



Review Article

Literature review – Parent involvement and mathematic outcome

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ABSTRACT

The impact of parent involvement with their children's educational outcomes can have a profound effect on learning, achievement, motivation, engagement, values, and goals. This literature review is the first to focus on parental involvement and educational outcomes in the subject of mathematics. Search engines identified 1397 articles from 2010 to 2019. In the wake of the inclusion and exclusion process, 169 articles (n-group) related to children aged from 6 to 16 years were selected for review. As a result, an extensive range of indicators associated with parent involvement was identified and linked to 37 different outcomes for children studying mathematics. Framed by a structured coding analysis, the parent involvement indicators were classified into 12 new categories and discussed in the context of established theories. Finally, the outcome indicators were coded in the following categories: Learning, Belief, Motivation, Emotion, and Behaviour. The analysis uncovered 403 indicator connections linking children's mathematic outcomes to parental involvement. A predominance of the research focused on parents' different beliefs, motivations, communication, and support. Many of the parent involvement indicators were related to the children's mathematical achievement, performance, and skills. An effects matrix revealed that a majority of indicators showed positive effects. Nevertheless, a positive generalisation about parental involvement has the potential to erroneously hide negative aspects. Further research is needed to ensure consistency and unambiguous operationalisation of parental involvement, while also covering blind spots in the research field documented in the review. Finally, this review contributes to a further discussion outside the mathematics context with respect to the parent involvement concept and the need for increased research quality and scientific rigour.

1. Introduction

Mathematics has evolved to become an obvious component of most basic education curricula, as well as most parts of work and everyday life. Many children and young people, despite ongoing pedagogical efforts by teachers, school leaders, and policymakers, face educational and subsequent psychological and social challenges as in example mathematical anxiety with the level and diversity of mathematic outcomes they are expected to acquire (Dowker, Sarkar, & Looi, 2016; Hembree, 1990). Children learn mathematics with different motivations and levels of achievement, and they establish different attitudes and an affinity towards mathematics. In further education and work, they choose to affiliate themselves with and be involved in mathematics to varying degrees. On the other hand, children's home environment and the influence from parents' involvement has been considered a relevant factor in their education for many decades, including mathematics (Blevins-Knabe, 2016; Wolfendale & Morgan, 1992). Since parents involve and collaborate in their children's basic education and mathematic learning and development with varying quantity and quality, it is

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necessary to provide, develop, and disseminate knowledge about the influence of parental involvement concerning children's outcomes in mathematics. The volume of this research has significantly increased in the last several decades. This literature review covers a research gap as it is deriving a set of indicators for both parental involvement and children's and young people's mathematical outcomes, emphasising the nature and the connections between the indicators.

The literature review identifies and compiles research articles from the last decade operationalising indicators of parental involvement and mathematic outcomes, while also suggesting categories for indicators of the connections between the two concepts. The purpose of this review is to answer the following research questions:

1. How does research literature related to children's mathematic outcomes operationalise parental involvement using indicators, and how can these indicators be categorised?
2. What indicators of children's mathematic outcomes are identified in published research on parental involvement, and what can be considered as focus areas for mathematic outcomes in research?
3. What connections and effects are found between parental involvement and children's mathematic outcomes, and what connections are emphasised or omitted?

These questions require a review of relevant literature and theories to create a research background and understanding of parental involvement and mathematic outcomes.

2. Literature

This review begins with a brief historical and theoretical background for the parental involvement concept to frame the presentation of previous literature. Theory-based research literature that provides definitions and operationalisations is highlighted for the first research questions to clarify the development trait and updated state of parental involvement as a research field. Mathematic outcomes are not an entrenched or controversial concept. Nevertheless, for the second research question and by framing other debatable concepts, it is clarified to create a common understanding. Finally, the emphasis on previous research results of connections between parental involvement and children's mathematic outcomes act as a springboard for the last research questions and constitute a justification for a literature review to bring these two concepts together, namely parental involvement and mathematic outcomes.

2.1. History and theory

Parental involvement research and literature have been evolving since the 1960s. "Social learning and personality development" (Bandura & Walters, 1963) and "Early learning in the home" (Bloom, 1965) are generally considered as forerunners and awakers in the field. Around the same time, "Equality of educational opportunity" (Cooper, 1998), known as "The Coleman Report", claimed that the child's home conditions, parents, and socio-economic status have greater significance for learning than all school-related variables. During the first decades of the 1960s, literature related to parental involvement developed from these two main theoretical approaches that emphasised parenthood and parenting. A growing body of research literature has roots in theories about parenthood, with different forms of social and family capital (Bourdieu, 1986; Coleman, 1991) emphasising the parents' role and their positional and relational potential towards their children. "Social Learning Theory" (Bandura (1977) and "Ecological Systems Theory" (Bronfenbrenner, 1979) were developed as theories with potential as frameworks for parenting and the parents' interaction and action with their children. Bronfenbrenner describes influence from and relationships with those who are close to the individual as a microsystem, while interaction and connections between different microsystems constitute a mesosystem.

Entering the research field of parental involvement, Gordon's Impact Models (Gordon, 1979) and Epstein's Theory of Family-School Connections (Epstein, 1986) lay important foundations. Gordon differentiates the origins of the impact by describing the Parent Impact Model, School Impact Model, and Community Impact Model, which elaborates various microsystems from Bronfenbrenner. Epstein's focus on cooperation and connections between the child's home, school, and society is more closely related to Bronfenbrenner's mesosystem, and the research and literature on children's educational outcomes relating to the home, family, parents, community, and society have developed in two directions from this background, which can be labelled the *parent involvement direction* and the *school partnership direction*. The latter has developed as a continuation of parental involvement literature (Epstein et al., 2002) and emphasizes the relationship and collaboration between school, family, and community for the children's educational outcome. The parent involvement direction has a narrower focus on the parents' involvement, role, significance, and influence in children's educational outcome and is thus centred around a particular relationship at the microlevel. From the sociological perspective, a third direction of the parent involvement discipline is extended as theories related to expectancy-value (Eccles et al., 1983; Parsons, Adler, & Kaczala, 1982, Wigfield & Eccles, 2002) and control-value (Pekrun, Frenzel, Goetz, & Perry, 2007) have served as frameworks for research emphasising parentally influence on children's achievement by their attitudes, values, expectations, and beliefs. The title, research questions, and terminology used in this review are focused on how parents are involved with children's mathematic outcomes.

