

## Critical thinking in the preschool classroom - A systematic literature review

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### ABSTRACT

Critical thinking is acknowledged as a 21st century skill that allows humans to make considered and informed decisions based on the information available to them. Studies exploring critical thinking during the early years are of particular significance because they enable researchers to refine a general view of critical thinking and situate it in the context of young children. Current opinion regarding critical thinking is founded on years of international research in various fields, including primary and secondary education, higher education institutions and industry. This paper reports on a systematic literature review of 25 empirical studies which address various ways of teaching for thinking focusing on children attending early years services. The review aims to gain insights that lead towards a definition of critical thinking in an early years context. To this end, research conducted during 2015–2021 is examined for characteristics of critical thinking in early childhood and teaching strategies developed to support thinking in the early years' classroom. The methodology draws from the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA). Despite the small number of articles sourced which address the review questions, there was a reasonable weight of evidence to suggest the most common characteristics of critical thinking explored in young children are reasoning skills and problem solving. The findings suggest effective mediators in drawing out critical thinking skills include (1) classroom interactions including dialogue and questioning techniques, (2) the use of thinking language, and (3) story-based approaches. The cases in which critical thinking are investigated in early years environments were surprisingly few. The paper concludes with a summary of the implications of the findings for the future of learning and teaching and recommendations relevant to advancing teaching for thinking with young children.

### 1. Introduction and background

To think is human, everyone thinks, however, not everyone thinks well and not all educators teach students how to think well (Ennis, 2011; Pithers & Soden, 2000). The importance of developing critical thinking in students has been proposed as the most important skill set the education system can develop in students (Thompson, 2011). Although good thinking or thinking well are commonly associated with critical thinking (Pithers & Soden, 2000), this claim falls short when there is no clear definition of critical thinking or how to develop it in students. Thus, we ask, what is critical thinking?

Critical thinking has been defined in many ways. Some authors suggest that critical thinking is much more than good thinking;

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instead, it is thinking with logic or reasoning (Mulnix & Mulnix, 2010; Paul & Elder, 2019, 2020). Others focus on critical thinking as the mental processes used to make decisions and solve problems (Ennis, 1987; Sternberg, 1986). These ideas suggest that critical thinking is about giving good reasons for your beliefs and actions. According to Facione (1990), critical thinking includes analysis, evaluation, inference, and reasoning to make informed and rational judgments. Thus, a key element of critical thinking is applying the skills to evaluate if an argument is good or bad by assessing if a hypothesis supports a conclusion (Willingham, 2007).

While there is little disagreement about the value of critical thinking (Alsaleh, 2020), many scholars note that teaching critical thinking across the curriculum is diverse and challenging (Ennis, 2013; Willingham, 2007). According to Willingham (2007), if you are to think critically, you must have a sound knowledge base of the problem or topic of enquiry and view it from multiple perspectives. For Willingham, solving a problem at a surface level requires limited prior knowledge and will not necessarily require critical thinking. In contrast, solving a problem critically requires looking at its deep structure to understand it from different viewpoints. While it is a frequent practice in the preschool classroom to engage children in diverse ways to view the world, pedagogies to scaffold how children see the world from different perspectives are interwoven into curricula rather than identified as an explicit learning goal.

### 1.1. Objectives

The primary objective of this systematic review is to:

- Identify what characteristics of critical thinking are currently being explored in empirical research studies with young children attending early years services
- Examine what pedagogical approaches and methods have been proven effective in drawing out emergent thinking skills in young children.

It is not the intention of this review to delve into the complexity of critical thinking as a broad concept, rather, we attempt to seek clarity on where critical thinking fits into the early years' context. Nevertheless, it is important to provide an overview of the concept before exploring how critical thinking relates to young children.

This paper is organised in the following way: Section 1 provides an overview of critical thinking including related skills and definitions that reflect on the importance of critical thinking in early childhood; Section 2, the methodology, provides details of the systematic review of the literature; Section 3, presents the key results; Section 4, discusses the reviewed literature to reflect on the implications of the findings to enhance early years research and practice; Section 5 presents a conclusion and recommendation for future research on developing critical thinking with young children in a pedagogical context.

### 1.2. Overview of critical thinking

Literature on critical thinking spans the disciplines of philosophy, psychology, and education (see e.g., Lia, 2011). While definitions of critical thinking sometimes overlap across disciplines, this review will focus on the field of education. More specifically, the focus of this review is on critical thinking in early childhood education, however, the research defining the age children develop critical thinking is limited, consequently, providing the rationale for the current review. Nevertheless, some studies propose that children from as early as 3 years demonstrate early critical thinking (Heyman, 2008; Hübscher, Esteve-Gibert, Igualada & Prieto, 2017). Additionally, from an Irish context early years education concerns children from age 0–6, while some countries include children from age 0–8 (see, Burnett, 2010), therein, we limited the review to studies conducted in early childhood settings with children aged 0–8. Therein, the first part of this section regards critical thinking as a broad concept as we seek to explore the literature to expose what is known about critical thinking in early childhood education.

Critical thinking in education has been a focus of attention in research and pedagogy for over 100 years. Emphasised by John Dewey as an educational goal, Dewey proposed that developing critical thinking would empower students to become fair-minded and democratic members of society (Dewey, 1933). For Dewey, teaching critical thinking should begin by motivating students to actively and persistently consider distinctive features of a problem based on the information available to them. Many researchers agree with Dewey's suggestion that critical thinking begins with students' engagement with a problem. For example, Sternberg (1986) depicts critical thinking as the mental processes people use to problem solve, make decisions, and learn new concepts.

However, scholars of critical thinking propose that skills are not enough, instead, both skills and thinking dispositions are necessary to become a critical thinker (Fisher, 2001; Kuhn, 1999). Indeed, most researchers agree that critical thinking skills and dispositions are intrinsically linked. Critical thinking skills include analysing information and evaluating arguments (Ennis, 1987; Facione, 2011). In comparison, a critical thinking disposition is a tendency to be fair and open-minded, separating facts from assumptions or biases and being open to multiple viewpoints (Davies & Stevens, 2019).

### 1.3. Critical thinking dispositions

Thinking skills and dispositions are connected when thinking skills are matched with a person's willingness to act critically (Facione, 1990). In light of this, schools must develop critical thinking skills while also developing strategies to foster thinking attitudes (Facione, Sanchez, Facione & Gainen, 1995). Davies and Stevens (2019) summaries critical thinking skills and depositions as follows:

## Some elements of Critical thinking skills and Critical Thinking dispositions

Critical thinking skills	Critical thinking dispositions
Analysis	Open-minded
Inference	Fair-minded
Evaluation	Suspend judgement
Self-regulation	Inquisitiveness

While the key focus for this paper is on thinking skills rather than thinking dispositions, the findings will briefly outline how both concepts are treated in the reviewed studies.

#### 1.4. The relationship between critical thinking and other skills

Critical thinking skills have often been expressed under the umbrella of creative thinking (Baker, Rudd & Pomeroy, 2001; Vincent-Lancrin et al., 2019). For example, fostering students' creativity and critical thinking was the focus of an international action research project spanning 11 countries where attention was given to the value of fostering creativity and critical thinking during the school years (Vincent-Lancrin et al., 2019). The report argues that developing critical thinking and creativity in students can contribute to individuals' well-being and intellectual growth (Vincent-Lancrin et al., 2019). Consequently, creative and critical thinkers contribute to their communities as part of a democratic society.

While critical thinking and creative thinking are often inextricably entwined, for example in as expressed by Crane (1983) 'when reasoning fails you, imagination saves you' (p.7), or to put this in practice, in problem-based learning creative solutions are often the answer to analytic problems.

However, for this review, it is important to distinguish critical thinking from creative thinking. For example, creative thinking is divergent in nature, whereas during critical thinking, convergent thinking is dominant (Baker et al., 2001). This perspective suggests that creative thinking focuses on imagination, whereas critical thinking emphasises reasoning. Researchers also note that creative thinking promotes artistic expression without necessarily seeking clarity (Resnick & Robinson, 2017; Robinson & Aronica, 2015). In contrast, critical thinking focuses on employing cognitive skills to reach an evidence-based desired outcome (Halpern, 2014).

