

Understanding the complex relationship between quality and child outcomes in ECEC is challenging due to their interdependence across various structural levels, including interactions among children, groups, and staff [50, 58, 61]. Despite this dynamic complexity, researchers have developed methodologies to assess specific quality dimensions in ECEC settings.

Professionals internationally employ experimental designs and data to evaluate ECEC quality. They often use Quality Rating and Improvement Systems (QRIS) [29] and Environment Rating Scales (ERS), such as ECERS-(R) for children, ITERS-(R) for infants and toddlers, and CLASS for classrooms [10, 34, 62-63]. Critics argue that this focus on 'environments' primarily relates to 'learning environments,' which may emphasize the 'school-like' aspects of ECEC while overlooking other important elements of childhood that are difficult to quantify [64-66]. Nonetheless, researchers can measure cognitive (e.g., math, literacy) and non-cognitive (e.g., social, emotional, behavioral) outcomes, ensuring that their focus remains on essential aspects of child development [3, 11, 34, 42].

Two recent studies in the Netherlands and Denmark examined ECEC quality using ERS on preschool children [58, 67]. They found that specific domains of quality significantly impact child outcomes, showing varying levels of positive correlation. For instance, teachers with a bachelor's degree in ECEC provided better emotional support and classroom organization, leading to improved child outcomes [67]. These findings suggest that enhancing process quality through structural changes can positively influence multiple ECEC areas, regardless of their initial focus. Earlier research also supports the notion that investments in one domain can yield broader improvements, as skills developed in one area foster growth in others [5, 11, 68-69].

Child learning, playing, and development extend far beyond what can be measured by reading or math tests, as highlighted in ECEC literature on quality. This has led to research focusing on socio-emotional skills, *non-instructional interactions, playing*, *children's participation*, *self-organized child communities*, *self-regulation,* etc. [14-15, 25, 70-72]. Less-easily quantifiable domains of ECEC are considered equally valuable in a holistic view of the environment and are therefore important for researching ECEC quality, despite their lack of operational clarity. Investigating these empirically 'soft' areas can provide significant insights into creating safe and engaging child environments, which are crucial for overall ECEC quality and child outcomes [17, 73-74].

In summary, researching the impact teacher development has on quality of ECEC involves addressing multiple dynamic aspects of quality, both structural and processual. This requires

attention to a broad range of research, encompassing effects on overall ECEC or classroom quality, the skills and knowledge of teachers and children, as well as diverse child outcomes, including cognitive, socio-emotional, and behavioral development.

Improving ECEC Quality Through In- and Pre-service, Education, Training, and Professional Development of ECEC Staff

While decision-makers can implement various quality improvement strategies across structural domains, this research will specifically focus on enhancing the professional development of ECEC staff. This encompasses pre-service education, training, as well as in-service measures like coaching and short-term education programs. Henceforth, all education, training, coaching off staff will collectively be termed as 'professional development', abbreviated as PD.

PD is widely recognized as an effective method for improving staff quality in ECEC settings [75]. As outlined earlier, it serves as an effective means to elevate the quality standards of ECEC centers, classrooms, and interactions with children, thereby positively influencing outcomes [32, 76]. PD is primarily categorized into two streams: in-service interventions for existing staff and pre-service education for aspiring professionals, further subdivided based on specific methods of professional development [45, 77-78]. 'Pre-service PD' includes training, education, and specialization pursued by ECEC staff before entering professional roles, while 'in-service PD' focuses on enhancing the skills of currently employed professionals.

Pre-service PD is believed to yield significant outcomes based on the educational attainment of staff. In ECEC, a minimum requirement of a bachelor's degree for main staff is regarded as a key determinant of ECEC quality among experts [20, 23, 41-42, 79]. However, shorter accessible educational and vocational training opportunities, such as classroom assistant programs, also equip future ECEC staff with essential skills [38, 80].

Once staff are recruited into ECEC centers, various approaches exist to ensure continuous in-service PD, though substantial disparities in characteristics, funding, and prerequisites exist across countries and regions [44, 76, 81], and there is varying evidence of the effect on child outcomes [44- 45, 82]. Nonetheless, the consensus regarding PD as a beneficial and key component for maintaining qualified ECEC staff is firmly established [9, 33, 83-84].

Numerous methods of ensuring continual PD vary in their duration, methodology, intent and intensity [85-86], with some elements of intent such as *teacher practice*- or *fidelity*, and methods like *coaching* being prevalent across studies [9]. Coaching and instructional guidance, whether provided by internal experts or external consultants, are long-established as effective PD measures within organizational structures [87-88]. However, the landscape of ECEC PD is evolving, with innovative approaches emerging to tailor in-service PD to unique contexts and desired outcomes [47, 89].

PD interventions can be tailored to various ECEC domains, with some focusing on structural enhancements while others target specific classrooms or child groups. Certain initiatives aim to improve teacher skills, creating a cascading effect that enhances procedural and instructional quality, ultimately shaping each child's learning trajectory. Conversely, other measures focus

on individual child development outcomes by influencing teachers' reflections, beliefs and expanding their understanding of children's needs [14, 30, 89-92].

Scope of Research and Methodology

This review investigates how ECEC can develop a qualified workforce through pre- and in-service professional development (PD), exploring how these strategies improve quality and positively impact child outcomes. The research is motivated by the proposition that investing in staff development could be a cost-effective way to enhance ECEC quality and child outcomes, compared to more expensive structural reforms [34, 43, 53-56, 93].

A meta-systematic literature review of the evidence-based scientific literature will assess the role of PD of ECEC staff in improving care quality and outcomes for children. The review will examine whether the timing of PD—whether pre- or in-service—affects its effectiveness and how resources can be best allocated for optimizing staff qualifications.

Within PD categories, a range of interventions and measures will be explored to identify specific characteristics that drive improvement. Buysse et al. (2009) provides a conceptual model of change that delineates various levels, domains, and PD characteristics targeting ECEC, informing the importance of asking *How* the PD is enabled, as well as *What* the focus of the PD is, and *Who* the PD is aimed at (see Figure 2) [94-95].

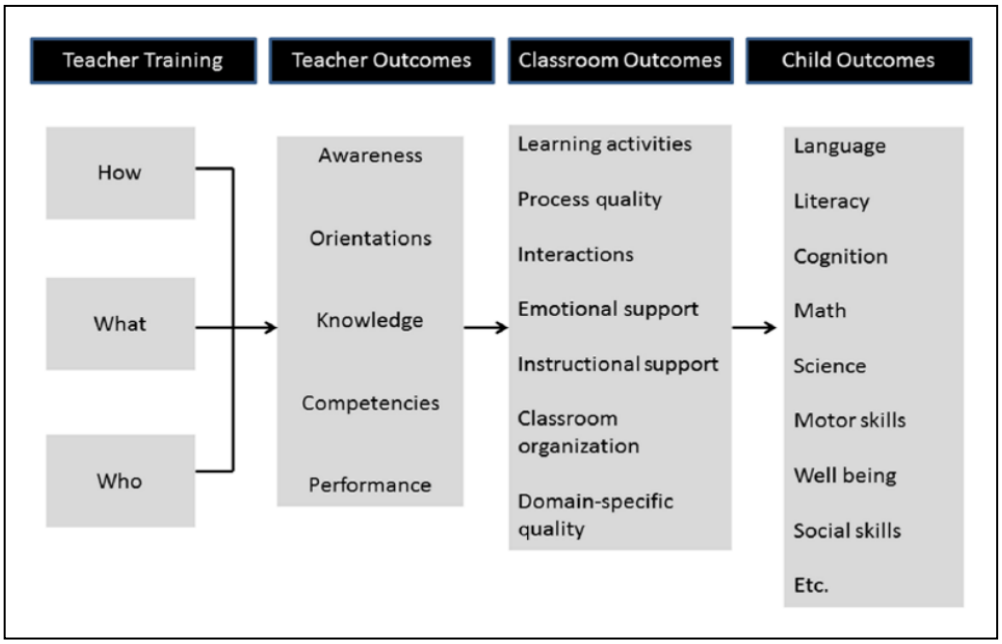

Figure 2: Model of change in ECEC, from Egert et al. (2018, p. 405)