2.2. Parent involvement inconsistency

In literature regarding parental involvement, an inconsistency is repeatedly identified. An overwhelming majority of studies have asserted the positive influence of parental involvement on children and young people's educational outcomes (Cole, 2017; Wilder,

2014), including mathematics learning outcomes (Civil, Bernier, & Quintos, 2003; Wilder, 2017). At the same time, an unambiguous definition of parental involvement has yet to be established in the literature (Ho, 1995; Salwiesz, 2015). Baker and Soden (1997) presented a comprehensive critical review of literature in general and of thirty earlier reviews from 1973 to 1993. The research field then had the potential for improvement in rigorosity, including, among other things, connections between variables and unambiguity in definitions. Decades later, the field of research still seems to lack conceptual agreement and scientific rigour (Fan & Chen, 2001; Wilder, 2014) as methodological challenges related to inconsistent operational definitions are discussed, as well as the reliance on non-objective measures. Simply stated, the effects of parental involvement are generally positive, though the literature is not entirely certain or unified on the definition of parent involvement. It is described as a complex construction (Hoover-Dempsey & Jones, 1997; Kohl, Lengua, & McMahon, 2000), and the concept is operationalised and measured more than it is actually defined. Some of the research has also been criticised (Mattingly, Prislín, McKenzie, Rodriguez, & Kayzar, 2002) for using simple, one-sided, or insufficient collections of indicators or variables to measure parental involvement without seeking out or contributing to a uniform conceptualisation of the phenomenon.

The term *parent* or *parental* is a designation of the position and role of a responsible guardian, provider, and/or caregiver vis-à-vis a child. However, the term *involvement* is interpreted and defined in different ways, and dictionaries (Cambridge Dictionary, 2020; Oxford English Dictionary, 2020) convey a multitude of explanations. In short, involvement can emphasise meaning in the direction of participation in an action, instance, or situation, though it can also be a state of active or passive integrated, included, or engaged physical or mental presence or relationship with other human beings. This may have led to the variety of definitions and operationalisations of parental involvement (Georgiou, 1997). Several dichotomies have been employed to describe parental involvement, such as behaviour and practical involvement (Fan & Chen, 2001), unidimensional and multidimensional involvement (Turney & Kao, 2009; Wong & Hughes, 2006), or as a continuum range from low or non-existing to very active involvement (Georgiou, 1997). Grolnick and Slowiaczek (1994) emphasised that parental involvement is regarded as threefold, including behaviour, cognitive-intellectual, and personal involvement, and is described as the parents' resources for the child. LaRocque, Kleiman, and Darling (2011) described parental involvement as the parent's investment in their child's education. The most widely used and prominent description that has persisted as a basic distinction in both research and literature is the distinction between school involvement and home involvement (Eccles & Harold, 1996; Epstein, 1987), based on the child's main locations for education and everyday life. For example, home-based involvement may include parents helping with homework or the reading and arithmetic activities with the child, while school-based involvement may include attending parent-teacher meetings and communicating with a teacher. Hoover-Dempsey and Sandler (1997) included this dichotomy and define parental involvement as the parents' activities at home and school related to the child's learning. Since the 1990s, the six types of parental involvement from Epstein (1995) have become the most widely recognised and used operationalising, and it has also been used in mathematics-related research (Sheldon & Epstein, 2005; Sheldon, Epstein, & Galindo, 2010). A distinction was then made among *parenting*, *communication*, *volunteering*, *learning at home*, *decision making*, and *collaborating with the community*.

Regarding definitions and relating to some key approaches and operationalisation of the concept (Epstein, 1987, 1996; Henderson & Mapp, 2002; Sheldon & Epstein, 2005), Jeynes (2007) defined parental involvement as "participation of significant caregivers in the educational processes and experiences of their children" (p. 83). The term participation has been used by others (Wolfendale, 1983) and is continued and discussed more recently in the literature (Salwiesz, 2015). The terms of active and passive participation (Castro et al., 2015), developed and expanded the definition to include more than activities and actions, and Ho (1995) described involvement as a process of parents' potential to provide active or passive help to their children, both at home and at school. Similar distinctions have been made between direct and indirect parental involvement (Salwiesz, 2015), and in a mathematic context, overt and subtle parental involvement (Roberts, 2013). Based on the operationalisations and definitions mentioned, a new definition provides a conceptual understanding for the research questions and selection of indicators. Based on the literature reviewed, and for the purposes of this research, parental involvement is defined as any active or passive physical, social, cognitive, or emotional presence or action that has an impact on children's educational outcomes, and in this context, mathematic outcomes.

2.3. Children's mathematic outcome

The use of the word "outcome" as a result or effect of an action or situation is inspired by previously conducted reviews (Desforges & Abouchaar, 2003) and is related to learning and educational outcome. The term "mathematic outcome" is chosen to indicate a broad understanding where parental involvement can impact all aspects of a child's position and relationship to mathematics and numeracy. Children learn and have expectations for achievement in mathematics, acquire knowledge and develop mathematic skills, experience self-confidence and self-belief in mathematics tests, act with joy and motivation facing mathematics issues, value success in mathematics problems, and choose studies and professions with mathematical content. Unfortunately, the reality confirms that all these parameters can also be described negatively. For this review, a "mathematic outcome" is defined as that which a child gets, develops, or achieves in mathematics as an outcome of learning, beliefs, motivations, emotions, and/or behaviour. The *learning* outcome incorporates typical educational descriptive concepts as achievement, competence, performance, and skills and is self-written in an educational context. *Beliefs*, *motivations*, and *emotions* are a continuation of Hannula's dimensions of mathematics-related affects as explanatory factors of learning and behaviour (Hannula, 2012), which can be seen as a further developed and alternative model of frameworks by McLeod (1992) and Op't Eynde, De Corte, and Verschaffel (2006) work. *Belief* deals with thoughts and information of self and the environment while *motivation* gives direction for decision making and behaviour. *Emotions* reflect affective expressions as feelings following the cognitive and motivational processes (Hannula, 2012). The last term, *behaviour*, incorporates practical actions and choices the child has made related to mathematics, such as perseverance and choice of studies.

2.4. Previous research

Half a century ago [McDill, Rigsby, and Meyers \(1969\)](#) highlighted parental involvement and commitment to children's learning and school activity as a source of educational environment that could generate an effect on children's mathematics achievement. Two decades later [Shaver and Walls \(1998\)](#) asserted that parental influence is a dynamic force regardless of children's gender and socio-economic background, affecting both children's mathematics achievement and application of mathematical concepts. During these initial decades, the link between parental involvement and mathematics outcomes was primarily through research on academic achievement and the children's mathematics achievement was often an essential part of the data material. A large volume of literature has over previous decades described how parental involvement relates, predicts, or mediates impact on children's academic achievement ([Coleman, 1991](#); [Henderson, 1987](#); [Mayeske, 1967](#)). Several literature reviews ([Boonk, Gijsselaers, Ritzen, & Brand-Gruwel, 2018](#); [Desforges & Abouchaar, 2003](#)) and meta-analyses ([Castro et al., 2015](#); [Erion, 2006](#); [Fan & Chen, 2001](#); [Hill & Tyson, 2009](#); [Jeynes, 2003, 2005, 2007, 2012](#); [Kim & Hill, 2015](#); [Milner-Bolotin & Marotto, 2018](#); [Patall, Cooper, & Robinson, 2008](#); [Sénéchal & Young, 2008](#)) have emphasised the impact of parents' involvement on children's achievement, in a total of 484 studies with an overall sample of more than 1.6 million children. A meta-synthesis by [Wilder \(2014\)](#) summarised nine of the meta-analyses and gives a picture of an overall positive relationship between parental involvement and academic achievement, regardless of the variation of definitions and measurements, and the effect is consistent across grade levels and ethnicity. A large volume of this research is relevant in the context of mathematics: In the latest review on parent involvement indicators and children's academic achievement ([Boonk et al., 2018](#)), 59 of 75 reviewed articles used the children's mathematics achievement to measure academic achievement. Similar figures have been demonstrated by the latest meta-analysis of [Castro et al. \(2015\)](#) on the same subject in which 22 out of 37 studies measured academic achievement through mathematics, among other criteria. This reinforces the impression that it is important to present this research literature as part of the working knowledge base.

