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Literature review on teachers' mindsets, growth-oriented practices and why they matter

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This literature review focuses on earlier research on teachers' mindsets, i.e., teachers' implicit beliefs about the malleability of basic human qualities such as intelligence. More specifically, the review focuses on what teachers' mindsets are, how teachers' mindsets manifest in the teaching, studying, and learning process, how teachers' mindsets and growth-oriented practices are related to students' mindsets and learning, and how teachers' mindsets can be developed. Three electronic databases and backtracking references were used to search articles published between the years 2012 and 2023. After evaluating the eligibility of the articles, 64 were finally included in the review. The findings indicated that teachers' mindsets and growth-oriented practices matter. Most earlier research has found some kind of connection between teachers' mindsets and growth-oriented practices, and/or students' mindsets and learning. The implications for teacher education, policy, and future research are discussed.

KEYWORDS

mindset theory, teachers, literature review, growth mindset, fixed mindset, education

1 Introduction

Concluding his meta-analysis, Hattie (2009, p. 239) asserted that teachers do matter: they are among the most powerful influencers in learning. Moreover, teachers who employ specific teaching methods hold high expectations for *all students* and create a positive student-teacher relationship are particularly likely to exert an above-average effect on student achievement (Hattie, 2009, p. 126). Thus, the impact of teachers, with their different beliefs and knowledge of content, teaching, learning, assessment, and students, can be far reaching. Evidence exists that teachers' beliefs influence, among other things, their pedagogical decisions and their classroom behavior (Levin, 2015). However, the link between beliefs and practice is far from simple and straightforward (e.g., Buehl and Beck, 2015; Trzesniewski et al., 2021). For example, belief in the importance of certain principles, notions, or practices does not guarantee that they will be manifested in classroom behavior. Nevertheless, teachers' beliefs have interested many scholars in the field of educational research for several decades (Pajares, 1992; Gill and Fives, 2015) and are seen as one of the key issues that teacher education should address (e.g., Pajares, 1992; Tirri and Laine, 2017; see also Levin, 2015).

In recent years, growing interest has been directed toward teachers' implicit beliefs (i.e., mindsets) about the malleability of basic human qualities, such as intelligence. According to Mindset Theory (Dweck, 2006; Dweck and Yeager, 2019; Yeager and Dweck, 2020), people can believe that intelligence, for example, is unchangeable (fixed mindset; entity belief; entity theory), or that it is malleable and can be improved through effort (growth mindset; incremental belief; incremental theory). For consistency, we use fixed and growth mindset to refer to these two types of implicit beliefs in this article. Most of the earlier research on mindsets has

concentrated on students' or learners' mindsets. With the help of these studies, researchers have concluded that different mindsets can affect students' learning motivation and academic achievement (see Dweck, 2000, for a review; e.g., Aronson et al., 2002; Good et al., 2003; Blackwell et al., 2007; Yeager and Dweck, 2012, 2020; Park et al., 2016; Yeager et al., 2016, 2019; Gouëdard, 2021). The results mentioned above highlight both the importance of students' mindsets in learning and the need to examine approaches to developing growth mindsets in students.

Consequently, intervention studies have aimed to influence students' mindsets. The results of these studies indicate that students' mindsets, while relatively stable in nature, can be affected through interventions (e.g., Aronson et al., 2002; Blackwell et al., 2007; Yeager et al., 2011, 2016, 2019; Paunesku et al., 2015). However, not all studies have been able to replicate these promising results related to mindset and academic achievement (e.g., Li and Bates, 2019; Burgoyne et al., 2020; Gandhi et al., 2020), which might be due to differences in student characteristics, subject areas, and educational contexts (e.g., Sarrasin et al., 2018; Yeager and Dweck, 2020). As early as 2010, Dweck (2010) noted that school culture and teachers' learning approaches could help students achieve longer-term change in their mindsets. Accordingly, Yeager and Walton (2011) concluded that the role of the teacher could be important in increasing the effectiveness of mindset interventions. Furthermore, in their review of mindset research, Dweck and Yeager (2019) acknowledged that short interventions are insufficient; rather, educators should create growth mindset cultures to induce more persistent change. Prior research has further indicated that the messages students receive from their teachers during their formal schooling years impact their mindset, goal orientation, and academic achievement (see Haimovitz and Dweck, 2017 for a review). More broadly, teachers' growth mindset is connected with their ethical and professional ethos in advancing the holistic development of students (Tirri, 2021). As a result, the amount of research on teachers' mindsets, their manifestation in teaching and practice, and the relationship between teachers' growth-oriented practices and students' learning and achievement has increased significantly over the last decade.

To the best of our knowledge, there exists only one earlier review which targeted (partly) teachers' mindsets. The study reviewed five quantitative studies focused on the role of teachers' mindsets in students' achievement (Zhang et al., 2017). The results of this review indicated that teachers' mindsets and growth-oriented practices can constitute a factor in student achievement, and there was also some evidence supporting the role of teachers' mindsets as a moderator, i.e., "teachers' mindset could moderate the relationship between parents' mindset and their child's academic potential" (Zhang et al., 2017, p. 1372). However, the review contained several limitations. First, it focused exclusively on quantitative studies. Second, it only examined the role of teachers' mindsets and growth-oriented practices in students' achievement. Nevertheless, teachers' mindsets and growth-oriented practices have been studied far more widely, also via qualitative and mixed-method studies, to better understand the nature and manifestation of teachers' mindsets (see research questions 1 and 2). Furthermore, earlier research on the connection between teachers' mindsets and growth-oriented practices has examined their association not only with student achievement but also with students' mindsets (see research question 3). Finally, as the number of studies considering teachers' mindsets has grown rapidly in recent years, the above-mentioned review can already be considered outdated and lacking the newest research. For instance, an emerging and relatively new research direction originating from the importance of teachers' mindsets and growth-oriented practices concerns their development for the benefit of students (see research question 4). Thus, the field still lacks a comprehensive literature review summarizing the full breadth of existing research in the field of teachers' mindsets.

This literature review aims to fill that gap by reviewing earlier quantitative, qualitative, and mixed-method studies about teachers' mindsets and their manifestation in practice, how these are related to students' mindsets and learning, and what is known about developing teachers' mindsets and growth-oriented practices. The purpose is to illuminate the kind of research that has been conducted on teachers' mindsets, the main results, and whether and why teachers' mindsets and growth-oriented practices matter.

In summary, we seek answers to the following four questions:

1 What are teachers' mindsets?
2 How are teachers' mindsets manifested in the teaching, studying, and learning process?
3 How are teachers' mindsets and growth-oriented practices related to students' mindsets and learning?
4 How can teachers' mindsets and growth-oriented teaching practices be developed?

2 Methods

The research strategy for this literature review included electronic database searches and backtracking references. Figure 1 illustrates the review process. First, we used ERIC, Ebscohost, and Google Scholar for the initial electronic search. In that search, we utilized keywords with different combinations of the following words: teacher, mindset, implicit belief, intelligence, growth mindset, teaching, and pedagogy. Second, the titles and abstracts of all the research articles we found were read and articles that met the following initial criteria were chosen:

1) The article was a scientific *research* article published in English in a peer-reviewed journal.
2) The article was published between the years 2012 and 2023.
3) The article was connected to teachers' implicit beliefs ('mindsets') about the malleability of basic human qualities, such as intelligence, and/or the article discussed teachers' pedagogy and practices in relation to mindsets.
4) The published research concerned pre-service and/or in-service teachers.
5) The context of the study was basic education, high-school/upper-secondary school, or pre-service teacher education.