The research done in this systematic literature review will examine the "How," "What," and "Who" of PD interventions in the existing literature. PD initiatives may target broad quality improvements, such as increasing teacher knowledge or optimizing classroom environments, or they may focus on specific child outcomes. Understanding the levels at which PD is directed and its cascading effects provides insight into its holistic impact on children and the overall ECEC work environment.

The findings of this review will guide decision-making and policy formulation at national and regional levels, offering insights into the benefits and challenges of various PD approaches. By understanding the effectiveness of different quality enhancement strategies in diverse contexts, both macro-level and local leadership can implement PD programs that most effectively enhance the quality of care and education provided in ECEC settings.

Research Aims and Research Questions

The aim of this research is to gather evidence on how professional development (PD) of ECEC staff—whether pre-service or in-service—can improve ECEC quality and child outcomes.

Research Questions:

1) What is the effect of in-service professional development on ECEC quality and child outcomes?
    a. What are the defining characteristics of the most effective measures and initiatives found within the literature?
    b. In what areas of quality and child outcomes do they demonstrate effectiveness?
2) What is the effect of pre-service education, training, and qualification on ECEC quality and child outcomes?
    a. What are the discernable differences in the effects on quality and outcomes depending on the multiple levels of pre-service qualification or educational attainment in the ECEC staff?
    b. Are there benefits related to proportions or thresholds of educational attainment in the ECEC staff?

METHOD

Research Design

The chosen method to answer the research questions is a meta-systematic literature review of existing systematic reviews and meta-analysis assessing the impact of education, training, and ongoing professional development in ECEC settings. This review will evaluate existing evidence, summarize findings, and provide an evidence-based synthesis for ECEC leadership [96], aiming to inform or challenge prevailing paradigms, identify knowledge gaps, and distinguish scientifically supported findings from unsubstantiated beliefs [97-98].

This review follows PRISMA guidelines [99-100], using a preset checklist to analyze and synthesize the literature [96]. Searches will be conducted systematically through EBSCOhost, the Scandinavian ECEC research database NB-ECEC, ERIC, and Google Scholar, ensuring consistency in inclusion and exclusion criteria to avoid bias [98].

Highlighting the Quantified Impact of Professional Development in ECEC: Moving Beyond Theoretical Evidence

ECEC research is often said to emphasize professional development, training, and education through qualitative and descriptive methods [64,101-103]. While valuable, these approaches offer limited insight into child outcomes or ECEC quality, as they depend on subjective perceptions that are hard to quantify. They also struggle to establish clear cause-and-effect relationships between PD and outcomes, weakening predictions about the impact of improvements in structural elements like (104-105].

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Therefore, this research focuses on systematic reviews and meta-analytic studies that can quantify the effect of PD in ECEC through empirical investigations of effect sizes, as well as systematic gathering of categorical and numerical data and research results [106]. Such studies not only provide empirical rigor but also helps to frame the assumptions and theories behind the research, thus integrating the qualitative views of the field. Through these types of publications, my aim is to collectively establish whether assumptions regarding the ability of PD to improve ECEC quality and child outcomes are well-founded in the evidence-based research literature [37, 96, 107].

Search Strategy

Table 1: Keywords*

Type of pre- or in-service training, education or professional development	Type of Study	Target Population	Quality/outcome
professional development or professional learning or professional training or professional education or continuing* education or continuing* training or continuing education or teacher qualification or caregiver qualification or staff* qualification or teacher improvement* or caregiver improvement or staff* improvement or in-service* training or coaching or feedback or mentor or mentoring* or pre-service* training or pre-service* education	systematic reviews or meta analysis or meta-analysis	early years or early years education or EYE or child care or preschool or kindergarten or pre-K or Pre-kindergarten or childcare or early childhood education and care or ECEC or creche or nursery or ECE or Early childhood education	outcomes* or benefits* or effects* or impact* or effectiveness*or efficacy* or quality* or achievement*

* Informed by search words used in introductory literature and personal communication with experts.

A systematic literature search was conducted to identify research on the impact of pre- and in-service PD on ECEC quality, as reflected in child outcomes or quality assessments. The focus is on children aged 0-6, the standard demographic across ECEC settings globally, with the target population primarily in standard center-based ECEC, excluding specialized care settings. A distinct set of keywords (see Table 1) was developed and used for the search in the EBSCOhost database, focusing on studies published between 2014 and 2024. Additionally, as indicated, the search was restricted to systematic reviews and meta-analyses to ensure a comprehensive and rigorous synthesis of existing evidence.

Inclusion and Exclusion Criteria and Process

Following the search, 609 articles/chapters/reports were found for screening, with a total of 454 from 2014 to 2024 after the removal of duplicates. The process of selecting the studies for final inclusion in the in-depth review involved a process divided into distinct stages of; identification, screening, eligibility, and final inclusion of studies in the review (see Figure 3).