In an attempt to classify critical thinking, one challenge is that scholars have defined critical thinking according to their own ideas; therefore, there may be as many definitions as scholars with diverse ideas (Atabaki, Keshtiaray & Yarmohammadian, 2015). To seek clarity on where critical thinking fits in an early years' context, we begin with the following characteristics as a baseline for enquiry:

#### 1.5. Characteristics of critical thinking include

- 'reflective and reasonable thinking that is focused on deciding what to believe or do' (Ennis, 1987, p.45)
- 'the mental processes, strategies and representations people use to solve problems, make decisions and learn new concepts' (Sternberg, 1986, p.3)
- 'skillful reasonable thinking that facilitates good judgement because it relies on criteria, is self-correcting and is sensitive to context' (Lipman, 1988)
- 'purposeful, self-regulatory judgement which results in interpretation, analysis, evaluation, and inference' (Facione, 1990, p.3)
- Perspective-taking, understanding that your own perspective may be different from others (Flavell, 1992)
- 'the use of cognitive skills or strategies that increase the probability of a desired outcome' (Halpern, 1998, p.450)
- 'judging in a reflective way what to do or what to believe' (Facione, 2000, p.60)
- 'seeing both sides of an issue, being open to new evidence that disconfirms your ideas, reasoning dispassionately, demanding that claims are backed by evidence, deducing and inferring conclusions from available facts' (Willingham, 2007, p.8)
- 'critical thinking is actually a sub-set of three types of thinking: reasoning, making judgements and problem solving' (Willingham, 2007, p.11)

#### 1.6. Skills researchers agree are part of the critical thinking process that includes

- Analysing information, claims, or evidence (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956; Ennis, 1985; Facione, 1990; Paul, 2005)
- Inferring using inductive or deductive reasoning (Ennis, 1985; Facione, 1990; Willingham, 2007),
- Reasoning strategies are used to generate logical judgement and draw conclusions (Lipman, 1982; Paul, Niewoehner & Elder, 2019)
- Critical thinking is used in effective problem solving through the process of analysing all available data related to the problem (McCormick, Clark & Raines, 2015; Sternberg, 1986; Syder and Snyder, 2008); focused problem-solving improves thinking (Paul & Elder, 2020)
- Thinking is based on criteria (Lipman, 1988), and standards of thought (Paul & Elder, 2020, Scriven and Paul, 1987)

Areas of exploration in the area of critical thinking include the extent to which it may be domain-specific (see e.g. Lia, 2011; Niaz, 1994; Smith, 2002) or influenced by culture and context (see e.g., Parks, 2021), and emotional intelligence (see e.g. Elder, 1996). However, these areas are beyond the scope of this article.

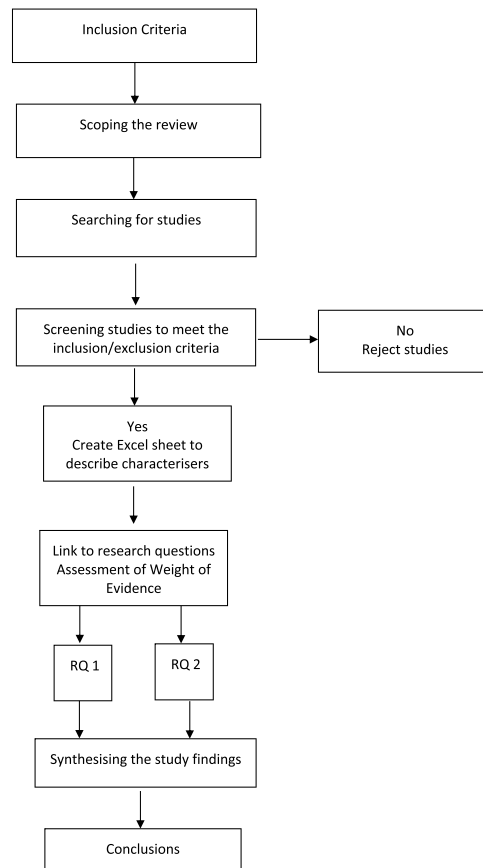


Fig. 1. Systematic review process error 5th box corrected.

### 1.7. Critical thinking in the early years

Critical thinking may be one of the most valuable skills the education system can develop in students but we are not born critical thinkers; therefore, we must develop these skills over time and through practice (Peter, 2012; Snyder & Snyder, 2008; Khun, 1999). Critical thinking is important in early childhood for several reasons.

For one, learning requires not only the ability to grasp information but also the ability to identify and avoid misinformation (Brosseau-Liard, 2017). For example, long before children begin school, they take in a vast amount of information from people and their surroundings; if children are not supported to analyse this information, they are in danger of being misled (Brosseau-Liard, 2017). With the vast amount of information available now compared to 30 years ago, it is even more important that people learn to filter this information through critical thinking (Halpern, 2013). Interestingly, Hübscher et al. (2017) suggest that children from age 3-years-old have the capacity to attain knowledge based on intonation (a feature of pronunciation) lexical and gesture in communication and these skills have been found to improve with age. This research indicates that in addition to the activity-based learning environment, preschool children make sense of their experiences through visual and audio cues.

Another important consideration of critical thinking is the idea that the quality of our life is often reflective of the quality of our thinking (Fisher, 2013). If this is true, then it follows that critical thinking should be promoted from early childhood. Yet little appears to be known about where critical thinking fits into the early years landscape.

Accordingly, in this paper, we draw on the concept of critical thinking as an essential 21st skill that could be developed in children from age three (see e.g. Heyman, 2008; Strasser & Bresson, 2017). This review was conducted to gain insight into this important area of early childhood research.

## 2. Methodology

A systematic literature approach was chosen because it allows researchers and publishers to access the strengths and weaknesses of an investigation in a transparent manner that is easily replicated (Liberati et al., 2009). Systematic reviews serve a distinct function by condensing a field of knowledge, determining what is currently known and exposing specific research gaps (Lachat, Hodge, Vandevijvere, Villamor & Tseng, 2015). The literature presented in this report was conducted following the procedure outlined in the

**Table 1**  
Inclusion/exclusion criteria.

Criterion type	Inclusion	Exclusion
Publication	2015–2021	Before 2015
Quality Assurance	Studies published in peer-reviewed journals	Not published in peer-reviewed journals
Language	English	Non-English text
Topic	Critical thinking in children	Critical thinking in adults
Geographical location	Worldwide studies	
Context	Early childhood	Children over eight years, secondary school, higher educational institutions
Additional needs		Excluded with reason
Digital technology		Excluded with reason

**Table 2**  
Types of literature and databases.

Type of literature	Search online databases
Peer-reviewed journal articles	Academic Search Complete ERIC (on EBSCO Host), ERIC (ProQuest) and PsycINFO

**Table 3**  
Search terms.

"critical thinking" OR "thinking dispositions" OR "thinking skills" OR "thinking ability" OR "meaning-making" OR "problem-solving" OR "making sense" OR "children's reasoning" OR "developing critical thinking" OR "reasoning" OR "Thinking classrooms" AND "Preschool" OR "kindergarten" OR "Early years" OR "early childhood education."
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Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) (Liberati et al., 2009). This PRISMA protocol supports quality and rigour when reporting on academic literature (e.g., Newman & Gough, 2020).

### 2.1. Eligibility criteria

The review included studies exploring characteristics of critical thinking and pedagogical approaches to developing thinking skills in young children. The systematic process leading up to data generation is illustrated in Fig. 1.

Scoping the review was conducted by developing specific inclusion criteria that would allow us to select relevant research studies (Table 1). Four electronic databases were used to source data (Table 2). A search string was developed to identify keywords in early years literature (Table 3). A criterion for assessing the quality of the articles was based on a guide developed by Gough (2007) (Table 4). The results of the screening process are illustrated in Fig. 2.