In the second stage, we removed all the duplicates from our data. Third, we checked the eligibility of each publication by reading the entire article. Next, we carefully examined the references in the chosen articles to find relevant studies that might have been lost in the electronic database search. Again, the titles and abstracts of the articles were read first and then the full text was read to check the eligibility of the publication. This third

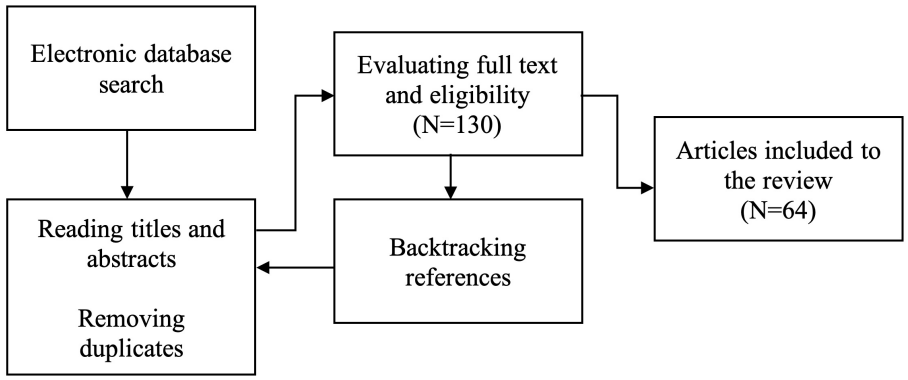

FIGURE 1
The strategy of the literature review.

stage continued until no new research was found. Some studies were removed at this stage, as the initial criteria were not met. For example, a highly cited study by Rattan et al. (2012) was not included, as the participants were neither pre-service nor in-service teachers. We also omitted studies that were related to teachers' mindsets about their teaching ability (e.g., Frondozo et al., 2020; Nalipay et al., 2021) or only measured the connection between mindsets and teachers' well-being or occupational stress (e.g., Zeng et al., 2019), as this review focused on teaching, studying, and learning. We also excluded studies that were not published in an international peer-reviewed journal (e.g., Gero, 2013; Gleason, 2018). As Figure 1 illustrates, a total of 130 articles were fully evaluated, and 64 research articles were included in the review.

3 Empirical research on teachers' mindsets

Table 1 summarizes the research conducted in the area of teachers' mindsets during the years 2012–2023. A total of 64 articles were finally included in the review. Most of the research was performed in North America ($n = 29$) and European countries ($n = 25$). By contrast, only a small number of studies used data from Asia ($n = 5$), the Middle East ($n = 4$), and Australia/Oceania ($n = 3$). International comparative data was used in only four studies. Teachers' mindsets were investigated primarily with quantitative methods ($n = 38$), but qualitative ($n = 13$) and mixed methods ($n = 13$) studies were also found. The research targeted both pre- ($n = 14$) and in-service ($n = 51$) teachers. A total of 20 studies also included students. We used four categories to highlight the main emphases of the studies. Accordingly, we named them *Nature* of Mindset ($n = 12$), *Manifestation* of Mindset ($n = 23$), *Connections* to students' mindset and learning ($n = 20$) and *Developing* teachers' mindset ($n = 9$).

This chapter is divided into four parts based on our research questions. The first part, "What are teachers' mindsets?," presents research connected generally to pre- and in-service teachers' mindsets. The second part, "How are teachers' mindsets manifested in the teaching- studying- learning process?," presents research that concentrates on the manifestation of teachers' mindsets in their pedagogical thinking and practices. The third part concentrates on current research evidence connected to the research question "How are teachers' mindsets and growth-oriented practices related to students' mindsets and learning?" Finally, the fourth part, "How can teachers' mindsets and growth-oriented practices be developed?," summarizes research focused on changing and developing teachers' mindsets and practices.

3.1 What are teachers' mindsets?

Studies that have examined teachers' implicit beliefs, i.e., mindsets about intelligence, have found that pre-service (Jones et al., 2012; Patterson et al., 2016; Snyder et al., 2021; Meierdirk and Fleischer, 2022) and in-service teachers (Jones et al., 2012; Jonsson et al., 2012; Gutshall, 2013; Patterson et al., 2016; Makkonen et al., 2019; Zhang et al., 2020; Mesler et al., 2021; Willingham et al., 2021; Graham et al., 2023; Lee et al., 2023) tend to endorse a growth mindset toward intelligence. Moreover, studies indicate that teachers' mindsets are domain specific. For example, in-service teachers (Laine et al., 2016; Makkonen et al., 2019; Zhang et al., 2020) and pre-service teachers (Snyder et al., 2021), mostly regard giftedness as malleable, but to a lesser degree than intelligence (Makkonen et al., 2019; Zhang et al., 2020; Snyder et al., 2021). Furthermore, Snyder et al. (2021) study using latent profile analysis found that the majority of pre-service teachers they investigated held extreme views neither about the nature of giftedness nor intelligence; instead, the largest profile among these teachers was "Dual-Neutral." This kind of "mixed mindset" has been found in other studies as well (Gutshall, 2013; Laine et al., 2016; DeLuca et al., 2019).

Some studies have concentrated on examining whether teachers' mindsets vary across different academic domains. For instance, Patterson et al. (2016) found that both pre- and in-service teachers' views were most ability-based toward art domains and mostly effort-based in humanities domains (e.g., language, arts, and social studies). STEM subjects (e.g., physics, mathematics) were situated between arts and humanities. Furthermore, the study found that the more teachers endorsed a fixed mindset toward intelligence, the stronger was their belief that ability determined performance in basic skills, humanities, and STEM subjects (Patterson et al., 2016). Some studies have revealed teachers' mindsets to be more growth oriented toward mathematics (Willingham et al., 2021) and physics (Makkonen et al., 2019) than

TABLE 1 Descriptive information about the chosen teachers' mindset studies.