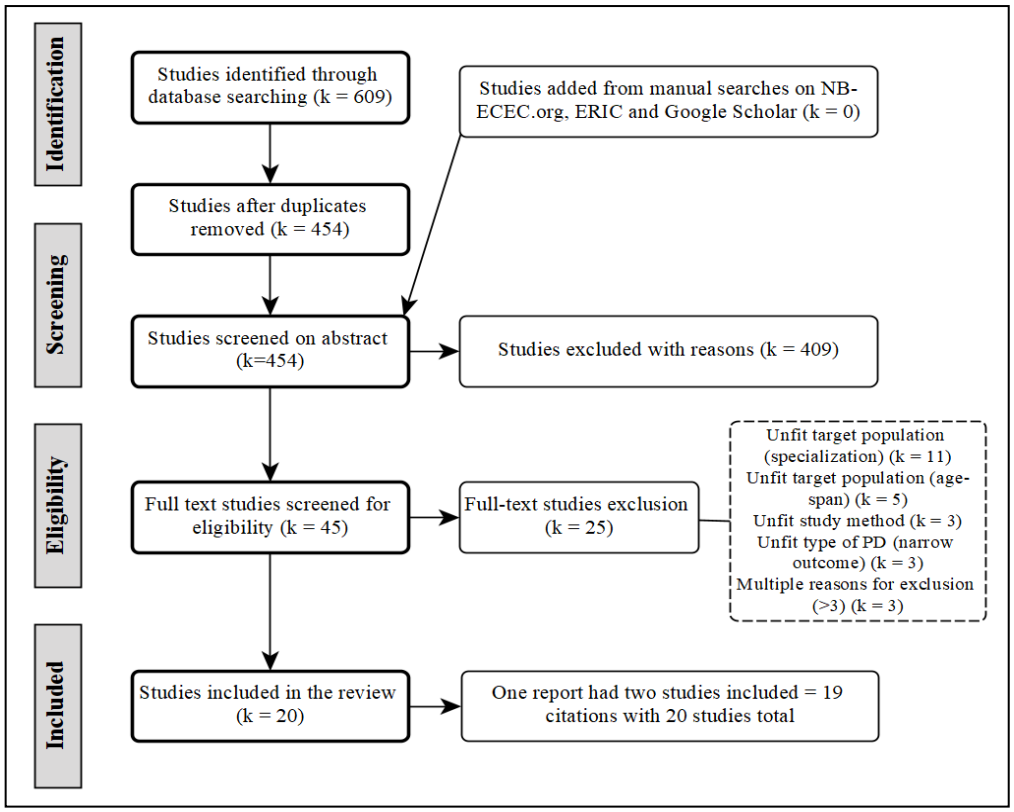

Figure 3: Flowchart diagram based on Prisma standards (Page et al., 2021) [100]

Initially, each study was screened according to preset inclusion criteria (See Table 2), also excluding duplicate publications. Each study underwent thorough assessment based on the preset criteria and objectives. Employing a predefined evaluation scheme ensured alignment with the research questions, study objectives, and inclusion criteria. By evaluating the aim, target group, and methodology of each study in this sequence, the relevance for inclusion in the research was ensured, facilitating the subsequent possibility of a synthesis of results into collective findings. This approach streamlines the synthesis process, enabling the derivation of more substantive conclusions and recommendations beyond the mere summarization of individual study results [96, 108].

Table 2: Criteria for Inclusion

Criteria	***Reasoning***
1) Professional Development	
Focus on pre-, or in-service professional development, training, or education. sub-domains of pre- or in-service PD-categories - for examples see search words in Table 1, or definitions at the onset of this thesis.	This study examines the professional development of ECEC staff, covering both pre- and in-service stages. It explores the educational content, training modalities, and developmental progression across various stages, including initial- and ongoing development or educational attainment. Sub-domains within these categories are also considered, as outlined in Table 1 or defined at the outset of this thesis.
2) Outcome- or Quality measures, and/or categorical- and numerical data.	

Data on outcomes for individual children, groups, or classrooms, as well as for the teachers and/or caregivers in ECEC settings; Data on ECEC quality measures, both processual and structural quality measured with ERS-tools.	The focus on child outcomes and ECEC quality is crucial for understanding their impact on children's development. Child outcomes reflect cognitive, non-cognitive, socio-emotional-, and academic skills, and overall development trajectories; while ECEC quality influences these outcomes through interactions and activities. Describing professional development characteristics through categorical- and numerical data aids in outlining typical program formats and content.
3) Age of Target Population; (primarily or exclusively) 0-6 years of age	
This is the standard age of children in ECEC. Most studies typically focus on age ranges at approx. 0-2-, or 3-6 years of age; targeting either toddlers/infants or children aged 3 to almost 6, reflecting those receiving early childhood care and education.	The 0-6 years age range is typical for ECEC worldwide, notably in Western contexts. Variations exist in settings: toddlers and infants experience nurturing care-focused environments, while older children gradually encounter settings resembling formal schooling with room for unstructured play. Transition to formal schooling often happens around age 6, marking ECEC completion. This study aims to cover the entire ECEC age group, including studies solely, or primarily, focusing on the 0-6 years demographic.
4) Setting of Target Population; (primarily or exclusively) standard care and education	
Specialized group settings or care are excluded from this thesis due to their characterization as atypical, making them unsuitable for synthesis across other settings; or to inform the broader ECEC sector.	In ECEC, various settings provide different types of care and education for children. Some studies narrowly define their groups and include only specific groups, such as; children in full- or part-time residential care; children who are severely at risk; or children in specialized care for specific disabilities or illnesses, etc. While they hold valuable insights in certain contexts, they would complicate the synthesis of the literature. Instead, the focus is on center-based care, which represents the majority of the ECEC target population.
5) Systematic Review or Meta-analysis	
Chosen for their methodical approach, which allows for comprehensive coverage of a wide range of studies, facilitating effective synthesis of the literature.	Systematic reviews and meta-analyses compile extensive scientific theories, evidence, and knowledge from global literature. Within the diverse ECEC sector, numerous studies on professional development, spanning pre- and in-service training, exist across various settings and countries. To synthesize literature comprehensively within the thesis timeframe, only these methodologies were chosen. They provide a systematic and rigorous approach to summarizing content and effects more effectively than individual studies
6) Publication date; 2014 - 2024	
Only recent studies are included to ensure the possibility of obtaining new knowledge and insights.	Recent studies have insights and knowledge that are more relevant to current ECEC conditions, and might hold new and crucial information not present in the broader, less contemporary, scientific literature. Additionally, the time allocated for this thesis limits the ability to include studies from broader time span.
7) English language	
Only English-language studies for possible assessment of both author and assessors.	My country of origin is Denmark, and I am proficient in Nordic languages and English, while assessors likely

	comprehend Dutch and English. Therefore, English, being the mutually understandable language, is chosen.

This process resulted in the exclusion of 409 publications and the inclusion of 45 studies for in-depth screening. Subsequently, the included studies were rigorously reviewed according to predefined criteria, leading to the exclusion of 25 additional studies that did not meet all criteria.

Table 3: In-service Professional Development

Citation	***Specification of PD***	***Method of study***
Brunsek et al. (2020)	In-service (PD Programs)	SR/MA
Egert et al. (2018)	In-service (Training)	MA
Jensen et al. (2019)	In-service (PD)	MA
Joo et al. (2020)	In-service (PD)	MA
Kraft et al. (2018)	In-service (Teacher Training)	MA
Lang et al. (2023)	In-service (Characteristics of coaching)	SR
Lee et al. (2023)	In-service (programs)	SR/MA
Markussen-Brown et al. (2017)	In-service (language- and literacy- focused PD)	MA
Obee et al. (2023)	In-service (PD)	SR
OECD (2018)	In-service PD (AND Pre-service qualification)	SR/MA
Peleman et al. (2018)	In-service (PD)	SR
Rogers et al. (2023)	In-service (PD- and Learning)	SR
Werner et al. (2016)	In-service (Interventions programs)	MA
Yang et al. (2022)	In-service (PD through coaching)	SR

In total, 20 systematic reviews (SR) or meta-analytical (MA) studies were included for review, with one report (OECD, 2018) [21] conducting studies on both In-service PD and Pre-service qualifications, totaling 19 distinct articles and reports on pre- and in-service PD, of which 14 studies on In-service PD (Table 3), and 6 studies on Pre-service PD (Table 4).

Table 4: Pre-service Professional Development

Citation	***Specification of PD***	***Method of study***
Dunst et al. (2019)	Pre-service education	MA
Falenchuck et al. (2017)	Pre-service education	SR/MA
Manning et al. (2017)	Pre-service education	SR
Manning et al. (2019)	Pre-service education	MA
OECD (2018)	Pre-service qualification (AND In-service PD)	SR/MA
Nocita et al. (2020)	Pre-service Specialization	SR/MA

Manual searches were performed using descriptors corresponding to the keywords on the Scandinavian ECEC Research Database *NB-ECEC.org* and the US education database *ERIC*, whereas relevant descriptors and keywords was utilized for a manual search on Google Scholar. However, no additional non-duplicate studies were found for inclusion.