### 2.2. Inclusion/exclusion criteria

The review excluded studies focusing specifically on (1) digital technology and (2) studies focusing on additional needs. These studies were excluded because; (1) digital technology does not align with the researcher's interest in generating learning environments rich in communication, eye contact and hands-on interactions; (2) we assert additional needs are a specialised area outside the primary researchers' field of expertise. Additionally, non-English language research was excluded. Moreover, the review sought to gain insights that lead toward a definition of critical thinking in contemporary research conducted in early educational settings. To this end, research conducted during 2015–2021 is examined for characteristics of critical thinking in early childhood and teaching strategies developed to support thinking in the early years' classroom. The rationale for limiting the review to literature published between 2015 and 2021 was due to the scope under which the review was conducted concerning time restrictions and a need to explore contemporary literature. The aspects of the inclusion/exclusion criteria are illustrated in Table 1.

The inclusion criteria required content relevant to the research questions, studies identified through keyword search, national and international literature, studies available in the English language, peer-reviewed journal articles, research published during 2015–2021 and participants from early childhood education settings. All methodological approaches were considered for the study. Studies where the focus was on special or additional needs or digital media were excluded from this review. We assert that research studies focusing on exclusion criteria require a field of expertise outside the scope of this study.

### 2.3. Search strategy

The search strategy involved an initial search of Google Scholar followed by a systematic search of four databases as outlined in Table 2.

**Table 4**  
Criteria for judging 'weight of evidence'.

Level 1–4	Methodology quality	Methodology relevance	Topic relevance
1. Excellent	Excellent research approach and method quality	Excellent use of the research design to answer RQs	Clearly defined research answers Referred to ethics concerning children
2. Good	Good relationship multiple review elements	Sound use of research design	Useful, relates to research questions
3. Satisfactory	It appears logical and relatable	Broadly matched to elements of research questions	Broadly relevant to research questions
4. Inadequate	Research design or analysis not clearly stated	Not suited to research questions	Did not answer research questions

(Source: adapted from [Gough, 2007](#)).

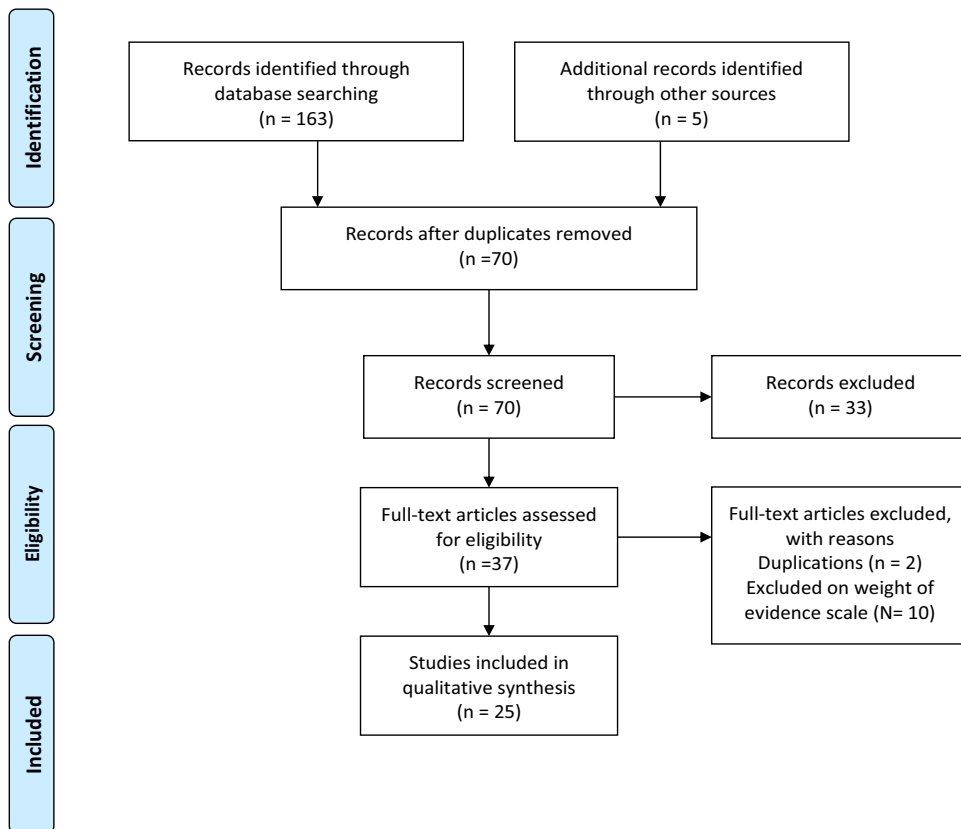


Fig. 2. Screening process.

Search strategies for all databases combine keywords and synonyms related to the research questions plus Boolean operators.

#### 2.4. Screening

As illustrated in Fig. 2, the article screening process took place in two stages: preliminary title and abstract screening and full-text screening. The lead author carried out the initial title and abstract screening with validation by all three authors. The primary researcher initially screened the title and abstracts, disregarding papers that did not fit the criteria. A random sample of 20 out of 70 articles was selected for validation and screened by two out of three authors. Inter-rater reliability was very high, for example, of the 20 papers reviewed, 2 were discussed in detail and one paper was rejected because 2 of 3 reviewers deemed the paper did not fit the study inclusion criteria. To ensure quality and rigour, criteria for assessing the quality of the articles were based on a guide developed by Gough (2007) (Table 4).

#### 2.5. Data extraction and analysis

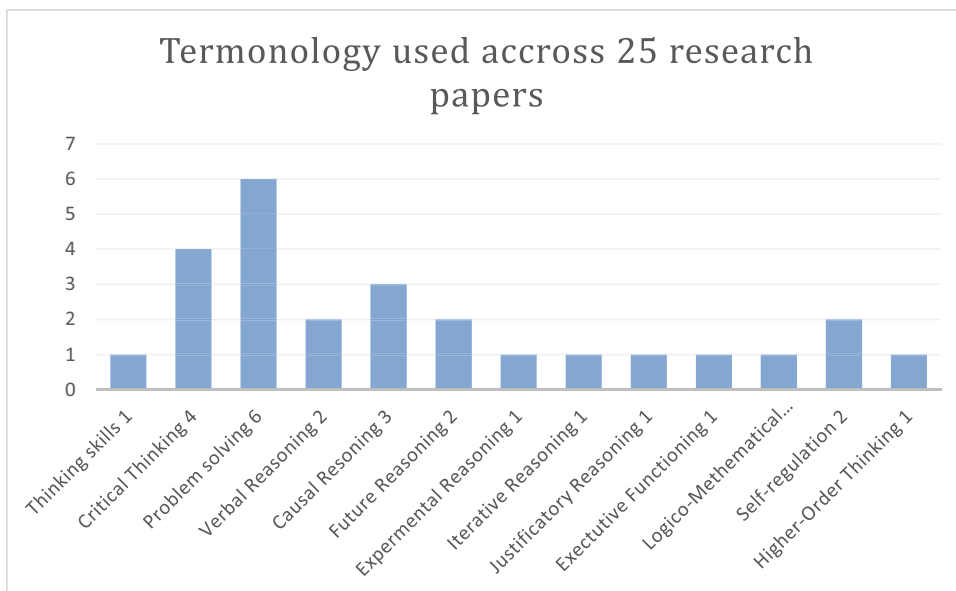
The details of each study were recorded in an excel spreadsheet, this included: author/s, country, year of publication, sample size and age of participants, research questions, duration, context, methods, findings, and comments. Two types of data analysis were used to organise and synthesis relevant data findings. First, a descriptive analysis was conducted and the following data were recorded: reference, the study focus, the key, and context. Second, a thematic analysis was performed to source the data into codes and categories. The content was systematically extracted and coded in alignment with the review questions (Clarke & Braun, 2014). This entailed searching the literature for areas of interest concerning the review questions or potentially valuable findings.

#### 2.6. Limitations

There were several limitations within this review. These include a modest quantity of literature sourced due to the restrictions placed following the systematic review protocol, diversity of thinking skills investigated across studies. The analysis of data was conducted without biases of theoretical or conceptual frameworks.