Study	Sample	Country	Methodology	Main emphasis
Jones et al. (2012)	Pre-service teachers (N = 237) In-service teachers (N = 33)	USA	QN	Nature
Jonsson and Beach (2012)	Pre-service teachers ($N_{1st\ study}$ = 176; $N_{2nd\ study}$ = 151)	SWE	QN	Manifestation
Jonsson et al. (2012)	Teachers (*N* = 226)	SWE	QN	Nature
Gutshall (2013)	Teachers (*N* = 238)	USA	QN	Nature
Shim et al. (2013)	Teachers (*N* = 209)	USA	QN	Manifestation
Asbury et al. (2015)	Pre-service teachers (*N* = 255)	GBR	QN	Nature
Inbar-Furst and Gumpel (2015)	Teachers (*N* = 392)	ISR	QN	Manifestation
Mascret et al. (2015)	Teachers (*N* = 60)	FRA	QN	Nature
Schmidt et al. (2015)	Teachers (*N* = 2) Students (*N* = 160)	USA	QN & QL	Connection
Bonne and Johnston (2016)	Teachers (*N* = 15) Students (*N* = 91)	NZL	QN	Connection
Gutshall (2016)	Teachers (*N* = 7) Students (*N* = 359)	USA	QN	Connection
Laine et al. (2016)	Teachers (*N* = 463)	FIN	QN	Nature
Park et al. (2016)	Teachers (*N* = 58) Students (*N* = 424)	USA	QN	Connection
Patterson et al. (2016)	Pre-service teachers (*N* = 73) In-service teachers (*N* = 53)	USA	QN	Nature
Rau (2016)	Teachers (*N* = 1) Students (*N* = 3)	USA	QL	Connection
De Kraker-Pauw et al. (2017)	Teachers ($N_{1st\ study}$ = 115; $N_{2nd\ study}$ = 23)	NLD	QN&QL	Manifestation
Fraser (2018)	Teachers (*N* = 5) Students (*N* = 28)	GBR	QL	Connection
Ilhan-Beyaztas and Dawson (2017)	Pre-service teachers (*N* = 315)	GBR & TUR	QN&QL	Nature
Strahan et al. (2017)	Teachers (*N* = 1) Students (*N* = 12)	USA	QL	Connection
Tiekstra and Minnaert (2017)	Teachers (*N* = 44)	NLD	QN	Manifestation
Anderson et al. (2018)	Teachers (*N* = 40) Students (*N* = 3,596)	USA	QN & QL	Connection
Cartwright and Hallar (2018)	Pre-service teachers (*N* = 8)	USA	QN&QL	Developing
Ramirez et al. (2018)	Teachers (*N* = 60) Students (*N* = 1886)	USA	QN	Connection
Rissanen et al. (2018a)	Teachers (*N* = 2)	FIN	QL	Manifestation
Rissanen et al. (2018b)	Teachers (*N* = 4)	FIN	QL	Manifestation
Seaton (2018)	Teachers ($N_{1st\ study}$ = 37; $N_{2nd\ study}$ = 17)	GBR	QN&QL	Developing
Truax (2018)	Teachers (*N* = 4) Students (*N* = 56)	USA	QN & QL	Connection
DeLuca et al. (2019)	Pre-service teachers (*N* = 396)	CAN	QN	Manifestation
Makkonen et al. (2019)	Teachers (*N* = 131)	FIN	QN	Nature
Patrick and Joshi (2019)	Teachers (*N* = 120)	USA	QL	Developing

(Continued)

TABLE 1 (Continued)

Study	Sample	Country	Methodology	Main emphasis
Rissanen et al. (2019)	Teachers ($N = 1$)	FIN	QL	Manifestation
Ronkainen et al. (2019)	Teachers ($N = 1$)	FIN	QL	Manifestation
Sun (2019)	Teachers ($N = 4$)	USA	QL	Manifestation
Zilka et al. (2019)	Teachers ($N = 14$)	ISR	QL	Developing
Bostwick et al. (2020)	Teachers ($N = 91$) Students ($N = 1,414$)	AUS	QN	Connection
Francome and Hewitt (2020)	Teachers ($N = 12$) Students ($N = 286$)	GBR	QN & QL	Connection
Jorif and Burleigh (2020)	Teachers ($N = 7$)	USA	QL	Manifestation
Tassell et al. (2020)	Pre-service teachers ($N = 37$)	USA	QN & QL	Developing
Soleas and Hong (2020)	Teachers ($N = 232$)	USA & CAN	QN & QL	Developing
Willingham et al. (2021)	Teachers ($N = 583$)	USA	QN	Nature
Zeeb et al. (2020)	Teachers ($N = 1$) Students ($N = 59$)	DEN	QN	Connection
Zhang et al. (2020)	Teachers ($N = 127$)	FIN & CHN	QN	Manifestation
Griful-Freixenet et al. (2021)	Pre-service teachers ($N = 1,134$)	BEL	QN	Manifestation
Mesler et al. (2021)	Teachers ($N = 57$) Students ($N = 1957$)	USA & CAN	QN	Connection
Rissanen et al. (2021)	Teachers ($N = 5$) Students ($N = 85$)	FIN	QN & QL	Connection
Seo and Lee (2023)	Students ($N = 6,040$)	USA	QN	Connection
Snyder et al. (2021)	Pre-service teachers ($N = 163$)	USA	QN	Nature
Shoshani (2021)	Teachers ($N = 155$)	ISR	QN	Developing
Tan and Maeda (2021)	Students ($N = 15,648$)	USA	QN	Connection
Tao et al. (2021)	Teachers ($N = 271$)	CHN	QN	Manifestation
Barger et al. (2022)	Teachers ($N = 132$)	USA	QN	Manifestation
Meierdirk and Fleischer (2022)	Pre-service teachers ($N = 118$)	GBR	QN&QL	Nature
Porter et al. (2022)	Students ($N = 1996$) Teachers ($N = 50$)	USA	QN	Connection
Schnorr (2022)	Teachers ($N = 11$)	USA	QL	Manifestation
Stephens et al. (2022)	Pre-service teachers ($N_{1st\ study} = 313$; $N_{2nd\ study} = 57$)	NZL	QN	Developing
Yeager et al. (2022)	Students ($N = 8,775$) Teachers ($N = 223$)	USA	QN	Connection
Yu et al. (2022)	Students ($N = 2,200$) Teachers ($N = 358$)	FIN	QN	Connection
Cai et al. (2023)	Teachers ($N = 11$)	CHI	QL	Manifestation
Graham et al. (2023)	Teachers ($N = 140$)	USA	QN	Manifestation
Heyder et al. (2023)	Pre-service teachers ($N = 576$)	GER	QN	Developing
Huang (2023)	Teachers ($N = 560$)	TPE	QN	Manifestation
Lee et al. (2023)	Teachers ($N_{1st\ study} = 341$; $N_{2nd\ study} = 267$)	HON	QN	Manifestation
Sypré et al. (2022)	Teachers ($N = 122$)	BEL	QN	Manifestation
Zeeb et al. (2023)	Teachers ($N = 59$) Pre-service teachers ($N = 53$)	GER	QN&QL	Manifestation

toward general intelligence. Studies have found that the proportion of teachers who hold a fixed mindset ranges from one quarter (Jones et al., 2012; Gutshall, 2013) to one-third (Laine et al., 2016).

One focus of mindset research has been to determine whether teachers from different disciplines vary in their implicit belief preferences. Jonsson et al. (2012), for example, found that language and social science teachers showed a significantly higher preference for an incremental theory of intelligence and a lower preference for an entity theory, whereas mathematics teachers displayed no such preference. The authors concluded that math teachers we more likely to view achievement as associated with inborn ability than were teachers from other disciplines. Using an implicit approach, Mascret et al. (2015) found that, compared to liberal arts teachers, science teachers were more likely to form an implicit negative association between the words "intelligence" and "modifiable." Furthermore, they found that male science teachers were more likely to form a higher negative association between the words "intelligence" and "modifiable" than were other teachers. Moreover, they were more likely to consider that intelligence was stable (Mascret et al., 2015). However, Meierdirk and Fleischer (2022) found no statistically significant connection between subject taught and mindsets among pre-service teachers.