Data Extraction from Publications/Studies

Before reviewing the 19 publications, two data tables were prepared to synthesize and compare key data points. This systematic approach aimed to identify consistent elements across the studies, maximizing the potential for drawing meaningful conclusions [96].

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The first table outlined the characteristics of each study, including origin, sample sizes, sample sources, and the span of publication dates for the primary research (see Table 5). The second table focused on more specific data points, such as: 1) Citation, method, and study origin; 2) Research question or purpose, including assumptions about professional development (PD); 3) Number of secondary publications and effect sizes; 4) Results; 5) Conclusions; 6) Limitations; 7) Recommendations for future research and ECEC practice.

This process consolidated the studies' contributions into a comprehensive description of key findings. Detailed descriptions of the data, results, and conclusions facilitated an overarching synthesis to address the research questions [100], helping create a clear overview of the literature [97].

A cross-sectional analysis was then conducted to explore variations in results across study types. Publications were categorized by research type, objectives, target group characteristics, and origin, to show how specific features and traditions may influence outcomes [96,97]. The studies were divided into two subgroups —Pre-service PD and In-service PD—based on the research questions, with further analysis of distinct features, aims, and measured outcomes.

Table 5: Characteristics of included studies

Citation	*Type of Study*	*Pre-, or in-service domain*	*Outcome- or skill measured*	*Target population*	*Country of origin; 1) main study 2) included studies*	*Publication date of included studies*	*Number of included studies and samples*
OECD (2018)	SR / MA	Both	Academic / Socio-Emotional / Behavior / Interactions	3 to 6 years of age	1) US (Meta-analyst), 2) 13 US, 5 Germany, 3 Portugal, 1 Netherlands, Chile, Tanzania, Belgium, Finland & Australia (A total of 28 studies included in Meta-analysis - rest unknown)	2007 - 2017	44 studies, 28 studies for meta-analysis, number of samples unspecified
Brunsek et al. (2020)	SR / MA	In-service (PD Programs)	Language and Literacy / Academic - To a lesser degree: Health / Socio-Emotional / Adults Learning	Preschool age	1) Canada, 2) 55 US, 5 Canada & Bermuda, 2 Bangladesh & Portugal, 1 Germany, Chile, Singapore & NR	1987 - 2015	73 studies, 92 samples
Dunst et al. (2019)	Meta-analysis	Pre-service degree	ECEC Quality / Child outcomes	Preschool age (Study includes other ages)	1) US, 2) N/A	N/A	15 meta-analysis, each with a mean of 8.5 studies, and 18.33 effect sizes
Egert et al. (2018)	Meta-analysis	in-service (training)	Quality ratings / Child development	0-7 years of age	1) Germany, 2) 34 US, 2 Canada	1992 - 2011	36 studies, 42 samples
Falenchuck et al. (2017)	SR / MA	Pre-service education	Academic / Cognitive / Socio-Emotional	30 to 72 months	1) Canada; 2) 36 US, 1 Canada, 1 Mixed 1 N/A,	1972 - 2014	39 studies, 50 samples
Jensen et al. (2019)	Meta-analysis	In-service (PD)	Cognitive / Language and Literacy / Math / Cognitive / Socio-Emotional / Behavior	3 to 6 years of age	1) Denmark, 2) 3 Germany, 2 Denmark & Netherlands, 1 France & Wales (only European studies as criteria for inclusion)	2009 - 2017	9 studies, samples NR*
Joo et al. (2020)	Meta-analysis	In-service (PD)	Cognitive / Academic / Health / Mental Health / Behavior / Socio-Emotional	0-5 years of age	1) US, 2) 9 US	1972 - 2006	9 studies, 9 contrasts 54 effect sizes

Kraft et al. (2018)	Meta-analysis	In-service (teacher coaching)	Classroom instruction / student achievement	Pre-K age (Study includes other ages)	1) US, 2) NR*	2006 - 2017	31 studies on Pre-K
Lang et al. (2023)	Systematic Review	In-service (Characteristics of coaching)	N/A*	0-6 years of age	1) US, 2) NR*	2008 - 2020	117 studies
Lee et al. (2023)	SR / MA	In-service (programs)	Teacher/student interactions	0-5 years of age	1) US, 2) 30 US, 8 Korean	1992 - 2019	38 studies, 40 samples
Manning et al. (2017)	Systematic Review	Pre-service education	Quality ratings (Learning environment)	0-5 years of age	1) Australia, 2) NR*	1994 - 2015	48 studies, 82 samples
Manning et al. (2019)	Meta-analysis	Pre-service education	Quality ratings (Learning environment)	0-5 years of age	1) Australia, 2) NR*	1992 - 2015	49 studies, 83 samples
Markussen-Brown et al. (2017)	Meta-analysis	In-service (language- and literacy- focused PD)	Vocabulary / Phonological awareness / Alphabet knowledge	3-6 years of age	1) Denmark, 2) NR* - (Mostly US, according to text)	1995 - 2013	25 studies, 30 trials
Nocita et al. (2020)	SR / MA	Pre-service specialization	Academic / Cognitive / Socio-Emotional	30-72 months	1) Canada, 2) 20 US	1972 - 2018	6 studies, 6 samples (Quantitative Synthesis) - 16 studies, 21 samples (Qualitative Synthesis)
Obee et al. (2023)	Systematic Review	In-service (PD)	Classroom management / Behavioral support	3-5 years of age	1) US, 2) NR* (Mostly US, according to text)	1998 - 2021	42 studies
OECD (2018)	SR / MA	Both	Academic / Socio-Emotional / Behavior / Interactions	3 to 6 years of age	1) US (Meta-analyst), 2) 13 US, 5 Germany, 3 Portugal, 1 Netherlands, Chile, Tanzania, Belgium, Finland & Australia (1 unknown)	2007 - 2017	44 studies, 28 studies for meta-analysis, number of samples unspecified
Peleman et al. (2018)	Systematic Review	In-service (PD)	ECEC Quality Ratings	0-7 years of age	1) Belgium, 2) 7 UK, 5 Portugal, Ireland & Sweden, 2 Belgium, 1 Croatia, Germany, Italy, Netherlands & Slovenia (including native language studies)	1993 - 2013	29 studies
Rogers et al. (2023)	Systematic Review	In-service (PD- and Learning)	Characteristics of Professional Development- and Learning	0-6 years of age	1) UK, 2) NR* (Mostly US, according to text)	2004 - 2012	24 studies
Werner et al. (2016)	Meta-analysis	In-service (Interventions programs)	Quality promotion of Caregiver-child interactions	0 to 5 years of age	1) Netherlands, 2) 14 US, 2 Netherlands & Canada	2003 - 2012	18 studies, 19 samples
Yang et al. (2022)	Systematic Review	In-service (PD through coaching)	Teacher instruction / Child development / Language- and Literacy	3-5 years of age	1) China, 2) NR* (Mostly Western, according to text)	2006 - 2017	33 studies

RESULTS

The included studies comprise 14 studies on the effect and characteristics of In-service PD, and 6 studies on Pre-service PD, with one study (OECD, 2018) [21] focused on both In- and Pre-service PD, adding up to a total of 20 studies from 19 citations. Additionally, two studies on Pre-service PD (Manning et al., 2017; 2019) [77, 79] demonstrate significant overlap in their analyzed studies, with the former being a systematic review and the latter a meta-analysis.