**Table 5**  
The geographic location of studies.

Country	No. of Articles	Country	No. of Articles
USA	5	Belgium	1
Turkey	4	Columbia	1
Canada	2	Sweden	1
Greece	2	New Zealand	1
Estonia	2	Taiwan	1
Serbia	2	Hungary	1
Netherlands	1	Germany	1
			1



**Fig. 3.** Features of thinking reported spelling errors corrected.

### 3. Results

The criteria for considering studies for this review reduced the initial papers sourced from 168 journal articles to 25 papers that underwent full-text analysis. In all, 25 papers were included in the final review (see Appendix A for an overview of the study characteristics). Of these, 16 were quantitative studies, 7 were qualitative studies and two were mixed methods. The majority ( $N = 19$ ) of studies adopted classroom-based experimental design using different intervention strategies. The intervention methods included questioning techniques, play-based activities, story-based approaches, sorting games, and a variety of classroom activities. For example, one study used a PowerPoint presentation in combination with asking related questions to assess if children could infer which variable had a causal link to a specific outcome (Goddu & Gopnik, 2020). Researchers also used case design ( $N = 2$ ), design-based research ( $N = 1$ ), narrative enquiry and naturalistic observational method ( $N = 2$ ). In the qualitative studies, data was generated from observations, audio-video recording, semi-structured interviews and document analysis. The studies took place in very diverse geographical and cultural contexts (see Table 5) with the vast majority in North America and Europe. The generalisability of the findings must be considered in light of this diversity and the limited number of review articles ( $N = 25$ ). The following sections set out the characteristics of critical thinking identified in early years, current pedagogical approaches to developing thinking skills in young children and finally the research methods most commonly deployed in the field.

#### 3.1. Organising and presenting findings

The data was organised according to the research. First, we describe the findings concerning the characteristics of critical thinking in early years. We then present the findings regarding current pedagogical approaches and methods researchers are using to explore ways to develop thinking skills in young children.



**Table 6**  
Characteristics of pedagogical approaches.

Pedagogy	Characteristic
Dialogue – Questioning to prompt thinking	Philosophical enquiry Questioning techniques Classroom discussion to prompt thinking i.e., talking about story Content and mind-mapping
Modelling – Fostering thinking classrooms	Educator uses thinking language Educator encourages verbal thinking
Scaffolding – scientific enquiry	Games and activities to stimulate or challenge thinking

### 3.2. Characteristics of critical thinking in early years

In line with the search strategy focusing on the keyword ‘thinking’, the studies set out to investigate a range of thinking skills evidenced in children attending early years educational settings. All the studies reviewed involved some element of exploring strategies that could potentially help children actively think and learn in early childhood. Within the 25 articles, there were 13 different terms used (Fig. 3). Of these, six distinct aspects of reasoning were explored: iterative reasoning, causal reasoning, verbal reasoning, future reasoning, and justification reasoning with the most researched skill explored being problem solving. While six papers named problem solving in the title paper, problem solving was included in many of the studies’ full content where it is linked to the cognitive activity of analysing, interpreting and evaluating evidence. This data suggests that reasoning skills and problem solving are the key focus for research on critical thinking in early childhood.

Interestingly, three of the four studies with critical thinking in the paper’s title did not identify specific characteristics of critical thinking. Instead, these studies focus on critical thinking by investigating educational practices that encourage classroom interactions, thinking language and thinking dispositions. For example, nurturing positive attitudes through philosophical enquiry (Karadag, Demirtas & Yildiz, 2017), adopting a pedagogy of thinking language (León, 2015), and mind-mapping through philosophical enquiry (Polat & Aydin, 2020). From this, we deduce that critical thinking could be developed concurrently with thinking dispositions as part of the classroom culture (see i.e., McGuinness, 1999; Khun, 1999).

The fourth study with critical thinking in the paper’s title identified the following as essential skills of thinking: 1) analysing, 2) interpreting and 3) evaluating information (Papadopoulos & Bisiri, 2020). These concepts are widely accepted as core elements of critical thinking that can be developed during the school years (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956; Facione, 2015; Facione & Facione, 2013; Krathwohl, 2002).

Regarding problem solving as a characteristic of critical thinking, we note that problem solving does not always require critical thinking, yet it is often discussed in critical thinking discourse. For example, existing research demonstrated that critical thinking is a complex mix of skills that challenge learners to engage in reasoning, which results in practical problem-solving (Facione, 1990; Paul, 1981; Ennis, 1981). Importantly, the authors note that critical thinking is engaged only when the situation requires an analysis of the problem (Sternberg, 1986; Syder & Snyder, 2008; McCormick et al., 2015). Thus, not every issue will require an analysis of the situation (Paul & Elder, 2020). This is noteworthy as it highlights the need for the educator to be knowledgeable of when problem solving requires critical analysis of the issue and when it does not. Consequently, awareness of critical thinking allows educators to scaffold thinking skills by understanding and exploring diverse pedagogical practices.

### 3.3. Pedagogical approaches

Across the 25 papers, there was a significant variation in the teaching and learning approaches applied in the classroom. We grouped these approaches under educational disciplines; Language/Arts and Science. Aspects of language and Arts were combined in many studies and therefore are grouped together. The key data patterns are listed in Table 6 (see Appendix B).

The pedagogical approaches used across the studies are diverse in their design providing the children with different levels of instruction to interact with a task or activity. Nevertheless, there are commonalities within the application of the methods. For example, all the approaches involve talking to the children and encouraging them to share their ideas concerning a task or activity. Consequently, at some level, all of the above are encouraging active thinking.

Paul and Elder (2020) propose that if an educator teaches a child how to think critically, the educator must explicitly understand what they are teaching and explain this with clarity to the learners. Evidence of explicit instruction was demonstrated in four studies that promoted thinking language and modelling thinking skills in the classrooms (Aras & Aslan, 2018; Kelley, 2018; Maric & Sakac, 2020, 2018). While in León’s (2015) observational study, findings also referred to the impact of thinking language. Results from this study suggest that a range of classroom interactions promote critical thinking when the educators are aware of the concept of critical thinking. In León’s study, the participating educators had taken a training course on conceptual pedagogy.

Drawing from multiliteracies pedagogy, Papadopoulos and Bisiri’s (2020) designed an educational programme to develop critical thinking by encouraging preschoolers to critically analyse content delivered through folk stories, fairy tales and games. The findings suggest that the use of storytelling worked as a mediator to develop critical thinking, which was documented through communicative aspects of children’s interactions.

Additionally, Maric and Sakac’s (2018) study demonstrated how encouraging thinking words scaffolded metacognitive knowledge in 346 children aged 3–6. In this study, the researchers suggest that children with high metacognitive abilities (understanding their

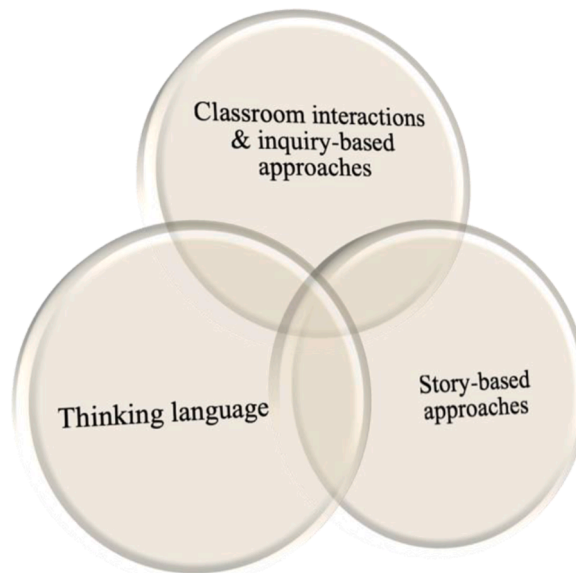


Fig. 4. Pedagogical practice to foster critical thinking.

thinking, thoughts and self-regulation) as measured using Whitbread's Descriptive Statistics Checklist for Independent Learning (Whitebread et al., 2009) were significantly better problem-solvers than their peers.

Significantly, the 25 articles reviewed were located across 15 different countries; thus, overall, the research was sparse. Our findings suggest that there was sufficient evidence to support the importance of scaffolding critical thinking skills in the early years using pedagogies that utilise classroom interaction to stimulate thinking. From these findings, we infer that the commonalities across the studies relate to pedagogical practises based on interactions, communication and dialogue where children are exposed to thinking language.