Upon closer examination of categories and indicators related to parental involvement, parents' positive expectations and aspirations have been reported as the strongest and most influential factor affecting children's mathematics achievement, and these results have been repeated as important for academic achievement from the 1970s ([Becher, 1984](#); [Fan & Chen, 2001](#)). Moreover, the encouragement for learning mathematics and the parent-child communication about school ([Jeynes, 2003, 2005](#); [Nye, Turner, & Schwartz, 2007](#)), increasing positive communication between home and school, support for learning, and positive marking of accomplishments from parents ([Ginsburg, Block, & McWayne, 2010](#)) have all been associated with positive mathematics outcomes for elementary school children. The positive aspects of parental involvement have led to several programs for parent participation in mathematics or numeracy ([Wolfendale & Morgan, 1992](#)). Nevertheless, research has also reported on the varying and even negative significance of parental involvement in homework and negative focused rules and control in the home ([Boonk et al., 2018](#); [Desforges & Abouchaar, 2003](#); [Hill & Tyson, 2009](#); [Patall et al., 2008](#); [Wilder, 2014](#)). This contrast confirms the problem with claiming parental involvement is positive for academic achievement and also mathematics achievement when there are some individual indicators of parent involvement that suggest differently. A precise definition and operationalisation of the parent involvement concept are needed when it is to be used.

From the turn of the millennium, the amount of research on parental involvement and mathematics educational issues increased ([Civil et al., 2003](#)) and evolved from measuring children's mathematics achievement to incorporating a greater breadth of mathematics outcomes. The parental influence on children's mathematics anxiety ([Ashcraft, 2002](#)) is one of many subjects that is thematised to a greater extent in research. Together with the described positive potential of parental involvement, this is the underlying motive and justification for this literature review summarising the research literature of the last decade. It would be an important and helpful contribution to the interpretation of the existing knowledge in the field and make it accessible and transferable to educators, policymakers, and researchers. This can contribute to further changes in structures, plans, and practice to boost the quality of parental involvement and ultimately, children's outcomes in mathematics.

3. Method

This review article is constructed as a traditional literature review following recognised literature ([Cooper, 1998](#); [Creswell & Creswell, 2018](#); [Dellinger, 2005](#); [Galvan & Galvan, 2017](#); [Gliner, Morgan, & Leech, 2016](#)). The review has similarities with scoping reviews ([Arksey & O'Malley, 2005](#); [Levac, Colquhoun, & O'Brien, 2010](#); [Munn et al., 2018](#)) in terms of aiming to clarify definitions and conceptual boundaries of the topic and the field, identify categories, and present tabular and quantified synthesis and data extraction and coding through inductive data charting ([Grant & Booth, 2009](#)). The Coding Manual of [Saldaña \(2021\)](#) with interpretation and elaboration for literature review of [Onwuegbuzie, Frels, and Hwang \(2016\)](#) constitute the coding approach for the data collection and a methodological framework for the results and analysis section. [Saldaña \(2021\)](#) describes coding methods for the main phases of data collection and analysis. For the review, the following combinations of methods have been used:

- Phase 1 of data collection coding: Structural, Magnitude and Motif Coding – a numerical coding of variables in the reviewed articles to identify the presence and repetitions of indicators for parental involvement and mathematics outcomes.
- Phase 2 of data analysis coding: Pattern, Protocol and Focus Coding – a content-coding by analysing commonalities and similarities for synthesising and grouping in new or a priori categories and register frequency to identify prominent focus points and connections.

Many of the indicators of parental involvement and mathematics outcomes are concepts with multiple interpretations and

overlapping meanings, and the diversity of reality in social science makes it impossible to neatly code in separate or hierarchical categories. At the same time, structuring is appropriate and relevant to create meaning by identifying commonalities, similarities, and connections. The large number of reviewed articles require quantification of selected elements to make a structure, and consequently, parts of the result and analyses are presented in tables.

3.1. Literature search

This review is based on searches (Appendix A) in Eric April 2020 according to search engine guidance of library professionals and piloting of words and combinations for wide possible range and percentage of relevant research articles on the selected criteria. Supplemented identical title searches were performed in *PsycInfo* and *Web of Science* to ensure access to literature related to mathematics education, social science, sociology, and psychology. Linguistic variations of the keywords *mathematic* and *numeracy* combined with *parent*, *family*, *mother*, *father*, and *home* were used (Appendix A). The third group of relevant words was considered in the search combinations with words such as *involvement*, *engagement*, *influence*, *support*, and *impact*. However, the piloting then revealed a smaller range search without a significantly higher percentage of research articles on the selected criteria.

Appendix A, Appendix B, and Fig. 1 enables verifiability and transparency in the search selection and the inclusion and exclusion process. The original searches yielded 1563 articles, and after removing 166 duplicates, the content and framework conditions of the articles (N = 1397) were set against the criteria for inclusion and exclusion.

3.2. Demarcation of field

The reviews' delimitation with inclusion and exclusion criteria is an integrated necessity to refine and clarify the scope of any review, though, at the same time, it constitutes permanent limitations. Three significant demarcations of the field constitute relevant contexts in terms of content and size. First, research pertaining to parental involvement and children's general educational outcomes without a discussion of mathematic outcomes were excluded. However, a significant part of this research measures children's educational outcomes through different forms of mathematic outcomes (Boonk et al., 2018), and thus constitutes a partially coincident research field. Second, articles about *homework* without the parent involvement aspect were excluded. Nonetheless, homework normally constitutes an important and natural area for parental involvement in the home, and research on homework thus constitutes a partially overlapping, relevant, and important field of research. Third, articles about children's and parents' *socio-economic status (SES)* were excluded if the parent involvement aspect was not discussed. It is not unambiguously correct to exclude all variables indicating SES, even in the definition of parental involvement. For example, parents make active or inactive choices related to education, occupations, place of residence, residential stability, use and consumption of physical and social capital, the number of children, and acceptance for leisure activities or lack thereof (Won & Han, 2010), and school enrolment year (Ünal, 2019). Research shows that such