In this review, various effect size measurements were extracted to comprehensively assess the impact of PD. Different studies employ different statistical techniques and methodologies, leading to the utilization of diverse effect size metrics, with various reasoning, to capture the nuances of their findings accurately. We have chosen to represent them, as they are stated in

the original study, throughout this review, as the different calculations have their own distinct nuances and applications [98,109].

In-service Professional Development

The synthesis of studies on in-service PD in ECEC reveals a diverse display of valuable insights, spanning various approaches, outcomes, and implications for educator practices and child development. While the studies concentrate on a distinct part of structural quality, the specific areas of research vary significantly, yielding a diverse array of valuable insights that contribute pivotal information for the comprehensive understanding of improvements through PD in ECEC.

A recurring theme across multiple studies is the pivotal role of staff-child interactions in shaping children's outcomes, e.g., in literacy and numeracy learning [21, 89], for improving overall process quality in ECEC [61], and the fostering of positive child development outcomes [110].

In the OECD report (2018) the In-service training of staff emerged as the single-most critical structural quality across regions and child outcomes in their Systematic Review. While training effects vary across targets, it consistently enhances language and literacy-specific quality. Specialized training focusing on staff-child interactions, particularly with coaching components, proves most effective. Short-term interventions with feedback components are also notably successful. Moreover, training involving early childhood education content, on-site support, and appropriate duration yield better outcomes [21]. Yang et al. (2022) found promising results regarding the impact of coaching components on language and literacy in several studies, indicating large effects in studies assessing coaching within professional development (PD). Notably, studies examining in-service PD, specifically combining a PD course with coaching, demonstrated substantial effects. For instance, one included study reported a large effect size[1] (Cohen's d = 0.77) for the combined approach, whereas having only a PD course yielded a smaller effect size (Cohen's d = 0.23). Markussen-Brown et al. (2017) also found that effect sizes of the language- and literacy focused PD was influenced by the duration and intensity, but most importantly, the total numbers of components to the PD intervention. The study showed small to medium effects on receptive vocabulary (SMD = 0.21), phonological awareness (SMD = 0.30), and alphabet knowledge (SMD = 0.12) across the trials. Medium and large significant effects on the overall quality was also found (Process quality SMD = 0.59; Structural quality SMD = 1.07) but these results are possibly influenced by ECEC quality components outside the specific PD intervention [61], and a similar study on this topic in the OECD-report (2018) found less pronounced effects. Collectively, these studies underscore the pivotal role of in-service professional development in shaping teacher-child interactions and child outcomes across diverse developmental domains. They also emphasize the importance of cultivating supportive and enriching environments within ECEC settings to optimize children's developmental trajectories. Moreover, they highlight the critical influence of specific characteristics of professional development on outcomes for children, professionals, and overall ECEC quality.

[1] Cohen's d-, Hedges' g-, and SMD effect size thresholds can vary between field of study but are typically interpreted as follows: small (0.2), medium (0.5), and large (0.8) [109, 111].

The significance of evidence-based guidance in designing and implementing effective PD programs also emerges as a common thread in several studies. Peleman et al. (2018) emphasize the need for PD programs to be grounded in research and empirical evidence, ensuring that interventions are based on proven strategies and methodologies. By incorporating evidence-based practices, PD programs can better address the diverse needs of educators and promote high-quality teaching practices in ECEC settings. In addition, several other studies emphasize the importance of evidence-based guidance in designing and implementing effective professional development (PD) programs. For example, Rogers et al. (2023) discuss the effectiveness of coaching and mentoring as methods rooted in evidence-based practices for improving teacher outcomes and promoting children's learning outcomes [113]. Furthermore, Kraft et al. (2018) highlight the value of integrating coaching with other professional development elements, such as group training and resources, to enhance teaching practices and ultimately benefit children's outcomes; similar to Markussen-Brown et al. (2017). Coaching practices, with various length and components, showed a moderate and significant positive effect on instructional practices (Cohens d = 0.48, p <.001) leading to small significant improvement in student achievement in literacy and reading, with the strongest effects coming from smaller studies [87]. These studies collectively underscore the significance of evidence-based approaches in shaping the effectiveness of PD interventions in early childhood education settings. This emphasizes a shift towards empirically supported approaches that yield evident benefits for both educators and children, aligning with the broader movement towards evidence-based practices in education; with coaching, or programs including coaching consistently showing promising evidence.

Amidst the common themes, however, some studies diverge in their findings, revealing nuanced perspectives and complexities in the relationship between PD interventions and outcomes. For instance, Joo et al. (2020) report small, but negative effects (Hedges' g = -0.18, p<.001) on pre-academic skills from intensive PD in ECEC enhancement programs, challenging the prevailing notion of PD as universally beneficial. Werner et al. (2016) and Egert et al. (2018) discuss the difference in effect on outcomes across their studies, with variations in results based on the level of intervention (classroom level, caregiver level, child level). In one study, meta-analyses revealed distinct effect sizes: Hedges' g = 0.39 for classroom-level outcomes across 11 studies, Hedges' g = 0.44 for caregiver-level outcomes across 10 studies, and Hedges' g = 0.26 for child-level outcomes across 6 studies [110]. The study by Egert et al. (2018) showed a small effect at the child level (ES = 0.14, p < .001) and a medium effect at the corresponding classroom level (ES = 0.45, p < .001). This divergence in findings questions the one-size-fits all approach across levels, and underscores the importance of context, specific characteristics, and the target intent of In-service PD-interventions in ECEC.

Jensen et al. (2019) likewise observed a comparable outcome in their meta-analysis, finding an overall beneficial impact of PD interventions in European settings on children's outcomes. Their analysis revealed an estimated effect size of 0.35, signifying a 'modest' effect that falls slightly short of the significance seen in similar international research findings. This underscores the importance of scrutinizing potential methodological factors and contextual bias when interpreting results in PD research. In a similar vein, Brunsek et al. (2020) delved into the correlations between PD program content and outcomes for children in ECEC. Their comprehensive review uncovered inconsistencies in these associations, particularly contingent upon the measured outcomes. They observed significant but modest effect sizes spanning from

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0.07 to 0.27, with the most favorable outcomes evident in domains such as language/literacy, letter identification, and behavioral changes [112]. Accumulatively, this highlights the importance of considering contextual factors and individual differences when evaluating the impact of PD interventions.

Beyond the direct impact on child outcomes, studies also explore the influence of PD interventions on educator practices and program quality through specific types of PD. Notably, coaching has emerged as a powerful PD strategy, showing significant effectiveness across various domains; but the results also depend, like the overall effects, on specific characteristics.

For example, Yang et al. (2022) conducted a comprehensive study on coaching interventions within PD-frameworks, revealing their crucial role in enhancing teacher-child interactions, fostering a supportive classroom environment, and improving instructional quality. Egert et al. (2018) also found compelling evidence of solely-coaching-program's impact, reporting a remarkable threefold increase in process quality ($g = 1.98$) compared to other programs ($g = 0.67$); with results not showing differing results depending on the number of components, or whether it was on-site or online.