#### 4. Discussion

This section refers to the reviewed literature to present the main pedagogical practises we consider valuable mediators for fostering early critical thinking skills in an early years context. As we analysed the findings, the pedagogical practices that showed the greatest potential to scaffold characteristics of critical thinking in the early years were: classroom interactions linked to enquiry-based approaches, thinking language and story-based pedagogy as illustrated in Fig. 4.

##### 4.1. Classroom interactions & inquiry-based approaches reorganised as recommended

As we know, the ability to communicate is at the heart of early years learning and development (National Council for Curriculum and Assessment, 2009). This systematic review results show that classroom interactions and enquiry-based approaches were implemented successfully to engage the developing minds of young children. More specifically, there was sufficient evidence across ten studies to suggest that children's thinking skills were enhanced following participation in questioning techniques (Säre, Luik & Fisher, 2016; Säre, Tulviste & Luik, 2019) or semi-structured interviews involving questions (Aras & Aslan, 2018; Bilir Seyhan, Ocak Karabay, Arda Tuncdemir, Greenberg & Domitrovich, 2019; Cesur & Yarali, 2020; Kirkland, Manning, Osaki & Hicks, 2015; Nikiforidou, 2017; Walan & Enochsson, 2019) and enquiry-based techniques (Dejonckheere, De Wit, Van de Keere & Vervaet, 2016; Habok, 2015). The key concepts described in this section focus on questioning techniques and enquiry-based techniques.

##### 4.1.1. Questioning techniques

Collins (2016) applied a questioning technique to explore children's thinking skills. In this study, the researcher used book reading and story discussion by employing the following techniques: (1) low-level questions and (2) high-level cognitively demanding questions. In the experimental group, where participants benefited from the researchers' high-level questions to challenge thinking, children had a significantly higher number of correct answers concerning both inferential and literal questions. Findings suggest that high cognitive demand encourages children to reason, analyse, summarise and explain story content. The improved engagement in thinking was attributed to the educator's prompting questions.

Other literature focused on the types of questions educators can use to encourage thinking, such as open-ended and closed questions. In support of stimulating verbal reasoning using questioning techniques, it was argued that although questions can be a powerful method to support learning and prompt thinking, the types of questions presented must be carefully considered (Säre et al., 2016, 2019). The researchers questions were guided by the children's responses; there was no strategic order for open or closed

questions. An unexpected finding in one study was that asking open-ended and closed-ended questions was more effective than only asking open-ended questions (Säre et al., 2019). This is of particular interest, noting that it is more commonly suggested that open-ended questions alone support learning. However, the literature reviewed highlights that questioning alone is limited as a pedagogy.

#### 4.1.2. Inquiry-based techniques

Pointedly, one author notes that only a sample of children's thinking is demonstrated by answering questions, suggesting that children should be offered alternative ways to engage in thinking other than questioning or enquiry-based methods (Pantaleo, 2017). This coincides with previous research suggesting that while enquiry-based learning can help develop cognitive skills there are limitations (Khalaf, Zin & Bt, 2018). For example, enquiry feeds from prior knowledge, therefore suggesting a young child cannot address what is unknown (Khalaf et al., 2018). This argument is developed in other critical thinking literature reviews where authors report that background knowledge is essential if students are to demonstrate their critical thinking skills (see e.g., Case, 2005; Kennedy, Fisher & Ennis, 1991; Lia 2011). While this research does not minimise the importance of enquiry-based learning, it acknowledges that in early education, this pedagogy must be seen as complementary to other approaches in order to scaffold children's prior learning.

This awareness was evident throughout the literature, where enquiry techniques were implemented as part of the study's approach rather than implementing enquiry approaches as a complete methodology. For example, Dejonckheere et al. (2016) implemented an enquiry-based didactic intervention with preschoolers to assess children's attention for causal events and their understanding of scientific reasoning. Interacting with 15 activities over 7 weeks children were exposed to (1) introduction phase, (2) exploration phase, and (3) prompt questions phase. The children in the experimental group who had the advantage of the educators' prompts were more spontaneously exploratory when interacting with the activities. However, this study failed to determine the exact contribution the probing questions contributed to the children's learning. The authors suggest that further research is necessary to clarify the specific component of the intervention such as the exploration phase or the prompt questions was the greatest contribution to children's learning.

To summaries, the findings outlined above support previous studies proposing that enquiry-based teaching using classroom dialogue or questioning techniques can help educators scaffold various critical thinking skills (Anderson and Krathwohl, 2001; Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956,1976; Greenwood, Austin, Bacon, & Pike, 2022; Siddiqui, Gorard & See, 2019; Strasser & Bresson, 2017). However, we argue that for enquiry or questions to work well, we must consider variables such as what current classroom practises draw out emergent critical thinking skills, what types of questions stimulate thinking, as discussed above (see Säre et al., 2019). To further explore this we examined the literature for evidence of pedagogical practices that could potentially be combined to increase the scope of teaching critical thinking skills in early years classrooms.

#### 4.2. Language for thinking

Language for thinking is the idea that we use thinking words to help learners understand and scaffold the process of thinking through verbalising thinking words. In such incidences, thinking language becomes a mediating tool when children repeat the word or internalise the process to help make sense of experiences. This idea was well executed in three studies, which demonstrated that children exposed to thinking language were better able to understand the process of thinking and use thinking words to extend and explore ideas.

For example, Marić and Sakač (2018) conducted a two-year study exploring metacognitive knowledge in children aged 3–6 and the correlation with problem-solving ability. The authors claim that with support, children learned and employed general thinking words such as an idea, mind, think, and thoughts. Findings reported that 98% of the children used these thinking words during a problem situation. Additionally, the children with high metacognitive abilities (understanding their thinking and self-regulation) exhibited significantly better problem solving skills than their peers.

From a different perspective, thinking language has been linked to critical thinking when language is used to help children understand their world from different perspectives (Flavell, 1992; Willingham, 2007). Aras and Aslan's (2018) focus was on determining if thinking words and thinking activities could support emotional perspective-taking skills in children aged 4–5. In this study the children were taught words such as, not, or, same, different and happiness, sadness, anger; with some of the activities designed to encourage listening and attention skills. The findings from this study suggest that learning the language of thinking helped participants to understand the viewpoints of others (Aras & Aslan, 2018). This research supports prior literature which proposes that thinking critically becomes part of the daily routine and children become aware of incidents where concentrated thinking is required (Salmon, 2008). Moreover, the research highlights the importance of critical thinking to limit the chance of seeing only one side of an argument as previously suggested by Willingham (2007).

Regarding communication and thinking, Cesur and Yareli's (2020) propose that children aged 5 need help to develop the skills to verbalise their thoughts and emotions. To distinguish between (1) how children find solutions to problems and (2) how they feel in these situations, they conducted a four-month study employing an 'I can Problem-Solve Perspective-Taking Test'. The methods used to generate data involved workshops drawing from a range of 56 activities relating to emotions and problem solving. Findings suggest that children aged five could identify issues and problem solutions verbalised by their peers. The findings proposed that children could establish empathy with a character but could not name the emotion. The implications of this finding concern how children develop emotional-self regulation skills to minimise problem behaviour and support social skills. It was suggested that teaching children words to express their thoughts and emotions should be scaffolded in early years settings. Specific words to support emotional expression were not named in this article.

Nikiforidou (2017) conducted a study based on choice methodology to explore preschoolers reasoning and thinking concerning risk perception. During this study, children were asked to make risk-based judgements concerning a choice of images. The task was to identify and discuss risk and propose what caused the risk to occur. The findings propose that children aged 5 years have the linguistic capacity to express reason, cause, and consequence when presented with images displaying risky situations. These studies highlight how the development of critical thinking cannot be divorced from the development of empathy and emotional intelligence. They also highlight that the nature of how these aspects interact is not fully understood and requires further targeted study.

In summary, the literature reviewed in this section allows us to deduce that having the language to convey emotions versus the emotional capacity to understand emotions are two different skills in young children. Moreover, the literature evidenced children ability to read images along with their linguistic capacity to convey meaning to images before making risk based judgements. Therein, from a pedagogical stance, we consider the combination of thought, language, emotional development and concept formation as intrinsically linked (Panhwar, Ansarim & Ansari, 2016). From this stance, we explored the literature for evidence of pedagogical approaches that offer multiple means of teaching and learning.