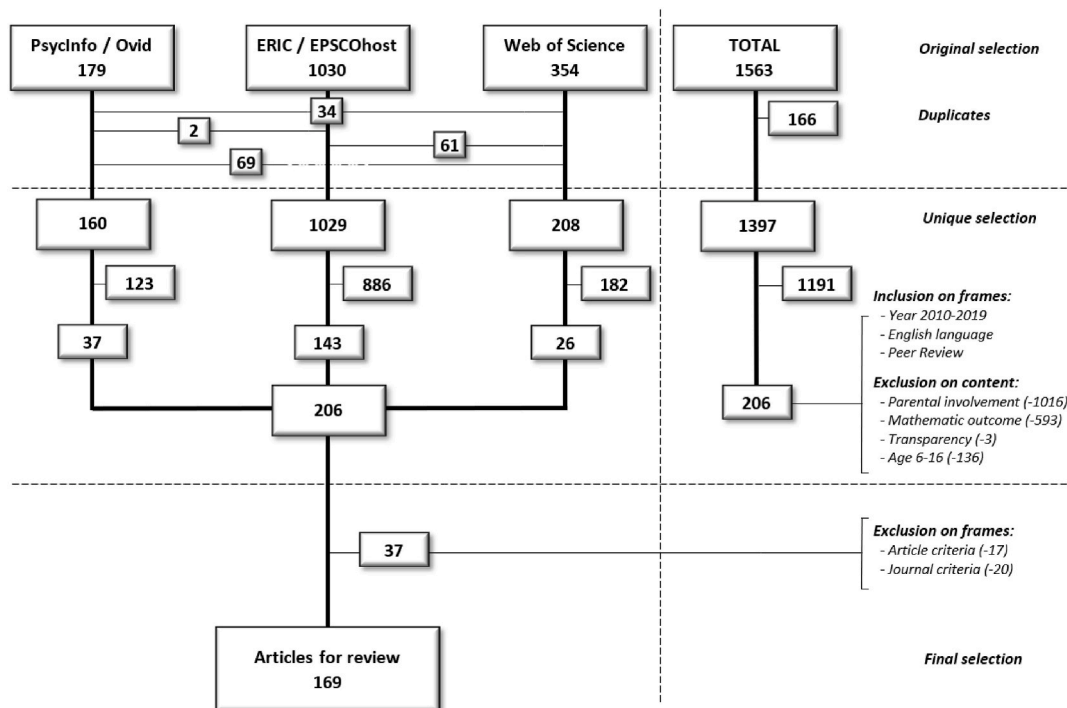


Fig. 1. Article selection process.

variables affect children's outcomes in mathematics (Dearing et al., 2012; Hancock, Lawrence, Shepherd, Mitrou, & Zubrick, 2017) and could be described as parental involvement. The totality of research related to parental involvement and mathematic outcomes can be found in the embrace of these fields, while in this review, priority has been given to a naturally delimited sample that to a greater extent brings out the diversity and distinctive features on research exclusively dealing with research connecting parental involvement and mathematic outcome.

3.3. Inclusion and exclusion

The basic searches in the engines included peer-reviewed English journal articles from 2010 to 2019. The language choice constitutes an adequate and available selection, and the year limitation has been justified to provide insight into the latest research literature and covers approximately half of the research in the field since its early beginning in the 1960s.

Inclusion based on content (Fig. 1) was conducted primarily by reading abstracts of the 1397 articles supported by a structural coding table that labelled and provided access to elements from the data material for the inclusion and exclusion process. Furthermore, a magnitude and numerical coding (Saldaña, 2021) of the articles as included (1) or excluded (0) was performed according to the following criteria: First, parental involvement and the mathematic outcome must be explicitly operationalised in one or more observable, defined, or measured indicators. In addition, the indicators must be related to each other, as connected variables or as mediating or predictable independent and dependent variables, respectively. Secondly, as described in Appendix B, the articles were excluded based on a lack of methodological transparency according to the content and size of the data material and the stated nationality and age (6–16 years) for the respondents, interpreted as basic education. These criteria were interpreted respectively *especially* and *not exclusively*, and two examples are given to illustrate: (1) the mathematic outcome could not just be part of the data material to meet the *especially* of the first criterium, it had to be part of the topic for the research question and discussion, and (2) second, the research could involve children from for example 3–9 years and thus be *not exclusively* to meet the second criterium for children aged 6–16 years.

Finally, the articles had to be journal research articles and published in a sufficiently recognised journal. The last exclusion criteria were based on double negative results on two claims: First, lack of presence or failure to be approved of national classification schemes for international journals for both Norway, Finland, and Denmark, and secondly, the lack of presence or registration in an international reputable journal ranking (SCImago, 2020). The 169 remaining articles (n-group) listed in Appendix B were included in the literature review and constitute the data material to be further presented and analysed.

4. Result

Through the motif coding (Saldaña, 2021) of indicators in operationalisations for parental involvement and mathematic outcomes, 79 and 37 indicators were identified, respectively, as listed with their frequency in Table 1. The data material confirms a large volume and diversity of indicators of parental involvement, and a predominance of research emphasising expectations, motivation, anxiety, beliefs, and values, in addition to home settings, activity, support, communication, and encouragement. On the other hand, the identification of mathematic outcome indicators confirms previous literature (Boonk et al., 2018; Wilder, 2014) with a marked dominance of achievement and similar concepts as performance, skills, and ability. Besides, a significant proportion of research is related to children's attitude, motivation, self-efficacy, and values related to mathematics, and for example, previous research on *anxiety* (Ashcraft, 2002) has been continued and developed.

A total of 169 articles in the review process required a balance between detailing and overview, and one consideration was addressed through the analysis: The reviewed articles are referred to exemplary and not exhaustive. The selection of examples is made to improve the reading experience required in the text and table presentations.

Table 1
Indicators of parental involvement and mathematic outcomes.

Parental Involvement Indicators	Mathematic Outcomes Indicators
ability (2), absence (2), activity (28), advising (2), anxiety (10), arousal (1), aspiration (4), assistance (5), attachment (2), attendance (2), attitude (12), availability (1), behaviour (1), belief (24), cohesion (1), communication (14), conference (1), control (8), conversation (1), directiveness (1), discussion (6), discipline (1), dispositions (1), education (3), encouragement (11), engagement (5), enrolment (4), environment (5), expectations (34), experiences (3) frequency (1), functioning (1), future identity (1), goal (7), help (8), home settings (12), numerical information (2), instruction (4), interaction (3), interest (4), learning (1), liking (4), math-focused (2), modelling (1), monitoring (5), motivation (18), nutrition (3), parenting (2), participation (3), peer networking (1), perception (1), practice (1), praise (2), presence (4), pressure (3), problems (1), program involvement (4), punishment (2), reading (5), academic reinforcement (1), responsiveness (1), rules (2), satisfaction (1), scaffolding (1), school contact (7), school changing (1), self-efficacy (2), stereotypes (2), stimulation (5), strictness (1), structure (4), supervision (3), support (36), teacher meetings (5), teaching (1), tutoring (6), value (22), view (1), warmth (4)	ability (6), achievement (168), anxiety (13), arousal (3), attainment (4), attendance (1), attitude (15), behaviour (6), belief (6), competence (2), confidence (3), emotion (1), engagement (4), enjoyment (2), expectations (5), failure (3), fluency (1), goal (6), growth (3), intentions (2), interest (7), learning (7), liking (2), motivation (16), perception (6), performance (31), persistence (8), positivity (2), practice (2), self-concept (8), self-efficacy (10), skills (20), studies (20), understanding (1), value (19), vulnerability (1), worry (1)

Note: Frequency in parentheses.