In opposition, some research has highlighted the benefits of integrating coaching with specific other PD elements, such as group trainings and resources. Kraft et al. (2018) demonstrated the shared effects of combining coaching with instructional materials, e.g., curricula and materials, showed enhanced teaching practices and positive child outcomes (0.21 SD larger); while 'video-libraries' as extra material can limit benefits (-0.27 SD smaller). This integrated approach equips educators with a diverse toolkit to address the varied needs of young learners effectively, with varying effects. These studies underscore the transformative potential of coaching in improving educator practices and program quality in ECEC; but ambiguous results warrant careful implementation.

The researchers consistently advocate tailored training programs adaptable to diverse geographical and cultural contexts. Integrating ECEC-content, providing on-site support, and ensuring suitable training durations are key. Additionally, incorporating collaboration and feedback into professional development is widely endorsed, enhancing classroom quality, and fostering collaboration through, e.g., Professional Learning Networks (PLNs) as a resource for the ECEC staff and leadership [113].

Clear reporting standards and research quality are perceived as imperative. Transparent reporting of study design, program components, and sample characteristics is necessary, along with assessing implementation fidelity for accurate evaluation. Diverse samples are emphasized for applicability across contexts, and cultural responsiveness in interventions is deemed crucial. Long-term follow-up and impact assessment are essential, with longitudinal studies being recommended to evaluate sustainability and lasting benefits on educators and children [88-89, 101, 114-115].

The researchers recognize several limitations in their studies. Diversity in research designs, encompassing various methodologies and outcome domains, poses challenges for generalization. Additionally, inconsistent reporting practices impede the assessment of program quality. There is also a regional bias that restricts the applicability of findings,

exacerbated by a scarcity of research consistently evaluating the effects of professional development on children's outcomes. Furthermore, the absence of socio-economic moderators complicates the interpretation of results [77]. Underpowered studies and the lack of meta-analysis further undermine the strength of certain conclusions, albeit they offer valuable insights into overarching trends [110, 114-115]. Tailored, collaborative, consistent, and culturally responsive professional development in ECEC is recommended, with clearer reporting, diverse research samples, and rigorous evaluation methodologies being needed for ECEC advancement [86, 88, 101, 112].

Pre-service Professional Development

The synthesis of multiple studies in the field of ECEC sheds light on several critical themes. On the topic of teacher qualification, a consensus emerges regarding its positive correlation with overall ECEC quality. Higher teacher qualifications are associated, in theory and through extensive systematic reviews, with improvements in program structure, activities, language and reasoning, and interactions with parents and staff [21, 79, 115].

However, the significance of teacher qualifications varies across different aspects of ECEC quality, with some subscales of pre-service educational attainment showing little-to-no effect on the quality or outcomes. Nevertheless, the accumulated evidence advocates investing in teacher education to elevate the quality of ECEC settings, thereby fostering positive developmental outcomes for children. The meta-analysis of Manning et al. (2019) showed that the overall evidence suggests a positive correlation between teacher qualification and overall ECEC quality, as measured by Environment Rating Scales, indicating a moderate to strong positive association between teacher qualifications and the quality of the ECEC learning environments [77]. Out of 72 samples examined, 61 demonstrated a positive correlation between teacher qualifications and ECEC quality, further strengthening the observed relationship. However, like other studies, they also acknowledge methodological challenges, such as heterogeneity in defining and measuring staff education, which underscores the need for refined research approaches to better understand the relationship between staff education and child outcomes. Their meta-analysis showed an overall *'small-to-medium'* mean correlation (r = 0.19, confidence limits [0.153, 0.228]) between overall quality measured by ERS and higher levels of qualified teachers (Manning et al., 2019 [77], p. 401).

Conversely, the impact of pre-service qualifications on child outcomes appears to vary in other studies. The OECD report (2018) suggest that there may be some positive associations between pre-service qualifications and interactions between staff and children, with an effect size of 0.12, a finding echoed in the Manning et al. (2019) study. While these interactions could typically lead to improved child outcomes, the OECD's meta-analysis specifically examining the effects on child behavior, social skills, and academic skills found no direct impact, with combined effect sizes approaching zero. Thus, the influence of pre-service qualifications on child outcomes is likely indirect at best and may be negligible according to the OECD study.

Nocita et al. (2020) indicate that the overall evidence remains inconsistent, with limited significant associations found between educator ECEC-specialization and child outcomes; with effect sizes ranging from -0.03 to 0.07 resulting in non-significant mixed results across four cognitive categories (r_{pooled} = 0.04; 0.03; 0.02; -0.05), and weak positive associations for social skills (r_{pooled} = 0.04). In Falenchuk et al., (2017) the meta-analysis shows weak positive effects

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of 0.05 on *applied problems skills*, and a weak positive- and significant effect of 0.05 on *vocabulary skills* from teachers having a BA degree [101].

Thus, regarding staff educational attainment as a definition of pre-service qualification, a predominant finding emerges from the synthesis of various studies: the absence of substantial and consistent associations with child outcomes. Although some studies report weak positive correlations, particularly in language outcomes, some studies indicate no significant relationship between staff education and child development across cognitive, social-emotional, and physical domains. Surprisingly, there is ambiguous evidence regarding outcomes across multiple levels of educational attainment. One study showed small to no difference across educational attainment levels, and staff proportions [101]. A larger study performing multiple meta-analysis showed larger mean effect sizes of BA degrees compared to HS degree of 0.33 for *classroom quality* and 0.14 for *child-achievement* [80]. Furthermore, there are complex correlations between compared outcomes and quality, across multiple levels. The increase in quality is largest between BA and HS, with effect being lower when comparing BAs with AAs/CDAs, and MAs[2]. Most substantial is the difference in *teacher beliefs* between BA and HS-degrees (ES = 0.77), with BA teachers showing substantially higher levels of commitment to their work; and the difference in *teaching practices* (ES = 0.53) between BA in favor of HS-degrees. Notably, the largest effect in the comparison of *teacher beliefs* came from the smallest sample size of 550 children. Moreover, the authors noted that very little evidence can be obtained regarding specific child outcomes. This stands in contrast to their theoretical assumptions.

Through close examination of the study from Dunst et al. (2019), results indicates that the greater the disparity between the educational degrees being compared, the larger the effect sizes observed in terms of overall quality. The latter is also true for child outcomes, but unexpectedly the effect sizes are weaker with e.g., BA compared to HS being 0.14, and only 0.05 between MA and AA degrees. The results only further add to the complex nature of what specific child outcomes can be expected, compared to the overall quality in ECEC. While some studies propose weak positive correlations between pre-service specialization and language and social skills, the overall body of evidence suggests limited significant associations with child outcomes. Notably, the absence of discernible disparities in outcomes based on children's backgrounds implies a nuanced relationship between pre-service qualifications and child development. Furthermore, literature recommends policy interventions aimed at enhancing teacher education and training programs to improve the quality of ECEC, to ensure or maintain positive and lasting outcomes for children and their families.