#### 4.3. Story-based approaches

Stories in education have long been seen as a natural mediator for stimulating dialogue, investigation and problem-solving in children (Fisher, 1998; Landrum, Brakke & McCarthy, 2019; Paley, 2013). The advantage of story-based approaches over general teaching approaches is that children are naturally drawn to stories as it is intrinsically interwoven in childhood (Paley, 2013). Of the 25 studies, engagement with a story was the focus of four research studies.

Reed, Hurks, Kirschner and Jolles (2015) used an innovative approach to investigate how shared picture book storytelling within a peer-group setting could stimulate causal reasoning in young children. What was interesting about this study is it was undirected with no scaffolding. The children were left alone to discuss and critique the picturebooks. Findings suggested that the children in the most improved group engaged in critical thinking by constructing ideas together and offered justification for their statements (Reed et al., 2015). These findings suggest that collaboration and developing justification scaffolds critical thinking in young children. Early years educators could capitalise on this finding by working with the children on justifications and collaboration skills in order for them to be better prepared to use those skill across domains.

Walan and Enochsson (2019) combined storytelling and drama to teach young children science. In this study, participants listened to a story about *Rhinovirus Rita*, a character whose immune system was impacted by a virus. Although the findings suggested the pedagogy of storytelling and drama combined, positively engaged children's critical thinking about complex topics, i.e., understanding and discussion on the immune system, the researcher recommended that further research be conducted to explore how storytelling and drama could advance children's scientific knowledge.

Taking a multiliteracy approach to teaching, Papadopoulos and Bisiri (2020) developed a program based on multicultural stories to investigate children's skills in analysing, interpreting and evaluating information. In this program, children aged 5 had the opportunity to work collaboratively by analysing the content of folk stories, fairytales and collaborative games. The findings suggest an improvement in children's critical thinking attitudes, skills and knowledge after participating in the multiliteracy program. Overall, this qualitative study was reported to successfully enhance critical stances, behaviours, and participants' understanding of critical thinking. Thus, in this study, the combined mediators of storytelling and dialogue were found to scaffold the critical thinking skills of conceptualising, analysing, applying appropriately and applying creatively.

This review identified and discussed the presence of specific characteristics of critical thinking skills in preschoolers involve reasoning skills and problem solving abilities. Findings for the current review coincide with previous studies suggesting that teaching preschool children to think, analyse, infer and solve problems effectively requires thoughtful and informed decision making (Butera et al., 2014).

##### 4.3.1. Section summary

From a pedagogical stance, the review highlighted important teaching strategies which contributed to the development of these skills in early years learning and teaching environments. Researchers propose key practises to developing critical thinking in young children, include the use of enquiry-based strategies and the use of language for thinking to encourage focused thinking. The results of this review have implications in improving preschoolers developing critical thinking skills and early childhood education. Further research would be useful to explore how enquiry based pedagogy could be intertwined with storytelling and thinking language to offer children a multimodal pedagogy for developing critical thinking in preschoolers.

## 5. Conclusions and recommendations

Scholars emphasise that if critical thinking is to be explored in the learning environment, a clear and accurate conceptualisation of its characteristics is essential (Facione, 2011; Leś & Moroz, 2021). By highlighting characteristics of critical thinking by naming the skills of reasoning and problem solving (see Table 6), we now have a clear baseline from which we can develop pedagogies that suit the context in which we teach. In doing this, the review has identified thinking processes in children's everyday experiences that educators, through awareness, can support.

The results of the systematic review strongly suggest that critical thinking can be developed through pedagogical practices in an early years context when educators know what skills to build and how to draw out these skills (see Table 6). This review has reinforced messages from the literature recognising the importance of developing critical thinking skills during the school years (Nickerson,

1988). Thus, we recommend that the research gap identified in respect of early education could be addressed by investigating pedagogical practices that could include further research investigating how storytelling as pedagogy could scaffold critical thinking skills in preschoolers.

### Authors' statement

#### Breakdown of CRediT statement

The research team consist of Catherine O'Reilly, Ann Devitt and Nóirín Hayes.

Authors contributions to the published work:

The role of authors

Catherine O'Reilly

- Primary PhD researcher
- Initial preparation, planning and writing
- Collaborate and engage in fortnightly constructive feedback meetings
- Conduct extensive research using Trinity College Library resources
- Writing review and editing with supervisors

Ann Devitt

- Expert adviser in the field of conducting a systematic literature review
- Methodology – evaluate the work of Catherine as a new researcher
  - Sample work and provide constructive support and guidance
  - Validation – review Catherine's work including interpretation of findings for clarity and accuracy
- Review and editing with research team

Nóirín Hayes

- Expert advisor in the field of early childhood education
- Conceptualisation – evaluate the work of Catherine as a new researcher
  - Sample work and provide insights from the perspective of early childhood research
  - Validation – review Catherine's work concerning the pedagogical frameworks for clarity and accuracy
- Review and editing with research team

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### Ethics approval and consent

Ethics approval is not required for the current systematic review presented here

### CRediT authorship contribution statement

**Catherine O'Reilly:** Visualization, Methodology, Conceptualization, Writing – original draft, Writing – review & editing. **Ann Devitt:** Supervision, Methodology, Validation, Writing – review & editing. **Nóirín Hayes:** Supervision, Conceptualization, Validation, Writing – review & editing.

### Declaration of Competing Interest

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

### Data Availability

No data was used for the research described in the article.

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## Appendix A

Table A1.

**Table A1**  
Characteristics of the literature.

Author	Study focus	SampleDuration	MethodologyInstrumentsAssessment measures	Key Findings
Aras and Aslan (2018).	To determine the effects of <i>I Can Problem Solve</i> (ICPS) program on preschool children's perspective taking skills	51 children aged 4–5 2 kindergartens 3 Months	Experimental design Intervention: ICPS Programme Test: Perspective Taking Test for Children (PTC) this has three theoretical dimensions. 1. perceptual perspective taking, 2. cognitive perspective taking, 3. emotional perspective taking, 24 items on the ICPS activity programme.	Young children could learn to understand other viewpoints by using thinking words and thinking activities. Storytelling was suggested as an excellent instrument to stimulate thinking skills.
Brocas and Carrillo (2020).	To investigate iterative <b>reasoning</b> in children from pre-kindergarten to 1st grade	122 children across three grades: 1. (4–5) pre-kindergarten, 2. (5–6) Kindergarten, 3. (6–7) 1st grade.	Design and procedures: games that are easy to grasp plus games that require strategic thinking. Treatment: Half the participants in each group completed the games. The children were asked <b>questions</b> like 'What do you think your partner did?' Data was presented using graphs, tables and figures.	They hypothesise that age would be a strong predictor of both equilibrium behaviour and equilibrium belief about others' behaviour was supported in the findings. Children can make logical deductions once the starting point of the reasoning is clear. The results suggest that preschool children are in the process of acquiring logical deductive skills but have trouble formulating hypotheses.
Cesur and Yarali (2020).	To determine how children generate solutions to <b>problems</b> and how they feel in such cases	11 children ages 5	Qualitative research Case Study using interview techniques. Interviews were evaluated with content analysis.	Children were able to problem solve concerning empathy regarding others. Children had difficulty expressing their own emotions. Support is needed to help children think about and express emotions'.
Collins (2016).	Examining the effects of low and high cognitive demands questions and discussion on children's story comprehension. Identify contributions to discussion on initial vocabulary and parent involvement.	70 English learner preschoolers from two schools in Portuguese speaking communities Twelve Weeks	Experimental Study Between-group and within-group design Books were read Effects of Story Discussion (Experimental) No story discussion (Control) Stories were discussed using low-high cognitive demand Analysis: descriptive statistics demonstrated in Tables	The treatment group had a significantly higher number of correct answers concerning both inferential questions and literal questions. High cognitive demand encourages children to reason, analyse, summarise, explain and improve comprehension. Engaging in inferential thinking helped children to understand the process of high-level thinking and generate new ideas
Dejonckheere et al. (2016).	This study tested the effects of an enquiry-based dyadic method for preschool science in a preschool classroom TF Inquiry-based pedagogy	57 Preschool children age 4–6 From 4 different schools Language: Dutch Seven weeks	Experimental design pretest/posttest 15 activities spread over 7 over weeks Three phases: Introduction phase, exploratory phase, and a trigger phase. The dependant measure of interest is if the child performed informative and meaningful experiments or actions.	The experimental group who had the educators' probing questions used more spontaneous exploratory when interacting with the activities. Lacking: The study did not determine the exact extent of the independent variables such as probing questions, specific activities and cooperative learning