Studies concentrating on mindset differences among teachers with different lengths of work experience have produced mixed results. Some studies have indicated that teachers with the least experience hold more malleable views than do teachers with the longest work experience (Makkonen et al., 2019). Similarly, Jonsson et al. (2012) found that the oldest and the most experienced teachers were more likely to adhere to an entity theory of intelligence; nevertheless, interestingly, the youngest and the least experienced teachers were also prone to hold a similar view. By contrast, studies comparing pre- and in-service teachers' mindsets have not reported any statistically significant differences between the two groups (Jones et al., 2012; Patterson et al., 2016).

Most studies investigating teachers' mindsets have been conducted in Western countries, and research has seldom examined differences between the mindsets of teachers from different cultural settings. However, a few such comparative studies are available. For example, Ilhan-Beyaztas and Dawson (2017) studied differences between English and Turkish pre-service teachers and found that Turkish pre-service teachers were more likely to hold an entity rather than an incremental view of intelligence, whereas their English peers preferred an incremental theory of intelligence. Moreover, Zhang et al. (2020) compared Chinese and Finnish teachers' mindsets and found that in both countries there was a tendency toward a growth mindset and that no significant difference existed between the countries. Furthermore, in their study, Asbury et al. (2015) compared pre-service teachers from different places of origin (United Kingdom and East Asia). The study found that a growth mindset predominated in both groups, but pre-service teachers raised in the United Kingdom were significantly more growth-mindset oriented than were their peers raised in East Asia (Asbury et al., 2015).

There is an evident lack of research on teachers' mindsets toward students with differing needs, even though a growth mindset is seen to be especially helpful for at-risk students. Only a small number of studies are available. In one such study, Gutshall (2013) investigated both teachers' general mindsets toward intelligence and mindsets toward students with differing characteristics. To obtain information on student characteristics, the study used four hypothetical student scenarios. The scenarios were short texts in which one piece of critical information about the student (female, male, learning disabilities, and no learning disabilities) was changed between the scenarios. The results indicated that teachers' general mindset about intelligence correlated with their mindsets for different student characteristics. However, teachers' mindsets were more growth oriented than fixed in all the scenarios used in the study. Furthermore, the study found no statistically significant differences in teachers' mindsets between the different student scenarios. Thus, teachers' mindsets were found to be more positive when specific characteristics were mentioned – female student, male student, student with learning disability, and student without learning disability – than when measured toward general intelligence (Gutshall, 2013). Moreover, Asbury et al. (2015) found that pre-service teachers of UK origin were more growth oriented than their peers raised in Asia in relation to students' academic potential, behavior, dyslexia, and ADHD.

3.2 How are teachers' mindsets manifested in the teaching, studying, and learning process?

3.2.1 Pedagogical thinking and practice

One important factor characterizing the classroom learning context is its goal structure. Goal structure is connected to the type of achievement goals that are encouraged: in mastery-oriented goal structures, learning, and effort are emphasized, whereas, in performance-oriented goal structures, high grades and displaying competence are highlighted (Pintrich, 2000). In their study, Park et al. (2016) found that teachers with a stronger fixed mindset reported higher performance-oriented instructional practices than did teachers with a growth mindset, who reported more mastery-oriented instructional practices. Similarly, Rissanen et al. (2018a) qualitative case study revealed the connection between teachers' mindsets and their methods for motivating students: a fixed mindset was linked with a performance orientation, as evaluation and achievement goals were central. A growth mindset, on the other hand, was related to a stronger mastery orientation, in which the emphasis was progress and learning goals (Rissanen et al., 2018a). Furthermore, qualitative case studies (Rissanen et al., 2018a; Ronkainen et al., 2019) have also identified a connection between teachers' mindsets and traits and process-focused pedagogical thinking. In these studies, teachers with a growth mindset focused strongly on the process of learning and aimed to show their students how much they could achieve (Rissanen et al., 2018a; Ronkainen et al., 2019), whereas teachers with a fixed mindset focused strongly on their students' fixed traits (Rissanen et al., 2018a).

However, not all studies have been able to identify a straightforward connection between teachers' mindsets and classroom goal structure. For example, Shim et al. (2013) study failed to find support for the mediational relationship between mindsets and goal structure. Instead, the findings supported an interactive relationship: the study found a significant connection between teachers' achievement goals for teaching and their classroom practices, whereas mindsets played only a minor role. Teachers with a mastery goal approach to teaching also established a classroom with a mastery goal structure, whereas teachers with a more performance goal approach established a class culture with greater emphasis on student

competition, comparison, and the encouragement of superior skills. Moreover, there was some indication that teachers with both a fixed mindset and performance-avoidance goals promoted a performance-goal structure less than did teachers with other combinations of orientations. The authors speculated that this pattern might be the root cause of these teachers' attempts to protect their students' self-esteem (Shim et al., 2013). There is also evidence of cultural differences. For example, Zhang et al. (2020) study found support for a connection between teachers' fixed mindset and a performance goal orientation among Finnish teachers, but not among Chinese teachers. The study found that Finnish growth-oriented teachers were more prone to use strategies that supported mastery orientation, whereas Chinese growth-oriented teachers used mixed pedagogical strategies (Zhang et al., 2020).

In Finland, researchers have investigated growth mindset pedagogy (GMP), which is defined as pedagogy which is "likely to cultivate a growth mindset in students and is associated with the teacher's own growth mindset and process-focused pedagogical thinking" (Rissanen et al., 2019, p. 206). GMP includes four key features: supporting students' individual learning processes, promoting mastery orientation in the classroom, teachers' persistence, and fostering students' process-focused thinking (Rissanen et al., 2019, 2021; Ronkainen et al., 2019). However, Rissanen et al. (2019) study found critical points in GMP representing situational variations and possible pitfalls. For instance, the study identified differences between academic and moral domains, with teachers' incremental beliefs and process-focused thinking stronger in the domain of academic learning and weaker in the domain of morality. Moreover, another critical point involved teachers' failure to recognize and actively counter students' fixed mindset behaviors. This was evident in a situation where the teacher attempted to prevent academically competent students from making mistakes to save them from embarrassment (Rissanen et al., 2019). Interestingly, a recent study by Zeeb et al. (2023) found no relationship between teachers' growth mindsets and their ability to recognize and notice students' fixed mindsets. However, teachers' knowledge about learners' implicit beliefs (including mindset theory) was found to enhance their ability to notice students' fixed mindsets (Zeeb et al., 2023). Furthermore, studies have found that teachers with GM orientation tend to practice GMP primarily for low achievers, whereas FM teachers practiced it for high achievers (Rissanen et al., 2018a, 2019, 2021). Such pedagogical practices imply that teachers fail to teach all students to cope with failures and protect some students from challenges. Ronkainen et al.'s (2019) study further illustrated the manifestation of growth mindset pedagogy in teaching, especially in terms of teachers' use of the message 'not yet' to convey that students were on the path toward mastery, thereby encouraging their study motivation. Cai et al. (2023) studied GMP in a Chinese context among math teachers, with the results revealing that despite some shared features with Finland, context-specific GMP features were also evident. More specifically, in their interviews, the teachers highlighted the centrality to GMP of differentiated teaching, avoiding stereotypical views of mathematics learning, praising specific things, and emphasizing the relevance of mathematics to daily life. Together, these studies illustrate that teachers with a growth mindset aim to acquaint themselves with their students as individuals, provide emotional support, and help students find their own learning strategies in learning.