Methodological complexities, such as variations in operational definitions of specialization and outcome metrics, underscore the complexity of comprehending how educator specialization influences children's development. This highlights the imperative for further research endeavors aimed at unraveling the subtleties of this relationship and effectively informing policy and practice. Although each subdivision of the meta-analysis included few studies, potentially impacting both the effect size and the ability to extrapolate findings to the broader

[2] HS = High school, AA = Associate's degree, CDA = Child development associate's degree, BA = Bachelor's degree and MA = Master's degree (Dunst et al., 2019, p. 8).

ECEC field, the sample sizes remained substantial and should not be disregarded as insufficient for analysis[3].

DISCUSSION

The synthesis of research on in-service PD in ECEC reveals its potential to enhance educator practices and child outcomes, particularly when grounded in evidence-based practices and supported by structured environments. Effective PD often includes coaching and targeted interventions, with studies showing positive effects on language, literacy, and process quality. However, results are varied, highlighting the need for context-specific approaches and careful implementation. Despite ongoing challenges, in-service PD remains a cost-effective strategy for improving both caregiver competence and overall quality in ECEC settings.

The synthesis of multiple studies on pre-service PD in ECEC reveals varied results regarding the relationship between teacher qualifications and child outcomes. While higher qualifications, particularly a BA degree, are generally associated with better overall ECEC quality, especially in the systematic reviews, while the direct impact on child outcomes remains inconsistent and limited in the evidence, especially in the meta-analysis. Some studies report weak positive correlations, especially in language and social skills, while others show little to no effect. Methodological complexities, such as varying definitions of qualifications and outcomes, contribute to these divergent findings. The review emphasizes the need for further research to clarify how teacher education influences child development and to inform policies aimed at improving ECEC quality.

The research provides some clear guidance on in-service PD. Well-designed, evidence-based PD programs that integrate elements like coaching and mentoring, especially when adapted to diverse contexts, consistently enhance teacher practices and ECEC quality. Studies show that coaching, particularly when combined with group training, substantially improves instructional quality and yields better child outcomes.

For pre-service PD, higher education levels among ECEC staff correlate positively with the overall quality of ECEC settings, influencing elements like the environment, process, and teacher-child interactions. However, direct correlations between qualifications and child outcomes remain inconsistent, suggesting that while higher educational attainment enhances ECEC quality broadly, it has a more indirect effect on child-teacher interactions and specific developmental gains.

Contextual Importance of Professional Development

The requirements for effective ECEC vary significantly across different settings, both within countries and across regions. This diversity makes it challenging to provide universal recommendations based solely on the findings of this literature review. Contextual factors, which are not fully captured in this review, play a crucial role in shaping ECEC practices and outcomes.

[3] Sample sizes (based on available data) ranged from 550 to 14,750 children across up to 900 ECEC centers, across included studies.

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Despite efforts by international and national conventions to standardize ECEC resources and practices, substantial differences persist. Disparities in funding, availability of qualified personnel, quality of work environments, and the socio-economic backgrounds of children exist not only between Western nations and other developed countries but also within regions of the same country [2, 30, 76, 116-117]. As a result, recommending specific strategies for ECEC practice and further research must consider the unique contextual factors present in each setting. While this literature review provides valuable insights, it is essential to recognize the limitations in extrapolating findings to diverse ECEC contexts.

Contextual moderators complicate the analysis of the results of the meta-analysis, as well as the conclusions and theoretical assumptions drawn in the systematic reviews, as they may provide limited insights into PD-implementations in the context of specific countries, and within distinct traditions and standards of practice. Many studies heavily rely on US data and may not accurately represent global ECEC settings, even within the US context, due to variations in heterogeneity and unclear definitions of subdomains [86, 88, 101, 112]. While homogeneity is desirable for meta-analysis and systematic reviews because it enhances the validity of results [109], homogeneous research poses a challenge in informing the international ECEC community due to significant variations in traditions and content [17, 66, 81].

Another complexity is the contextualization of results across diverse ECEC settings globally, given that some findings may stem from measurements of more school-like achievements, classroom environments, and various ECEC settings with differing durations, formats, and content. Hence, it is crucial to assess whether both socio-emotional learning and cognitive learning, require the application of identical didactical and pedagogical methods by teachers across all types of ECEC [17, 74, 118]. Additionally, this consideration gains particular significance when considering the age of the targeted children, as it defines their susceptibility to learning [3, 14, 119-120].

Furthermore, significant advancements have been made in ECEC in recent years, which, in turn, can complicate both the results and a subsequent analysis. It is possible that the field of ECEC has seen substantial improvements in the countries from which most of the samples for the meta-analysis are drawn, which in turn complicates the analysis potential due to overall higher quality, and consequently, less variation in effect across settings [34, 117].

Consistency and Effects of Specific Components

Some PD components, such as coaching, demonstrate significant impact, albeit with mixed effect sizes, yet they still warrant policy interest among ECEC professionals. For instance, Yang et al. (2022) and Kraft et al. (2018) found coaching enhances outcomes, with varying effect sizes. Yang et al. (2022) reported a Cohen's d of 0.77 for combined coaching and PD courses, compared to 0.23 for PD courses alone. Kraft et al. (2018) demonstrated an average effect size of 0.49 SD across studies. Peleman et al. (2018) stress the need for evidence-based PD, which is supported by Kraft et al. (2018) showing coaching's consistent positive effect, with an effect size of 0.16 SD for children's achievement. Markussen-Brown et al. (2017) note duration, intensity, and intervention components influence PD effectiveness. Short-term interventions with feedback, highlighted by OECD (2018), and Professional Learning Networks [113], shows promise and could be cost-effective, showing potential from both on-site and online-based approaches.

While some results seem modest in their effect, it is important to note that experts in the field of educational research point out that significant results, even under 0.20 justify 'policy interest' at a larger scale, as results of that size are not meager, when measuring overall quality of education programs or child outcomes [77, 109, 121]. That claim is, however, disputed by experts in large-scale meta-analysis proclaiming that the threshold could be at the 0.40 point [122]. Other critics argue that overreliance on evidence-based approaches in ECEC have not consistently produced desired outcomes [123] and cannot always be uniformly applied to every daycare facility due to significant differences in their individual requirements, despite shared similarities [124]. Hence, what constitutes 'substantial evidence' is still up for debate in the scientific literature, and educational science is not different with strong opponents disregarding science based on threshold of effects, or the mode and method of the studies included for analysis [35, 44, 57, 122, 125-127].

Leading US child development experts point out, that small effects still can have large impact on children's lives [5, 35, 68], and that large effect sizes in-and-off itself does not constitute good ECEC-policy, but should be analyzed based on its proportional effects and costs, given that:

> *"A cost-benefit approach may be more useful because it quantifies the value of a program's effects relative to the costs incurred in achieving them."*
>
> *(Center on the Developing Child, 2007, p. 11 [35])*

However, regardless of the interpretation of results, the educational, and especially pedagogical field, are increasingly turning to more evidence-based approaches [122, 128], and the field of PD in ECEC practice do show promising results from these types of studies. Implementing evidence-based strategies in practice could represent a cost-effective means of enhancing overall quality and improving child outcomes. Especially In-service PD shows great promise, with consistent evidence indicating significant returns proportionate to the investment and effort [32].