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Table A1 (continued)

Author	Study focus	SampleDuration	MethodologyInstrumentsAssessment measures	Key Findings
Goddu and Gopnik (2020).	One study used a PowerPoint animated presentation adapted to assert if the participants' ability to reason and judge which variable is causally relevant.	Experiment 1: 24 children ages 3 and 24 children ages 4 Experiment 2: 22 children ages 4 and 26 children age five Experiment 3 20 children ages 3 and 20 children ages 4	Experimental study Study 1. A novel task where children observe evidence before selecting a novel variable. Participants so a brief PowerPoint animated presentation about a turtle character. They were then shown a sequence of causal events where the experimenter asked the children questions.	37 out of 48 children could infer which variable would create the desired outcome. These results concur with previous studies of causal reasoning. 38 of the 48 children inferred that the novel value of the previously relevant causal variable continued to be relevant. groups. The study argues that children's future preference (I will like X when I am an adult) conflicts with present vs. future desires. In contrast, children could identify ownership (I will have a car when I am an adult). The researchers argue that when children prefer or like an object, this is affective. In comparison, ownership is not effective and therefore less cognitively demanding. Hence, it was suggested that it is easier for children to anticipate what they will have as an adult vs. what they will like as an adult.
Goulding, Atance and Friedman (2019)	Explore age-related changes in future orientated cognition by comparing children's inferences about their future preferences with judgments about their future ownership	120 preschool children age 3–5	Experimental study Children were tested in one of two between subject conditions, ownership or preference. Tables are used to show results and demonstrate children's responses to the questions. Study 1 (N=120) 3–5-year-olds Study2 (N=123) 3–5 year-olds Children select child objects when asked what they would like in the future (Sippy cup). Children selected adult objects when asked about future ownership (Wallet).	Applying concept maps in the last year of kindergarten could foster children's understanding of connections and casualties through visual expression. The paper suggests that children from low SES homes need support to minimise their level of academic disadvantage. By talking about philosophical enquiry with children and explaining how the concepts support language and cognitive skills through formulating questions, children were able to understand the methodology. Strategies identified as positively impacting problem-solving skills were: 1. Modelling, 2. Mindful language. Modelling, the teachers' use of language played an integral part in supporting a child's problem-solving skills.
Habok (2015).	Apply project methods and enquiry-based methods that contain complex tasks focusing on interdisciplinary issues, with the support of concept mapping	2 Kindergartens Children in their last year of kindergarten Experimental group (N = 27) Control group (N = 27) Seven months	Experimental design Pre- and post-tests The developmental program was a step-by-step teacher-orientated project based on children's active learning.	Applying concept maps in the last year of kindergarten could foster children's understanding of connections and casualties through visual expression. The paper suggests that children from low SES homes need support to minimise their level of academic disadvantage. By talking about philosophical enquiry with children and explaining how the concepts support language and cognitive skills through formulating questions, children were able to understand the methodology. Strategies identified as positively impacting problem-solving skills were: 1. Modelling, 2. Mindful language. Modelling, the teachers' use of language played an integral part in supporting a child's problem-solving skills.
Karadag et al. (2017)	How do children's philosophical education sessions affect their critical thinking skills? Can a P4C scale help children identify if they understand the philosophy and can use it?	509 children ages five, six and 41 kindergarten educators	P4C materials aim to improve the skills and attitudes of critical thinking and to enhance the ability of children to engage in dialogue with their peers to solve a common problem	By talking about philosophical enquiry with children and explaining how the concepts support language and cognitive skills through formulating questions, children were able to understand the methodology. Strategies identified as positively impacting problem-solving skills were: 1. Modelling, 2. Mindful language. Modelling, the teachers' use of language played an integral part in supporting a child's problem-solving skills.
Kelley (2018).	Exploring the instructional approaches and strategies employed by a team of teachers to support preschool children's solutions to complex functional and social problems in the classroom	16 children ages 3–6 Diverse ethnic, language and socioeconomic backgrounds Two educators	A narrative study Classroom-based study Observations Field notes Teacher interviews Narrative design	Strategies identified as positively impacting problem-solving skills were: 1. Modelling, 2. Mindful language. Modelling, the teachers' use of language played an integral part in supporting a child's problem-solving skills.
Kirkland et al. (2015).	To determine the extent that a constructive curriculum emphasising logical thinking produces higher-level thinking in low socio-economic status (SES) preschool children TF Cognitive Learning Theory	66 children from 3 preschools Ages 3–5 And their teachers Urban area 5 months	Experimental design. Pre- and post-tests Both groups used a math curriculum. The experimental group had an additional 30 min per day of constructivist activities. The researchers used the child's performance on the classification test as evidence of a high level of logic	Results suggest in contrast to the math curriculum that teaches counting, finding and sorting skills, cognitive growth occurs when children engage in activities that encourage decision making and challenge their thinking.

Table A1 (continued)

Author	Study focus	SampleDuration	MethodologyInstrumentsAssessment measures	Key Findings
Köymen, Mammen and Tomasello (2016).	An investigation to discover if preschoolers alter the informativeness of their justification depending on common ground that they share with their partner TF Social Cognitive Theory Peer to peer interactions	74 preschool children age 3 and 74 children age 5	Experimental approach The study took place in pairs. Three conditions: 1. both children learned about a novel animal, 2. One child learned about the animal, 3. Both children learned separately (were not aware of their peers' knowledge) 3 sets of materials were used to assess children's justification reasoning Videotaped and transcriptions	In conditions where there was no shared learning, children assume their peers lack the knowledge. The study demonstrated that preschool children could use their shared ability to reason and make an argument 3-year-olds produced 30% warrants compared to the 5-year-olds who created 45% warrants in the trials. At age three, children were beginning to engage in reason-based justification.
León (2015)	To identify did different incidences of critical thinking and identified the instructional strategies teachers employed to develop critical thinking	98 children age 6–7 and 5 educators across 5 Preschool Classrooms in one school	Qualitative naturalistic research was recorded and transcribed. Data were coded, transcribed and analysed Data collection: Classroom observations Document analysis Teacher interviews	The study was based on interactions with educators; the children's input was not part of the study. Classroom interactions were found to support the development of critical thinking, including thinking language used by children and educators, and classroom practices with a logical and sequential pattern to support learning goals.
Marić and Sakac (2018).	To examine the relation between metacognitive components, declarative and procedural metacognitive knowledge and cognitive regulation	347 children age 3–6 from 9 preschools Group 1. Children age 3–4 ( $N = 114$ ). Group 2. Children age 4–5 ( $N = 117$ ). Group 3. Children age 5–6 ( $N = 116$ ) Two-year study	Descriptive analysis: Whitbread's Descriptive statistics Checklist for Independent Learning. Instrument: eight categories of problem-solving tasks Children's behaviours in different activities were assessed Participants individually resolved problems in a test room in their preschool Testing the hypothesis: 1. Checklist for independent learning, 2. Performance in problem-solving tasks, 3. SEM model	Results show general use of metacognitive words (e.g., idea, mind, think, thoughts) were used by 98% of the children during the problem situation. Children with high metacognitive abilities (understanding their thinking and self-regulation) were significantly better problem-solvers than their peers. The study suggests that by improving children's knowledge of cognition by teaching an understanding of how we think and supporting regulation of cognitive behaviours, educators can help children become skilled problem solvers.
Marić and Sakac (2020)	Metacognition in preschool children's indicators, developmental and socio-educational differences	416 preschool children. Age 3–4 ( $N = 139$ ), age 4–5 ( $N = 138$ ), and age 5–6 ( $N = 139$ )	Experimental design. The researchers and assistants created problem-solving situations. Tasks included: hidden pictures, classifying and sorting, and same and different, a task where children had to match similar objects.	Teaching children the importance of metacognition will improve their knowledge of cognition, their ability to regulate behaviours, and it will enhance the educational environment.
Nikiforidou (2017).	To explore children's own perspectives and perceptions of risky situations TF Psychosocial developmental theory	50 children age 5–6 from two nursery schools	An empirical study based on semi-structured interviews. Tools: were pairs of images and four questions per test. A choice and judgement methodology were implemented Children were tested in pairs	Out of 250 utterances, 81.2% were able to infer and predict future consequences. Preschoolers could assess the images correctly and demonstrate risk competence. Children age 5 had the linguistic ability to express