Some studies have concentrated on the connection between teachers' mindsets, specific teaching-related factors, and teaching methods. In a Belgian study (Griful-Freixenet et al., 2021), pre-service teachers' growth mindset was the second strongest predicting factor, after self-efficacy, in teachers' use of teaching methods connected to the Universal Design for Learning (UDL) model. The UDL model aims to promote more inclusive and accessible education for all and motivates teachers to proactively support their students' access, participation, and progress using inclusive practices. Regarding inclusive education, a study conducted among Israeli teachers (Inbar-Furst and Gumpel, 2015) revealed a link between teachers' implicit theories and their attitudes toward help-seeking when facing behavioral problems. Teachers with a growth mindset were positive about seeking help to enhance and improve their coping skills in the classroom. By contrast, teachers with a fixed mindset avoided help-seeking because of a fear of failure or from the desire to cope independently (Inbar-Furst and Gumpel, 2015). Similarly, Lee et al. (2023) found that teachers' growth mindsets were positively associated with perceptions of a new "positive education program" (study 1) and with teachers' self-efficacy regarding online teaching (study 2). Teachers' growth mindsets have also been linked to a more receptive attitude toward curriculum reform (Huang, 2023). Moreover, Graham et al. (2023) found that teachers' mindsets about intelligence and writing predicted their use of writing practices, more precisely the frequency with which students were asked to write and with which they taught writing skills and processes. In sum, teachers who viewed intelligence and writing ability as more malleable reported teaching writing more often (Graham et al., 2023). In Patterson et al. (2016) study, teachers' fixed mindset was associated with their lower endorsement of both teacher factors (e.g., classroom management and quality instruction) and student factors (e.g., motivation and persistence in promoting students' performance). In parallel, Sypré et al. (2022) study found a positive connection between teachers' fixed mindsets and the use of controlling and chaotic teaching styles, both of which are considered demotivating approaches to teaching. Finally, a Finnish qualitative case study provided an in-depth illustration of a teacher with a growth mindset taking responsibility for students' personal development and attempting to meet the individual needs of a student through her teaching strategies (Ronkainen et al., 2019). Similarly, another case study (Rissanen et al., 2018b) found that teachers' growth mindset related to a moral ethos centered around taking responsibility for students' personal development, meeting individual needs, and preserving individual rights. By contrast, teachers' fixed mindset was connected to a moral ethos centered around the fulfillment of responsibilities and striving for justice. Furthermore, these different interpretations were manifested in several ways in these teachers' teaching practice (Rissanen et al., 2018b). For example, teachers with a growth mindset trusted their students, did not predict their future behavior based on their previous actions, and helped them find explanations for their failures that did not concentrate on personal qualities. In turn, a fixed mindset was found to be related to a tendency to control students' behavior through punishment and strict assessment and labeling students, although two different cases showed that there was also situational variation in these practices (Rissanen et al., 2018b).

There are also indications that some teachers who report a growth mindset orientation fail to think and act in ways that align with their beliefs. This has been termed a false mindset. Barger et al. (2022)

found that teachers with a false growth mindset profile possessed a growth mindset measured with the traditional Dweck measure, but they experienced a similar level of math anxiety to that of teachers with a fixed mindset profile; moreover, they shared with the latter the view that math was accessible to only the few. Tiekstra and Minnaert (2017), on the contrary, concluded that teachers with a growth mindset may not know how to act in accordance with their beliefs. In their study, they concentrated on teachers' and educational professionals' implicit beliefs and practices concerning at-risk students. The study indicated that at least 34 percent of teachers' actions can be explained by implicit theories, with this figure rising to as high as 61 percent in denominational schools. Interestingly, the results showed that the actions of teachers who held a fixed mindset toward intelligence were more consistent when working with at-risk students than were the actions of teachers with a growth mindset. However, even though fixed-mindset teachers were more consistent, the methods they chose were in line with their entity theory and reflected a stronger performance orientation (Tiekstra and Minnaert, 2017).

A few studies have indicated that contextual factors might hamper teachers' ability to implement growth-oriented practices. Sun (2019) study demonstrated how existing school structures and policies related to tracking, instruction, and standardized assessment can hinder the ability of mathematics teachers to communicate growth mindset messages consistently to their students. Thus, despite their self-reported growth mindset, the teachers in this study sometimes sent contradictory fixed-mindset messages by using instructional practices that failed to promote a growth mindset in learning (Sun, 2019). A similar trend was found in a study by Francome and Hewitt (2020) conducted in England. The study compared two different types of schools, one which streamed students in mathematics teaching and another which used mixed ability groups. The results indicated that while students' and teachers' mindsets were more growth oriented than fixed in both schools, they were less so in the school that used ability groups. Furthermore, teachers' practices also differed between the schools. In the school which used streaming, teachers more often employed teacher-centered practices, whereas, in the school where mathematics was taught in mixed classes, student-centered and cooperative strategies were utilized more (Francome and Hewitt, 2020).

Two qualitative interview studies have illuminated teachers' perspectives on growth-oriented practices. In Schnorr (2022) study, teachers emphasized the importance of growth-oriented language and dialogue to motivate students to work hard, grow, and accept mistakes as part of the learning process. A growth mindset was considered something that both benefited students in terms of grades and achievement and also taught them not to give up in the face of challenges (Schnorr, 2022). A study by Jorif and Burleigh (2020) with secondary-school teachers illustrated these educators' perspectives on the way growth mindset concepts could be sustained in teaching and what might prevent this from occurring. First, teachers emphasized the idea that a growth mindset was, and should be, a regular, daily component of classroom practices and instruction. Second, to sustain a growth mindset in daily practices, both verbal affirmations and growth mindset learning tasks were required. Third, teachers considered it crucial that students experience both success and failure in their learning. Finally, teachers emphasized the importance of both support from the administration and parents and opportunities for professional development to continue the promotion of growth mindsets in their teaching (Jorif and Burleigh, 2020). Similarly, a study by Cai et al. (2023) found that a lack of professional support, lack of time, student differences and class sizes, ignoring cultural contextual elements, and poor partnership with parents and teachers were considered barriers to GMP among Chinese teachers.

3.2.2 Feedback and assessment

From the perspective of mindsets, two different kinds of feedback can be identified: fixed- and growth oriented (De Kraker-Pauw et al., 2017). Fixed-oriented feedback is targeted at results. Moreover, it contains praise or criticism directed at a person's traits, characteristics, or abilities. Growth-oriented feedback, on the other hand, is process-oriented. It involves praise for particular actions, such as effort and strategies (De Kraker-Pauw et al., 2017). Jonsson and Beach (2012) study among pre-service teachers indicated that those who preferred person-based praise also displayed a stronger fixed mindset and, further, believed more strongly that social comparison promoted learning. The study also found some indication of a positive correlation between teachers' growth mindset and the use of process praise (Jonsson and Beach, 2012). Recently, Tao et al. (2021) found that teachers' fixed mindset was associated with attributing students' poor performance to ability rather than effort. Case studies conducted among teachers have revealed a similar connection: teachers with a fixed mindset tend to comfort students and give up more easily, whereas teachers with a growth mindset are more persistent in providing honest feedback and helping students overcome their sense of helplessness (Rissanen et al., 2018a,b).