Table 2
Categories of parental involvement.

Categories	Keywords	Indicators of parental involvement	%
Parents math competence	<i>Competence</i>	Ability (1), numerical information (1), learning (1), math-focused (1), academic reinforcement (1)	2%
Parents math beliefs	<i>Belief</i>	Belief (4), dispositions (1), expectations (4), future identity (1), perception (1), self-efficacy (1), stereotypes (1), view (1)	17%
Parent math motivations	<i>Motivation</i>	Aspiration (1), goal (2), motivation (3), value (4)	13%
Parents math emotions	<i>Emotion</i>	Attitude (4), anxiety (2), arousal (1), interest (1), liking (1), satisfaction (1), warmth (1)	8%
Parents presence	<i>Presence</i>	Absence (1), attendance (1), availability (1), frequency (1), presence (1)	3%
Parents framing	<i>Framing</i>	Control (2), directiveness (2), discipline (1), monitoring (1), rules (1), structure (1)	5%
Parenting itself	<i>Parenting</i>	Attachment (1), behaviour (1), cohesion (1), functioning (1), modelling (1), nutrition (1), parenting (1), problems (1), punishment (1), scaffolding (1), strictness (1)	4%
Parents math activity	<i>Activity</i>	Activity (4), experiences (1), interaction (1), participation (1), practice (1), reading (2)	10%
Parent-child talking	<i>Talking</i>	Advising (1), communication (4), conversation (1), discussion (1), encouragement (3), praise (1)	9%
Parent math help	<i>Helping</i>	Assistance (2), engagement (2), help (2), instruction (1), pressure (1), responsiveness (1), stimulation (2), supervision (1), support (4), teaching (1)	17%
Parents educational choices	<i>Choosing</i>	Education (1), enrolment (1), environment (1), home settings (3), school changing (1), tutoring (2)	8%
Parents out-of-home activity	<i>Outing</i>	Conference (1), peer networking (1), program involvement (1), school contact (2), teacher meetings (1)	4%

Note: The numbers in parentheses are representative for the volume of the indicators in the data material: 1=<5 hits, 2=<10 hits, 3=<20 hits, 4 = 21 > hits.

4.1. Parental involvement

How does research literature related to children's mathematic outcomes operationalise parental involvement using indicators, and how can these indicators be categorised? Based on the operationalisations in the reviewed articles, a variety of indicators of parental involvement are presented in Table 1. In the second phase of pattern and focus coding (Saldaña, 2021), the indicators were reviewed to group concepts with nearly identical meanings as synonymous, and indicators with content-related similarities were grouped. Subsequently, prominent patterns and commonalities in the material were identified and coded to create and name overarching categories for the groups and the remaining individual indicators. This led to an overall operationalisation of parental involvement consisting of twelve categories with the keywords: *Competence*, *Belief*, *Motivation*, *Emotion*, *Presence*, *Framing*, *Parenting*, *Activity*, *Talking*, *Helping*, *Choosing*, and *Outing*. Some of the categories are discipline-specific to mathematics but can also be seen in general or in the context of another discipline. Table 2 presents the categories accompanying keywords, distribution and volume of included indicators, and percentage distribution of the research volume for each category.

The categories do not intend to simplify a complex reality, but instead, give language and create structures for interpretation and provide a justifying representation of the diversity of parental involvement. The categories for parents' *Belief*, *Motivation*, *Activity*, *Talking* and *Helping* appear with a somewhat larger volume. This confirms the development of diversity on what thoughts unfold in expectations, beliefs, motivations, and values behind parents' activity, communication, encouragement, and support towards their children and their mathematic outcome. In particular, a large volume of research on the subject of parents' expectations can be emphasised, which confirms previous research related to children's achievement in general (Wilder, 2014).

4.2. Mathematic outcome

What indicators of children's mathematic outcomes are identified in published research on parental involvement, and what can be considered as focus areas for mathematic outcomes in research? Based on the operationalisations in the reviewed articles, 37 indicators of mathematic outcomes are presented in Table 1. The indicators were subjected to protocol coding (Saldaña, 2021) as they were thematically grouped as previously described into a priori categories derived from the definition of mathematic outcomes with the keywords Learning, Belief, Motivation, Emotion, and Behaviour. Table 3 presents the categories accompanying the keywords, distribution and volume of associated indicators, and percentage distribution of the research volume for each category.

As for the indicators for parental involvement, it is necessary to emphasise the challenges associated with categorisation also for the mathematical outcome indicators. For example, concepts such as attitude, expectation, and value can be argued to belong to other categories or even alternative or overarching categories. Attitude is often defined as a way of thinking or feeling about something, and thus, has both cognitive and affective sides. Expectations can be said to be part of a belief structure and, like values, provide direction for behaviour and be regarded as a motivation. The coding chosen is nevertheless based on the relevant reviewed articles' predominant understanding and use of the terms. Divided into the given categories, the emphasis on achievement, performance, and skills is again confirmed (Boonk et al., 2018) in the *Learning* category. Nevertheless, we see a significant amount of research on children's cognitive and affective mathematic outcomes as the three middle categories represent 30% of the research volume. The literature has included an increasing amount of research on parental involvement related to children's anxiety, attitudes, values, and motivation for mathematics, and the volume of indicators for mathematic outcomes over the last decade reinforces the assertions from Civil et al. (2003) which suggests this is a growing research field.

Table 3
Mathematic outcome variables.

Categories	Keywords	Indicators of mathematic outcome	%
Children's math learning	<i>Learning</i>	Ability (2), achievement (4), attainment (1), competence (1), failure (1), fluency (1), growth (1), learning (2), performance (4), skills (4), understanding (1)	59%
Children's math beliefs	<i>Belief</i>	Belief (2), confidence (1), expectations (1), perception (2), self-concept (2), self-efficacy (2)	9%
Children's math motivations	<i>Motivation</i>	Goals (2), intentions (1), motivation (3), value (4)	10%
Children's math emotions	<i>Emotion</i>	Anxiety (3), arousal (1), attitude (3), emotions (1), enjoyment (1), interest (2), liking (1), positivity (1), vulnerability (1), worry (1)	11%
Children's math behaviour	<i>Behaviour</i>	Attendance (1), behaviour (1), engagement (1), persistence (2), practices (1), studies (4)	10%

Note: The numbers in parentheses are representative for the volume of the indicators in the data material: 1=<5 hits, 2=<10 hits, 3=<20 hits, 4 = 21> hits.