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Table A1 (continued)

Author	Study focus	SampleDuration	MethodologyInstrumentsAssessment measures	Key Findings
Papadopoulos and Bisiri (2020).	Examining a pedagogical program aimed to develop critical thinking. The program is designed and implemented within the context of preschool education. Multimodal teaching and learning environment.	25 preschool children age 5 Seven months	Qualitative descriptive analysis Intervention program where a mini syllabus was designed Children's participation in creative games based on folk-stories, fairytales. Methods to evaluate the programme: 1. Journal of the researchers 2. Child portfolios	reason, cause, and consequence. Characteristics of critical thinking skills were identified as: 1. behaviours of analysing, 2. interpreting, and 3. evaluating information. Critical thinking was fostered during multicultural folk stories, fairytales and games the exposed the class to sensitivities that encouraged dialogue concerning customs, cultures, and traditions outside the immediate context.
Polat and Aydin (2020)	To analyse the effect of mind mapping studies that support critical thinking through philosophical enquiry TF Philosophical enquiry	116 preschool children from six preschool classes Age 4–6 Eight weeks	Qualitative research Experimental Design, comparison study of three groups. Descriptive data from Pretest and posttest, two experimental groups, one control group. Datasets were created by carrying out the coding required in the analysis of the data.	There was a significant increase in critical thinking skills with children aged 48–72 months who participated in mind-mapping through philosophical enquiry. Interestingly, the results in the large group compared to the smaller group were more significant.
Reed et al. (2015)	An investigation into how shared picture book storytelling within a peer-group setting could stimulate causal reasoning in young children	28 children age 4–6 were placed into three groups Three mainstream primary schools (Dutch preschool is organised within separate classrooms in primary schools) Two weeks	Procedure: Two-week storytelling intervention Six Storytelling Groups Children's utterances during shared storytelling were analysed for narrative an interaction of functions Children were tested on cognitive functioning and causal reasoning	The study explored discourse during undirected shared picturebook storytelling within a peer-group setting. Children in the most improved group engaged in critical thinking by constructing ideas together and offered justification for their individual statements or shared understanding.
Säre et al. (2016)	to design an instrument for five and six-year-old children to help measure their verbal reasoning skills and assess the validity and reliability of the resulting instrument	Estonian-speaking children from one kindergarten Group 1. 24 children age 5–6 Group 2. 129 children age 5–6	Mixed Methods, part of a longitudinal study - 1567 questions and 1119 verbal reasons were analysed. The researchers designed the Younger Children Verbal Reasoning Test (YCVR-test) and a control instrument. The instrument was evaluated using the person correlation coefficient and Cronbach's alpha measure Twenty philosophical group discussions resulted in: 1. Open-ended questions (45.64%), 2. Closed-ended questions (30.5%), 3. Off discussions questions (23.86). Thematic coding for internal consistency	The instrument used to test the reliability of the YVCR-test showed a high level of reliability between scores. Findings indicate that the YVCR-test is a reliable tool to assess children's verbal reasoning. However, the test did not produce scientific language. It was suggested that this develops at a later age.
Säre et al. (2019).	To identify what researchers' questions preschool children respond to with verbal reasoning during philosophical group discussions TF Philosophy for Children	58 children from two kindergartens	Qualitative and quantitative experimental design The quantitative enabled an overview of the different types of questions asked. The qualitative data provides a holistic view of findings. Researchers designed a verbal reasoning test and an assessment tool to check the validity of the design	Closed questions were rated higher than that of earlier studies. Results suggest that integrating different types of questioning has a more significant impact on verbal reasoning than only using one questioning strategy.
Shiu, Wang and Chen (2020).	To draw on that area by Vygotsky and examine activities that could fit into the class schedule without substantially changing the	94 kindergarten children age From 4 kindergartens Over 12 weeks	Quasi-experimental design Treatment and control group The intervention consisted of two mediators 1. included charge songs and storytelling children who wanted to tell a story to peers needed to	There was a significant difference in self-regulation gains between the treatment group and the control group in the overall sample.

(continued on next page)

**Table A1** (continued)

Author	Study focus	SampleDuration	MethodologyInstrumentsAssessment measures	Key Findings
	basic curriculum and would require minimal training for implementation.		make a reservation one week in advance and prepared their story. 2. Activities were seven circle time games, including Showing Gun Game: Red Light, Green Light: falling, falling down. Some activities were more accessible to implement than others.	The researcher observed both children's and educators' interactions during the intervention.
Bilir Seyhan et al. (2019).	To examine the effects of Promoting Alternative Thinking Strategies (PATHS) on children's social, emotional competency perceived relationship between teacher and child	285 children age 4–6 and 21 classroom teachers from four preschools February to April	Implementation of PATHS Instruments: classroom atmosphere rating scale, teaching style rating scale, head start competency scale, student-teacher relationship scale, semi-structured play interview. Children were assessed during an interview to evaluate their skills and emotional regulation.	There were significant improvements in the classroom atmosphere; children in the intervention group had better behaviour, communication and problem-solving skills. Results found that the combination of storytelling and drama positively impacted children's attainment of complex topics.
Walan and Enochsson (2019)	To explore the outcome of using a model that combines storytelling with drama to teach young children science education	Two preschools One primary school. 25 children age 4–8	Case study approach, data collection and analysis: Storytelling and related drawings Semi-structures Interview questions Drawings to help children recall the stories. Interviews were recorded, transcribed and inductively analysed.	It was recommended further investigation is needed in the area of storytelling and drama
Pantaleo (2017).	What elements of young children's exploration of picturebook artwork affect comprehension and critical thinking?	Children age 6–7 One elementary school Low-middle class October 2015 until May 2016	Classroom-based research Two days a week for 80 min The children were asked to experiment and explore different elements of thought concerning the picturebooks and story plot	This study looked at children aged 6–7. However, it was included because it highlights that some children do not enjoy 'thinking on paper (writing). Children need to be offered alternatives ways to engage in thinking other than enquiry-based questioning methods and the standardised curriculum.

**Appendix B**

Table B1.

**Table B1**  
Pedagogical approach/discipline.

Language/Arts	Science
Interviews with children exploring problem solving abilities	I can problem solve Program to test perspective-taking skills
Story-based using high and low cognitive demand questioning;	Games followed by questions to test children's iterative reasoning
enquiry-based dyadic method during science to prompt thinking	PowerPoint animated character and questioning techniques to test causal reasoning
enquiry-based method using concept maps to support causalities through visual expression	Questions to test children's inferences and judgements concerning future preference
Supporting cognitive and language development through philosophical enquiry	Encouraging decision making and problem solving helps children to think logically
Supporting thinking by modelling mindful language and supporting children's problem solving	Testing reason and justification during shared learning. Three conditions, 1) a novel animal, 2) one child learns separately, 3) both children learn the same.
Naturalistic observations: Classroom interactions with a focus nurturing thinking classrooms	Checklist for independent learning and eight problem solving categories used to examine metacognitive knowledge
Semi-structured interviews using pairs of images to explore children's risk based judgements	Problem solving situations using sorting games, hidden pictures, matching objects
Pedagogical program using a mini syllabus designed to develop critical thinking.	Young Children's Verbal Reasoning Test (YCVR-test) to measure verbal reasoning skills using twenty philosophical sessions
Mind mapping for critical thinking through philosophical enquiry	Exploring what questions generate verbal reasoning
Storytelling intervention using undirected peer-group shared picturebook discourse to stimulate causal reasoning	

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