De Kraker-Pauw et al. (2017) conducted two independent studies on teachers' feedback. The first found a weak positive correlation between teachers' mindset and their appraisal of student improvement: a more growth-oriented mindset was related to a higher appraisal of students' development, indicating, in other words, a focus on student improvement. Female teachers were found to score higher than male teachers in their emphasis on students' improvement, but no connection was identified between STEM and non-STEM teachers in this matter. The second study found that teachers used only a limited amount of growth-mindset-oriented feedback, accounting for just one-fourth of the total feedback provided. In addition, the results indicated that growth-oriented teachers offered less feedback to students than did fixed-oriented teachers; moreover, the type of feedback was unconnected to the teachers' mindset. However, the study found that both male teachers and STEM teachers provided more growth mindset-oriented feedback than did female and non-STEM teachers. The results demonstrated the complex nature of beliefs (especially self-reported) and practice (De Kraker-Pauw et al., 2017).

DeLuca et al. (2019) explored pre-service teachers' mindset and its connection to classroom assessment. The results of pre-service teachers' self-assessment showed that none held a fixed mindset, and they were thus divided into those who held a growth mindset and those who held a mixed mindset. The study found that those pre-service teachers with a growth mindset were more likely to prioritize an *assessment as learning* approach compared to those with a mixed mindset. Assessment as learning focuses on the way students learn by providing feedback or experiences that foster students' metacognitive abilities and learning skills. By contrast, pre-service teachers with a mixed mindset were more likely to prioritize an

assessment for learning approach, i.e., highlighting the use of evidence to provide feedback on progress toward learning and to inform the next steps for learning and instruction. Furthermore, compared to their mixed mindset peers, pre-service teachers with a growth mindset were more likely to prioritize a *differentiated* approach, which emphasizes fairness from the perspective of individualized learning opportunities and assessment and values each student's unique learning needs and goals. Conversely, those holding a mixed mindset were more apt to prioritize an *equitable* approach, which refers to using differentiated assessment criteria only for those students who have been formally identified as requiring specific help (i.e., special education students; DeLuca et al., 2019).

3.3 How are teachers' mindsets and growth-oriented practices related to students' mindsets and learning?

3.3.1 The connection between teachers' mindsets and students' mindsets and learning

Research evidence on the direct relationship between teachers' and students' mindsets is relatively minor and contradictory. In their studies, Park et al. (2016) and Yu et al. (2022) found no direct association between teachers' and students' mindsets. A study by Mesler et al. (2021), using a large international dataset found a significant positive association between teachers' growth mindset and an increase in their students' growth mindset during one academic year. Furthermore, the analysis showed that this increase was higher for female students and students with female teachers. The results also indicated that teachers' fixed mindsets were related to more fixed mindsets among boys, but not among girls (Mesler et al., 2021). Gutshall (2016) found that while students' mindsets were related to teachers' mindsets, they were also connected to students' perceptions of those mindsets, which mediated the relationship (Gutshall, 2016). Our review identified only one study demonstrating the effects of teachers' growth-mindset orientation on student achievement: Bostwick et al. (2020) found that teachers' growth orientation was one factor affecting students' math achievement.

3.3.2 The connection between growth-oriented practices and students' mindset and learning

Although Park et al. (2016) and Yu et al. (2022) did not find a direct association between teachers' and students' mindsets, their studies illuminated the effects of teachers' growth-oriented practices. Firstly, Park et al. (2016) found a small but significant correlation between teachers' self-reported practices (mastery- or performance oriented) and students' implicit beliefs: the more the teacher reported performance-oriented practices, the more students endorsed fixed-mindset views at the end of the school year. As expected, a connection was found between teachers' mastery orientation and students' growth mindsets as well, but this correlation was below the level of statistical significance. The researchers concluded that from the perspective of students, what is important is not teachers' beliefs *per se*, but how they are embedded in teaching practice (Park et al., 2016). Secondly, Yu et al. (2022) found that students were more likely to report a growth mindset when their teachers engaged them more frequently in guided inquiry. In turn, they were more likely to possess a fixed mindset when their teachers more frequently used task differentiation based on ability. By contrast, group work and in-class ability grouping were not found to be connected with students' mindsets (Yu et al., 2022).

Some studies have examined students' perceptions of their teachers' mindsets and mindset-oriented practices and their connection to student performance. Ramirez et al.'s (2018) study indicated that ninth-grade students' perceptions of their teachers' fixed mindset beliefs partially mediated the relationship between the teachers' math anxiety and students' math achievement. The study found that higher teacher math anxiety was associated with a worse math GPA among students, even after adjusting for students' prior achievement and mindsets. More specifically the authors found that teachers' math anxiety was related to students' perception of their teachers' fixed mindset beliefs, which further weakened students' achievement in math. Furthermore, teacher math anxiety had a negative relationship with students' reports of their teachers' process-oriented practices, while no such association was found regarding student reports of their teachers' practical mathematical teaching knowledge (Ramirez et al., 2018). In their study, Tan and Maeda (2021) examined how ninth-grade students' perceptions of their science teachers' growth-mindset practices affected their initial science identity and its development. This large-sample study ($N = 15{,}648$) showed that students' perceptions of their teachers' growth-mindset practices predicted the initial science identity for the overall sample and for ethnic minorities and female students. Furthermore, these perceptions also predicted the science-identity development of the students for the overall sample, with the effect being strongest for ethnic minority and low-SES students (Tan and Maeda, 2021). Furthermore, another study (Seo and Lee, 2023) conducted among ninth-grade students demonstrated a connection between students' perceptions of teachers' fixed mindsets and a greater experience of stereotype threat in mathematics learning.

Recent studies have also indicated that the impact of mindset training is associated with teachers' instructional practices and classroom behavioral norms (Schmidt et al., 2015; Yeager et al., 2019). Schmidt et al. (2015) study indicated that teachers play an important role in supporting the positive outcomes of mindset intervention. More specifically, the study showed that teachers who emphasize mastery goals, remind students of the growth mindset, and use mastery-oriented learning strategies in classroom interactions improve students' learning outcomes more than teachers who send fixed-mindset messages (Schmidt et al., 2015). Yeager et al. (2022), with their large national sample, were able to demonstrate that while the growth mindset intervention program was able to influence students' mindsets, it was the growth-oriented learning context that was connected with the eventual improvement of students' math grades. In parallel, the math grades of those students whose teachers did not clearly endorse a growth mindset did not improve. However, more research is required on this connection and its direction and causality (Yeager et al., 2022).