4.3. Connections and effects of indicators

What connections and effects are found between parental involvement and children's mathematic outcomes, and what connections are emphasised or omitted? The inclusion criterion on the connection between parental involvement and mathematical outcome opens for answering the last research questions. A structured focused coding process (Saldaña, 2021) identified 403 connections between the various indicators for parental involvement and mathematic outcomes in the 169 reviewed articles. To present the indicator connections in an appropriate way for analysis, they were grouped according to the 12 pattern-coded categories of parental involvement and the 5 a priori categories of mathematic outcomes. A detailed matrix with the specific indicators for all the connections is given in Appendix C, while Table 4 summarises the emphasised research areas and blind spots as the numbers of indicator connections are given for all category combinations.

The large volume of research related to children's mathematic achievement, performance, and skills in the *Learning* category is largely connected to indicators from the parent involvement categories *Belief*, *Activity*, *Helping*, and *Choosing*. Parents' positive expectations (An, Wang, & Yang, 2019; Bodovski & Durham, 2010; Sibley & Dearing, 2014) and beliefs (Gladstone, Hafner, Turci, Kneisler, & Muenks, 2018; Kiwanuka et al., 2017) can be related to children's mathematic achievement, and research on home reading and numeracy activities (Coley, Kruzik, & Votruba-Drzal, 2019; Kleemans, Peeters, Segers, & Verhoeven, 2012; Kleemans, Segers, & Verhoeven, 2018), cognitive stimulation (Powell, Son, File, & Froiland, 2012), and autonomy support (Sorariutta & Silvén, 2018) are connected to a child's mathematic skills. Moreover, it is clear that a considerable amount of research is being done on how children's motivations in the area of mathematics are affected by parents' motivations through, for example, parents' values (Areepattamanni et al., 2015; Gniewosz & Noack, 2012; Šimunovic, Reic Ercegovac, & Burušić, 2018) and goals (Jiang, Song, Lee, & Bong, 2014; Kim & Chung, 2012). Table 4 also reveals that over a third of potential links between the given categories of parental involvement and the mathematic outcome are almost untouched. For example, it could be relevant to look at the significance of how parents' absence, quantity, or quality of presence and attendance in learning processes in the home influences children's affections towards mathematics.

The reviewed articles have a mixture of quantitative and qualitative methodological approaches, and the diversity does not allow a meta-analytical approach with quantification of significance and effect. Nevertheless, an overview of parental involvement indicators' impact on the various indicators for children's different mathematical outcomes is provided. Table 5 shows the number of positive, neutral, and negative indicator links, all at the category level.

The overall picture shows a majority of indicators of parental involvement with a positive effect on children's mathematical outcomes. An unequivocally positive effect was found in research related to the connection between parents' and children's

Table 4
Parental involvement and mathematic outcome indicator connections.

		Children's Mathematic Outcome				
		<i>Learning</i>	<i>Belief</i>	<i>Motivation</i>	<i>Emotion</i>	<i>Behaviour</i>
Parental Involvement	<i>Competence</i>	7				1
	<i>Belief</i>	39	11	7	5	9
	<i>Motivation</i>	17	5	20	5	4
	<i>Emotion</i>	14	3	5	7	2
	<i>Presence</i>	9				1
	<i>Framing</i>	9	1	3	2	6
	<i>Parenting</i>	15		1		
	<i>Activity</i>	37	1		3	1
	<i>Talking</i>	16	5	3	7	5
	<i>Helping</i>	41	7	2	11	8
	<i>Choosing</i>	29				1
<i>Outing</i>	5	3	3	6	1	

Note: The numbers of indicator connections.

Table 5
Impact of indicator connections.

		Children's Mathematic Outcome					
		Learning	Belief	Motivation	Emotion	Behaviour	Sum
Parental Involvement	Competence	5/2/0				1/0/0	6/2/0
	Belief	34/2/3	4/1/0	3/0/0	3/0/2	4/0/0	48/3/5
	Motivation	12/4/1	9/0/2	22/2/0	3/0/2	8/0/1	54/6/6
	Emotion	11/1/2	3/0/0	5/0/0	1/3/3	2/0/0	22/4/5
	Presence	7/0/2				1/0/0	8/0/2
	Framing	3/2/4	0/0/1	2/0/1	1/0/1	4/1/1	10/3/8
	Parenting	10/1/4		1/0/0			11/1/4
	Activity	31/3/3	1/0/0		2/1/0	1/0/0	35/4/3
	Talking	14/1/1	2/2/1	2/1/0	7/0/0	4/0/1	29/4/3
	Helping	30/5/6	6/0/1	2/0/0	8/2/1	8/0/0	54/7/8
	Choosing	24/3/2				0/0/1	24/3/3
	Outing	5/0/0	2/0/1	1/0/2	2/4/0	1/0/0	11/4/3
	Sum	186/24/28	27/3/6	38/3/3	27/10/9	34/1/4	312/41/50

Note: Respectively positive/neutral/negative. Neutral links represent research results where the effect has not been assessed or the significance of cause-effect has not been sufficiently demonstrated.

expectations and beliefs (Fernandez-Garcia, Torio-Lopez, Garcia-Perez, & Inda-Caro, 2019; Gladstone et al., 2018; Pesu, Aunola, Viljaranta, & Nurmi, 2016; Tomasetto, Mirisola, Galdi, & Cadinu, 2015) and motivations (Areepattamannil et al., 2015; Gniewosz & Noack, 2012; Häfner et al., 2017; Kim & Chung, 2012; Kim, Schallert, & Kim, 2010; Šimunovic et al., 2018) for mathematics. Other specific examples include the positive effect of parental involvement promoting early childhood reading and mathematics activities (Benavides-Varela et al., 2016; Berkowitz et al., 2015; Caro, 2018; Clerkin & Gilligan, 2018; Coley et al., 2019; Goforth, Noltemeyer, Patton, Bush, & Bergen, 2014; Hart, Ganley, & Purpura, 2016; Kleemans et al., 2012; Kleemans, Segers, & Verhoeven, 2013; Shahaeian et al., 2018; Zhu & Chiu, 2019) and encouragement and communication with the adolescents about school and mathematics (Herges, Duffield, Martin, & Wageman, 2017; Howard, Howard, Busse, & Hunt, 2019; Hyde et al., 2017; Mahuro & Hungi, 2016; McNeal, 2014; Mireles-Rios & Romo, 2010; Mujtaba and Reiss, 2016a; Sahin, Ekmekci, & Waxman, 2018).

Some indicators describe negative consequences of parental involvement: Parents negative control (An et al., 2019; Dinkelmann & Buff, 2016; Silinskas & Kikas, 2019), high degree of absence, different attachment styles (Gottfried, 2013; Hancock et al., 2017; McCormick, O'Connor, & Barnes, 2016), directiveness and punishment (Le & Nguyen, 2019; Leyva, Tamis-LeMonda, & Yoshikawa, 2019), and confirmation of challenges connected to help, assistance and pressure related to homework (Carmichael & MacDonald, 2016; Levpuscek, Zupancic, & Socan, 2013; Rivera & Waxman, 2011; Rodriguez et al., 2017; Silinskas et al., 2015; Töeväli & Kikas, 2017). Besides, research related to anxiety is visible in the column *Emotions*, where several studies demonstrate the positive correlation between parent anxiety and children's anxiety facing mathematics (Daches Cohen & Rubinsten, 2017; Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015; Soni & Kumari, 2017).