Careful Decision-Making in Pursuit of Specific Outcomes

This review highlights specific dimensions of PD associated with potential positive outcomes relative to its investment. While acknowledging the significant impacts of PD on certain areas, such as mathematical or literacy proficiencies, it cautions against overgeneralizing findings. Effective policy formulation based on positive study outcomes necessitates precise alignment between observed effects and the targeted objectives of the PD intervention. It emphasizes the importance of discerning whether observed effects correspond to the intended improvements sought through the PD intervention. For instance, while a PD initiative may enhance cognitive skills, such as math or literacy, its effectiveness in improving socio-emotional skills or addressing negative behaviors may vary. This underscores the nuanced nature of PD outcomes and the need for judicious interpretation in policy decisions.

Research indicates a reciprocal relationship between the two sides of ECEC suggesting that proficiency in one subcategory fosters development in the other [11-12, 68]. However, prioritizing non-cognitive aspects during the early years may yield greater benefits, as they exert a more substantial influence on the subsequent development of cognitive skills compared

to the reverse scenario [11-12, 109]. A content analysis of the content of PD in ECEC showed that the majority of PD interventions are focused on the more cognitive aspects, with only 28% focusing on the socio-emotional learning, and only few interventions focused on child behavior; with a majority focusing on more cognitive aspects [9]. This observation prompts reflection, as socio-emotional learning, despite its recognized importance in both theory and empirical evidence, presents substantial challenges in definition and measurement; with ongoing discourse regarding clear methods for assessing and quantifying its outcomes [129].

Whether the above-mentioned discussions should lead to alterations of content and intent of PD in the future remains inconclusive; but these additional elements of analysis should be considered when deciding what to improve in ECEC, depending on the target population, the staff, or the quality domain- or child outcome desired to improve.

LIMITATIONS

While initially intending to incorporate a significant amount of qualitative research into this literature review, we encountered a scarcity of meta-analyses or systematic reviews that encompassed such material. In Europe, and Denmark, the country of origin of the first author, the prevailing trend in ECEC research leans heavily towards qualitative studies, presenting an opportunity to delve deeper into knowledge that aligns with this scientific tradition [71, 102]. Adjusting the inclusion criteria of this study to encompass research beyond meta-analyses or systematic reviews, or directly targeting qualitative research, could have facilitated the incorporation of these narrative accounts and opinions. Previous research initiatives focusing on a distinct aspect of ECEC, demonstrated contrasting outcomes and consequently, different conclusions when researched quantitative and qualitative studies separately [26, 130]. Neglecting qualitative research potentially overlooks valuable insights into the experiences and perspectives of staff undergoing pre- and in-service professional development, which could offer crucial information; a problem noted in a similar recent research study [32].

However, two studies of Scandinavian-origin were included in this review; one revealed a prevalence of samples sourced from other countries, predominantly from the US in one study [61] and predominantly from other European countries in the other [131]. Although both studies demonstrated robust and statistically significant positive outcomes from PD, the effect sizes were notably larger in the predominantly US sample compared to the strictly European samples. Delving into the reasons behind this deviation appears to be a worthwhile pursuit for professionals operating within a European context; as they differ in their structures, traditions, and content [17, 33, 76, 81].

There has been critique regarding the scope and inclusion criteria of some studies included in this review. Reviewers from the Campbell Collaboration [44] have highlighted that certain systematic reviews and meta-analyses included in this work [61, 87, 95] incorporated studies with a high risk of bias, such as those lacking control groups or using non-standardized measures. When more rigorous inclusion criteria are applied, excluding these high-biased studies, the analysis often shows reduced or non-significant effect sizes [44]. A meta-analytical study excluded at the final stages of the inclusion-process for this review, McMuellen et al. (2020), describes evidence through their SR and MA that, paradoxically, experience is not

associated to better quality and outcomes[4]. This critique emphasizes the importance of maintaining strict methodological standards, as including lower-quality studies can result in overly optimistic conclusions that may not hold when more robust research designs are prioritized.

Furthermore, by focusing solely on secondary research, such as large-scale syntheses through systematic reviews or meta-analyses, we were limited in the ability to directly evaluate primary research. While meta-analyses and systematic reviews follow rigorous protocols to minimize bias and assess methodological quality, they do not always provide detailed descriptions of primary research components or contextual specifics [106, 109, 132]. These details could be crucial for a deeper understanding of the development, participants, and outcomes of the primary studies, offering valuable insights for those interpreting evidence on professional development for future implementation and policy-making decisions.

CONCLUSION

The synthesis of numerous studies in this review of PD in ECEC provides valuable insights into its impact and effectiveness. Key findings underscore the significance of evidence-based practices, supportive environments, and context-specific approaches in enhancing both teacher practices and child development outcomes in ECEC settings.

Despite the complexities and nuances observed across different studies, certain components of in-service PD, such as coaching, have consistently shown promising results in improving educator practices and program quality. Evidence-based guidance and the integration of diverse PD elements, including coaching, group trainings, and resources, offer potential avenues for enhancing teaching practices and ultimately benefiting children's outcomes. Furthermore, there seems to be potential in both in-person programs, and online-based approaches, if essential instructions are accompanied.

Whether pre-service PD is an effective measure to ensure quality remains somewhat inconclusive, as findings vary across studies. While some studies report substantial results, others show weak effects, and some indicate almost no effect. Additionally, there is ambiguous evidence regarding the impact of educational attainment overall, as different levels demonstrate varying effects across different quality- and outcome domains. Nevertheless, there is provisional evidence that pre-service PD ensures quality and better child outcomes through higher numbers of pre-service educated ECEC staff, especially BA's.

Additionally, it is essential to approach PD interventions with careful consideration, ensuring alignment between observed effects and targeted objectives. While most studies demonstrate positive effects of PD interventions, a minority presents contrasting findings, indicating the need for a nuanced understanding of PD effectiveness. Inconsistent associations between PD program content and child outcomes suggests the need for further investigation into the

[4] This study was excluded due to the high proportion of at-risk children in its sample (see Criterion 4, Table 2). In retrospect, McMullen et al. (2020) [29] could have been included, as it was on the borderline of eligibility. Several included studies did not thoroughly address this issue and may have had similar proportions of at-risk children. This highlights the need for more rigorous inclusion thresholds in systematic reviews. Including this study might have strengthened evidence for the associations between pre-service PD and ECEC quality.

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moderating and mediating mechanisms underlying PD effectiveness. While some studies suggest modest effects, it is crucial to acknowledge the significance of even small improvements in overall quality and child outcomes, especially when considering their potential long-term impacts.

This review highlights the need for continued research efforts to address methodological challenges, refine research approaches, and unravel the complexities of the relationship between staff education, PD interventions, and ECEC quality- and child outcomes. Future research could seek to reconcile the divergent perspectives on effectiveness in ECEC studies by integrating qualitative and quantitative research methodologies, clarifying causal effects between PD elements and outcomes, while exploring contextual moderators. Additionally, prioritizing both immediate and longitudinal studies could enhance the cost-benefit analysis of PD in ECEC, offering a broader perspective on its long-term effects on children.

Overall, while challenges and limitations exist, the synthesis of research on PD in ECEC underscores its potential as a valuable and cost-effective intervention for enriching teacher practices and promoting positive developmental outcomes for children. Moving forward, a nuanced understanding of PD effectiveness, informed by rigorous research and contextual considerations, is essential for advancing effective ECEC practice and policy.

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