3.3.3 Teacher-led mindset interventions

One effective mindset intervention is considered to be the mindset training provided by teachers to their students to build growth-oriented learning environments. There exists only one large-scale study (Porter et al., 2022) measuring the effects of growth mindset interventions delivered by teachers. In this study (Porter et al., 2022), teachers and their students were divided randomly into intervention and control groups. Teachers in the intervention group participated in

a two-week in-person training program in which they were taught about growth mindsets and guided to implement the Brainology program, which included a curriculum guide and lesson plans for their students. Intervention teachers also received support during the implementation of the program from implementation coaches. The results showed that both students and teachers experienced an increase in their growth mindsets. Furthermore, the grades of those students who participated in the Brainology intervention also increased. The effects were largest for lower achieving students whose teachers exhibited a fixed mindset at the beginning of the intervention (Porter et al., 2022).

In the latest study by Rissanen et al. (2021), teachers participated in training about growth mindsets and GMP and were instructed to use a growth-mindset intervention program called "I can learn" with their students. The intervention program focuses on brain malleability and neural processes of learning, normalizing challenges and mistakes in learning, and developing new ways to overcome difficulties. The results showed an increase in students' general intelligence mindset score toward a growth mindset and a decrease in negative effort beliefs between students' pre- and post-intervention scores. From the perspective of teachers, the study aimed to explore the varieties and nuances of teachers' perceptions of the impact of GMP on their pedagogical thinking and practice. The study found significant differences between fixed and growth mindset teachers in the ways they internalized and applied key principles of GMP: growth-mindset teachers' core beliefs were not challenged, and they were able to further develop GMP ideas, whereas FM teachers were more likely to exhibit a false growth mindset in their teaching practice or implement GMP in a formulaic manner (Rissanen et al., 2021).

Fraser (2018) study among Scottish teachers and students indicated four themes that are important in the implementation and application of growth mindset teaching and learning. The first theme, *embarking on the process*, highlighted the importance of initial planning, engagement, and encouraging staff cooperation. The second theme, *classroom culture and teaching*, included the school premises, teacher language, promoting mistake making, knowledge of brain plasticity, and teachers' mindsets. The third theme, *outside the classroom*, identified external factors, such as parents and friends, that affected students' growth mindset. Finally, the fourth theme dealt with *pupils' approach to learning*, such as embracing challenges and metacognitive skills. The study's teacher and student interviews and classroom observations revealed a development toward more growth-oriented learning behavior among students. However, the lack of a pre- and post-study comparison prevented assessment of whether the students' growth mindset had increased (Fraser, 2018).

In turn, Zeeb et al. (2020) German study aimed to develop teacher-led mindset training integrated into regular lessons. In their study, this training was provided in seventh-grade physics lessons. The training included both implicit parts, such as growth-mindset feedback, and explicit training sessions based on an earlier, well-established mindset intervention. The students who received the training were compared against a control group who received no training. The results showed that a growth mindset increased in those students who participated in the training, and the change persisted for at least 6 months. Furthermore, the training mitigated the decrease in student motivation that occurred in those students receiving no training, but it failed, however, to support students' self-beliefs about their own abilities (Zeeb et al., 2020). Similar results were found in Bonne and Johnston (2016) study, where those students who belonged to the study's intervention groups increased their incremental beliefs more than students in the control groups. In the intervention groups, teachers incorporated small micro-interventions into their lessons: they made their students' progress explicit and aimed to increase their students' mathematics self-efficacy (Bonne and Johnston, 2016).

Rau (2016) multi-case study illustrated the impact on fixed mindset students of a teacher-researcher's own efforts to build a more process-oriented language environment. The students' mindsets became more growth oriented as their focus of learning changed first from focusing on the speed of learning to focusing on the content and finally to focusing on the learning process. This shift was observed in their written reflections and their interaction in the classroom (Rau, 2016). Similarly, Strahan et al. (2017) study focused on a teacher's integration of growth-oriented activities into arts content instruction for seventh-grade students. This exploratory case study illuminated the different ways and patterns through which students articulate mindset-related concepts and suggested that students at this age can understand the concept of mindset when they are offered support and guidance (Strahan et al., 2017).

A study by Truax (2018) concentrated specifically on the feedback that teachers provide to students. The study found that when teachers used a type of feedback that objectively noted what their students had done well as writers or that encouraged a growth mindset, students were able to progress toward developing such a growth mindset. The developmental progression included four stages: (1) understanding that intelligence can change and that practice can affect change, (2) understanding that effort and taking time leads to increased ability, (3) recognition of improvement as a result of effort, and (4) asking for feedback and/or seeking challenges (Truax, 2018, p. 146).

3.4 How can teachers' mindsets and growth-oriented teaching practices be developed?

Some studies have examined the effects of teacher education on pre-service teachers' mindsets. For example, a study by Soleas and Hong (2020) on American and Canadian pre-service teachers found that in both countries pre-service teachers who had yet to begin their in-class training displayed stronger growth mindsets than did pre-service teachers who had already practiced in the classroom. This indicated that post-practicum pre-service teachers were less idealistic about the incremental nature of intelligence, and their approach to teaching was more pragmatic (Soleas and Hong, 2020). However, Cartwright and Hallar (2018) found that those pre-service teachers who completed their classroom training by teaching students science scored higher in the wider use of reform-based strategies and displayed a stronger growth mindset compared to those pre-service teachers who had only observed science lessons. This indicates the important role of active participation in professional development. In a study by Tassell et al. (2020), elementary pre-service teachers participated in three seminars connected to mindfulness, mathematics anxiety and self-efficacy, and mindset. The study journals and interviews revealed that during these seminars the participants became more aware of growth mindsets and the importance of these mindsets increased. Pre-service teachers also reflected on the domain-specificity of mindsets and began to make a connection with actual

teaching behavior (Tassell et al., 2020). Furthermore, in Heyder et al. (2023) study, pre-service teachers' growth mindsets increased after an indirect intervention where these teachers were asked to reflect on their aims as teachers. Finally, Stephens et al. (2022), in their two studies, described the way pre-service teachers' mindsets developed during a three-year teacher education program: their fixed mindsets decreased (study 1 and 2), and their growth mindsets increased (study 2).

Only a small number of studies have attempted to change in-service teachers' mindsets through intervention programs. In the most recent published intervention study conducted among teachers in Israel, Shoshani (2021) developed a mindset training program for math teachers. To test the program, teachers were divided into two groups: an intervention group and a control group. The teachers in the intervention group participated in a total of 10 three-hour training sessions, which were led by a psychologist specialized in the growth-mindset approach. The lessons were built around the central themes of growth mindset theory and research (Shoshani, 2021, p. 11). The results showed significant increases for the intervention-group teachers in both growth-mindset and well-being scores. Furthermore, the results indicated that students' engagement (i.e., lower dropout rates and higher new student enrolment rates) and math achievement were higher for the students of teachers in the intervention groups, indicating the positive effects of this teacher training on students' schooling (Shoshani, 2021). Similarly, Seaton's (2018) intervention study showed that teachers' mindsets became more growth oriented after their training program, and the effect remained for at least 3 months after the end of the intervention. The results further indicated that teachers experienced an increase in confidence concerning the use of the concept of mindset, recognizing their own and their students' mindsets, and applying mindset principles in teaching (Seaton, 2018). Unfortunately, the study provided no indication of the precise nature of the training offered to teachers, making it difficult to evaluate or replicate.