5. Discussion

5.1. Framing categories

The challenges with the definitions (Salwiesz, 2015) and operationalisations (Fan & Chen, 2001; Wilder, 2014) of parental involvement invite to discuss the developed parent involvement categories. Based on the framework of Epstein et al. (2002), challenges and a marked bias in coding are found for all the indicators. Four of Epstein's six categories fall under school-based involvement: *Communication*, *Volunteering*, *Decision making*, and *Collaborating with community*. All these categories belong to the twelfth category *Outing*, as *Parents out-of-home activity*, and represent a marginal part of the data material and identified indicators of parental involvement for the last decade revealed in this review. *Parenting* and *Learning at home* are the last two categories of Epstein and represent home-based involvement. It can be argued with broad definitions of these two categories, though out of respect for the amount and diversity of indicators, it appears that neither Epstein's six categories nor the geographical split of school and home involvement provide a justified representation of the identified parent involvement indicators. In this way, the twelve categories can differentiate the indicators for parental involvement to a greater extent, as well as acknowledge the home's position for parental involvement and the level of these types of involvement.

With the historical roots (Bandura, 1977; Bourdieu, 1986; Coleman, 1991) and theoretical approaches from the microsystem of the "Ecological System Theory" (Bronfenbrenner (1979), a further coding of analytical approaches suggests a new level of pattern coding with overarching categorisation to represent what parents are in parenthood, do parenting, and think parentally. The three divisions indicate the emphasis placed on different aspects of parental involvement, though notably, they should not be mentioned separately. For example, every parent's action is followed by unconscious or conscious thoughts and framed by multiple parenthood variables. Nevertheless, the threefold division among parents' being, doing, and thinking can bring an understanding of what parental involvement is by constituting an overall framework that incorporates various operationalisation and indicators of parental involvement. It can thus be suggested to interpret the first four categories as parental thinking (*Competence*, *Belief*, *Motivation*, *Emotion*), the middle three as parental being (*Presence*, *Framing*, *Parenting*), and the last five as parental doing (*Activity*, *Talking*, *Helping*, *Choosing*,

Table 6
Indicator connections in overarching categories.

		Children's Mathematic Outcome			Sum
		Learning	Affection	Behaviour	
Parental Involvement	Thinking	77	68	16	161
	Being	33	7	7	47
	Doing	128	51	16	195
	Sum	238	126	39	403

Note: The numbers of indicator connections.

Outing). Combined with a simplified overarching categorisation of the indicators for mathematic outcome grouping the *Belief*, *Motivation*, and *Emotion* as *Affection* Table 6 provide a picture of the variety of how the fields for research are covered.

Table 6 shows a significant amount of research on how parents' different actions in the *Doing* category affect children's learning outcomes, The lower volume of the middle parent involvement category *Being* can be seen in connection with a large volume of research on socio-economic status, also related to mathematics (Yildirim, 2019), but can also be interpreted as a somewhat less emphasised part of the research field. Definitions of parental involvement favouring terms like participation and activity can hardly incorporate less action-oriented indicators (Georgiou, 1997; Jeynes, 2007), nor do they invite research into the *Being* category. Both the threefold division between parents' being, doing, and thinking and the 12-part categorisation thus correspond with previous definitions to a greater extent, including passive (Ho, 1995) or subtle (Roberts, 2013) indicators of involvement. Also, there is a large proportion of research on cognitive and affective aspects in parents' involvement in the *Thinking* category, reflecting and continuing research as Parsons et al. (1982) and relating to children's learning of mathematics and affection outcome.

5.2. Children's outcome

A total of 66 of 79 identified parental involvement indicators are connected to children's achievement, performance, and skills in mathematics, representing a clear predominance of the 238 indicator connections in the *Learning* column in Table 6. This continues previous trends in research (Wilder, 2014) related to parental involvement, where mathematics achievement for several decades has been used as a measuring instrument and success criterion for parental involvement (Boonk et al., 2018; Castro et al., 2015). The same research also uncovers the strongest positive indications of effects, confirming previous results from reviews and meta-analyses (Boonk et al., 2018; Wilder, 2014) on the effect of parental involvement on children's educational achievement. Children's mathematic learning outcomes are positively influenced by parents:

- Positive expectations (Bowen, Hopson, Rose, & Glennie, 2012; Froiland & Davison, 2016; Huang & Liang, 2016; Kleemans et al., 2012; Kung & Lee, 2016; Long & Pang, 2016; Luo & Zhang, 2017; Paul, 2011; Rodriguez et al., 2017; Sibley & Dearing, 2014; Tan, Kim, Baggerly, Mahoney, & Rice, 2017; Vukovic, Roberts, & Green Wright, 2013; You, Lim, No, & Dang, 2016) and beliefs (Gladstone et al., 2018; Kiwanuka et al., 2017; Kung & Lee, 2016; Panaoura, 2017; Puccioni, 2015; Tan et al., 2017) for children's learning of mathematics.
- Values (Gladstone et al., 2018; Hong, Yoo, You, & Wu, 2010) and motivation (Häfner et al., 2018; Ing, 2014; McDonald, Ing, & Marcoulides, 2010) for children's learning of mathematics.
- Warmth (Hartas, 2015; Hsu, Chen, & Greenberger, 2019), interest (Häfner et al., 2017; Martin, Anderson, Bobis, Way, & Vellar, 2012), and positive attitudes (Cui, Zhang, & Leung, 2019; Giannelli & Rapallini, 2019; Kiwanuka et al., 2017; Lee & Kim, 2016) towards mathematics.
- Home presence and availability for interaction in the learning of mathematics (Petridou & Karagiorgi, 2018; Youn, Leon, & Lee, 2012).
- Home reading and numeracy activities for the youngest (Coley et al., 2019; Goforth et al., 2014; Hart et al., 2016; Kleemans et al., 2012; Kleemans et al., 2013; Kleemans et al., 2018; Shahaeian et al., 2018; Zhu & Chiu, 2019).
- Advising (Choi, Chang, Kim, & Reio, 2015; Fan, Williams, & Wolters, 2012), encouragement (Diab, Guillaume, & Punamäki, 2018; Herges et al., 2017; Mujtaba and Reiss, 2016a, 2016b), and positive communication about school and schoolwork (Howard et al., 2019; Mahuro & Hungi, 2016; Mireles-Rios & Romo, 2010; Petridou & Karagiorgi, 2018; Sad, 2012) for adolescents.
- Positive support (Burkhalter, 2014; Paul, 2011), engagement (Bartley & Ingram, 2018; Biag & Castrechini, 2016; Docherty, James, Spalding, & Walker, 2018), and learning stimulation (Crosnoe, Leventhal, Wirth, Pierce, & Pianta, 2010; Luo & Zhang, 2017; Powell et al., 2012; Zadeh, Farnia, & Ungerleider, 2010).
- Facilitating home learning resources and environment (Carmichael & MacDonald, 2016; Dearing et al., 2012; Long & Pang, 2016; Niklas & Schneider, 2014; Sad, 2012).

The same research also confirms a previous understanding (Hill & Tyson, 2009; Shaver & Walls, 1998) that a wide range of indicators for parental involvement positively influence children's mathematics learning outcomes across grade level, ethnicity, gender, and socio-economic background (Aturupane, Glewwe, & Wisniewski, 2013; Sylva et al., 2013; Youn et al., 2012).

Further, the *Affection* column in Table 6 identifies research of the last decade that focuses on underlying causes. There is an emphasis on children's perception (Mujtaba and Reiss, 2016b; Rice, Barth, Guadagno, Smith, & McCallum, 2013), self-concept (Häfner

et al., 2018; Silinskas & Kikas, 2019), and self-efficacy (Fan & Williams, 2010; Nugent et al., 2015) in mathematic learning, as well as children's motivation (Areepattamannil et al., 2015; Fan & Williams, 2010; Martin, Martin, & Evans, 2017), values (Gniewosz & Noack, 2012; Lazarides & Watt, 2017; Šimunovic et al., 2018) and attitudes (Maloney et al., 2015; McNeal, 2014) as a basis for growth and persistence in mathematically related work (Ing, 2014; Gintautas Saldaña, 2021) and choice of studies related to mathematics (Degner, 2013; You & Sharkey, 2012). This diversity is wider and deeper than in previous decades and can be demonstrated firstly by the supplement of the parent involvement approach to the large body of research on children's anxiety facing mathematics (Ashcraft, 2002). Parents' anxiety (Areepattamannil et al., 2015; Soni & Kumari, 2017) or negative attitudes (Daches Cohen & Rubinsten, 2017) can cause children's anxiety and negatively affect children's mathematical achievement (Häfner et al., 2017; Maloney et al., 2015), while parents' positive valuing or active help and support can counteract anxiety (Birgin, Baloglu, Catlioglu, & Gurbuz, 2010; Boehme, Goetz, & Preckel, 2017; Burkhalter, 2014). Secondly, this is demonstrated by research relating to, for example, expectancy-value theories of Eccles et al. (1983), which describes parent's beliefs, values, motivation, and expectations' positive influence on their children's mathematic beliefs, motivation, confidence, and achievement (Gladstone et al., 2018; Lauermaun, Eccles, & Pekrun, 2017; Martin et al., 2017; Šimunovic et al., 2018).

6. Conclusion

This literature review identified research articles from the last decade that operationalised and compiled parental involvement and mathematic outcome. Emphasis was placed on how research literature related to mathematic outcomes descriptively defined parental involvement by operationalisation, and a new 12-part categorisation was developed and proposed as a framework to better describe parental involvement. Moreover, an overview of the diversity of mathematic outcomes showed that research on parental involvement was aimed at and the indicators were grouped into categories with the keywords Learning, Belief, Motivation, Emotion, and Behaviour.

Some of the results appeared through analysis and discussions, which were particularly notable. First, there is still a vast majority of parental involvement research related to children's achievement, performance, and skills in the area of mathematics. Secondly, a predominance of parental involvement through affective expressions, such as expectations, attitudes, and values, is connected to children's mathematical learning, affinity, and behaviour. Thirdly, there were identified both connections and effects of connections between indicators of parental involvement and mathematic outcome. This literature review emphasised the focal points and blind spots in the research field. A majority of different types of parental involvement have a positive effect on children's mathematic outcomes. Some categories contrasted the result, which are related to parents' negative attitudes, affections, lack of appreciation, strict boundaries, and lack of help, rather than creating a good environment for learning mathematics.

The literature review thus mainly covers two research gaps: First, it covers an unfilled role as a review of research literature connecting parental involvement to mathematic outcomes. The overall picture describes a growing and developing field of research, including a variety and diversity of research relating parental involvement to the mathematic outcome. Secondly, it contributes to establishing a conceptual understanding and new operationalisation in categories of parent involvement related to children's mathematic outcomes. Regardless of the direction for further research, this will contribute to the challenges of establishing rigorous and unambiguous conceptual understanding and operationalisation of parental involvement.

6.1. Limitations

Given and developed possibilities as well as clarified and conscious limitations are together important strengths of a study. In addition to the mentioned demarcations in the field, challenging compromises were identified in the literature search and inclusion and exclusion process. The search was done for articles in English, which can be considered a world language, though the provision of access to articles from all continents still limits the potential of articles. In the same way, the requirement for peer review and the selection of articles in journals according to given quality criteria is delimiting. Consequently, and in respect of the dimensions and interdisciplinarity of the field, the article quality in selection is given priority over potentially overall completeness. From the analysis, the tending to give an overview rarely provides all the details as divisions into categories within social science have weaknesses and limitations in terms of accuracy. As mentioned, categories can be challenging to distinguish, as some of them also can be interpreted as either overlapping or hierarchical. As an example, from the categorisation of parental involvement, it can rightly be argued that several of the categories could have been included in the seventh category, namely *Parenting itself*. The goal of creating a balanced depth and full breadth in the categorisation to provide legitimate space for all the various indicators of parental involvement in the data material is thus prioritised at the expense of rigid thinking of categories.

6.2. Implications

The review can be described as a basic study for the research field, to provide conceptual language and a structural framework, while also strengthening and inspiring research related to parental involvement and children's mathematic outcomes. For parents, this review confirms some longitudinal messages about the involvement in children's connections and intersections to mathematic through 50 years of research from McDill et al. (1969): It is important with positive expectations and affections towards children as mathematicians, in addition to establishing good learning environment in the home through valuing, communication, encouragement, and motivation for mathematics.

For research purposes, the following four recommendations are provided. First, a scoping review on the diversity of disciplines through journals and articles and methodological variation of data collection and analysis of parental involvement and children's

mathematic outcomes would provide insight into the status and quality of the methodology in the research field, as well as contribute to transparency and quality in methodological considerations for further research. Secondly, meta-analyses of significance and causal-effect relationships at the indicator level between parental involvement and the mathematic outcome could also be examined for selected articles based on comparable quantitative methods. Thirdly, a more specific analysis of the indicators of parental involvement is needed to ascertain which ones have a positive effect on specific mathematic outcome indicators at different age levels, as well as possible links to other variables, such as gender and ethnicity. And finally, it could be essential to work in the identified blind spots in the research field. This will strengthen the opportunities to improve both parental involvement and children's mathematic outcome. By considering the diversity of indicators from the operationalisation of parental involvement, it is reasonable to assume that it may be relevant with further theorising of the developed parent involvement categories and the threefold of parenthood being, parenting doing, and parentally thinking.

Founding source involvement

None.

Author contributions

One author.

Declaration of interest statement

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Appendices A–C. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.edurev.2022.100458>.

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