Patrick and Joshi (2019) study in the United States focused on teachers from three different schools who were participating in a larger project aimed at improving students' non-cognitive skills, including mindsets. During the project, teachers received training on mindsets and the implementation of growth-mindset practices. The researchers used interviews to capture the teachers' understandings and conceptions of growth and fixed mindsets. The results indicated that even though most of the teachers displayed some familiarity with the two concepts, they often defined them using vague and over-simplified terms. The study also found two relevant misconceptions. First, a growth mindset was defined as relentless positivity and a fixed mindset as a cultural trait. In the latter, a fixed mindset was connected to lower performing, low-income, and immigrant students. While many teachers reported that they already engaged in growth-mindset practices, many stated that learning about growth and fixed mindsets had prompted them to rethink and reflect on their own mindset. The researchers called for a stronger teacher-researcher partnership to better support growth-mindset initiatives (Patrick and Joshi, 2019).

In a study by Anderson et al. (2018), teachers participated in a professional development (PD) course connected to what they termed a "mathematical mindset approach." The course included both online and face-to-face approaches. This one-year mixed method study followed 5th-grade mathematics teachers' learning in a "mathematical mindset network" and changes in students' beliefs and achievement. Lesson observations, online course responses, and teacher surveys demonstrated a development in teachers' relationship with mathematics which caused changes in their classroom practices. For example, teachers experienced a shift from direct instruction to valuing students' ideas and strategies. Teacher interviews also deepened the researchers' understanding of the change these educators had experienced. In addition to teacher change, the study identified changes in both students' beliefs and achievement, with students displaying a stronger growth mathematical mindset after the PD. The PD also affected students' mathematical achievement: the achievement of students whose teachers participated in the PD was higher than that of students whose teachers did not participate. Furthermore, the teachers' participation in the PD particularly benefited female students, English learners, and economically disadvantaged students (Anderson et al., 2018).

What factors might then prevent or promote the development of teachers' growth mindset? This area, too, remains under-researched. However, in one of the few studies on this topic, Zilka et al. (2019) qualitatively researched how Israeli teachers perceived the factors that shaped the development of their growth mindset. While these teachers mentioned both internal and external factors, the former, such as values, life experiences, successes and failures, and the inner motivation to shape their malleability beliefs received the most emphasis. However, external factors, such as mentorship, feedback, reward, appreciation, the general learning atmosphere, and support from principals were also seen to strengthen growth mindsets. It was concluded that internal and external factors work together when facing change. By contrast, inhibiting factors included teacher status, burnout, ego, and an unsupportive environment (Zilka et al., 2019).

4 Discussion

4.1 A brief summary of the results

This review presents research conducted in the field of teachers' mindsets between the years 2012–2023. More specifically the review answered four specific questions: "What are teachers' mindsets?," "How are teachers' mindsets manifested in the teaching-studying-learning process?," "How are teachers' mindsets and growth-oriented practices related to students' mindsets and learning?" and "How can teachers' mindsets and growth-oriented teaching practices be developed?"

To conclude, based on this review, it seems that both in-service and pre-service teachers mostly hold a growth mindset when measured with self-reports (e.g., Jones et al., 2012; Gutshall, 2013; Patterson et al., 2016; Makkonen et al., 2019; Snyder et al., 2021; Meierdirk and Fleischer, 2022; Graham et al., 2023; Lee et al., 2023). Furthermore, most studies on the manifestation of teachers' mindsets and the connection between teachers' mindsets and growth-oriented practices, on the one hand, and students' mindsets and learning, on the other, reported at least some connection between the former and the latter. The research presented in this review indicates that teachers' growth mindsets are associated with the use of mastery-oriented instructional practices (Park et al., 2016; Rissanen et al., 2018a), process-focused pedagogical thinking (Rissanen et al., 2018a; Ronkainen et al., 2019), providing honest feedback, assisting students to overcome their feelings of helplessness (Rissanen et al., 2018a,b),

fostering students metacognitive abilities and learning skills, prioritizing bespoke opportunities for all students during assessment (DeLuca et al., 2019) and taking responsibility for students' holistic development (Rissanen et al., 2018b; Ronkainen et al., 2019). Teachers' growth mindsets are also linked to students' growth mindsets (Gutshall, 2016; Mesler et al., 2021; Yu et al., 2022), and achievement (Bostwick et al., 2020). Whereas growth-oriented practices are linked to an increase in students' achievement (Schmidt et al., 2015; Yeager et al., 2022), students' growth mindsets (Bonne and Johnston, 2016; Zeeb et al., 2020; Rissanen et al., 2021; Porter et al., 2022), and students' growth-oriented behavior (Rau, 2016; Fraser, 2018; Truax, 2018).

Teachers' fixed mindsets, by contrast, are linked to their performance orientation (Park et al., 2016; Tiekstra and Minnaert, 2017; Rissanen et al., 2018a; Zhang et al., 2020), use of person-based praise (Jonsson et al., 2012; Tao et al., 2021), comforting students (Rissanen et al., 2018a,b) and lower endorsement of teacher and student factors in promoting performance (Patterson et al., 2016). Teachers' fixed mindsets are also connected to students' fixed mindsets (Gutshall, 2016), especially among boys (Mesler et al., 2021). Furthermore, teachers' fixed-oriented practices are connected to students' higher endorsement of a fixed mindset (Park et al., 2016) and to their weaker achievement in math (Ramirez et al., 2018). Only a small number of studies in our review report contradictory results (Shim et al., 2013; De Kraker-Pauw et al., 2017; Sun, 2019); i.e., their findings were not fully in line with expectations based on mindset theory.

Our review further illuminated how mindsets affect teaching (Patterson et al., 2016; Tiekstra and Minnaert, 2017; Sypré et al., 2022) and the use of certain teaching methods (Griful-Freixenet et al., 2021; Graham et al., 2023). Some studies found that teachers' growth mindsets did not guarantee growth-oriented practices, as teachers might hold a false mindset (Barger et al., 2022), lack knowledge of how to act in accordance with their beliefs (Tiekstra and Minnaert, 2017), or work in educational surroundings unconducive to growth-oriented practices (Jorif and Burleigh, 2020; Cai et al., 2023). By contrast, teacher-led mindset intervention studies, albeit very differently implemented, indicate that teachers can develop students' growth mindsets effectively (Bonne and Johnston, 2016; Rau, 2016; Strahan et al., 2017; Fraser, 2018; Truax, 2018; Zeeb et al., 2020; Rissanen et al., 2021; Porter et al., 2022).

Our review highlighted some preliminary indications that teachers' mindset and mindset practices can be developed and affected through teacher education (Heyder et al., 2023), and interventions and professional development (Anderson et al., 2018; Seaton, 2018; Rissanen et al., 2021; Shoshani, 2021). These interventions and PDs also influence students' engagement (Shoshani, 2021), beliefs (Anderson et al., 2018; Rissanen et al., 2021), and achievement (Anderson et al., 2018; Shoshani, 2021).

4.2 Limitation of this review

Before drawing conclusions and exploring the implications of our findings, it is necessary to address the limitations of this review. First, our review suggests that teachers' mindsets are mostly growth oriented in relation to both intelligence and different school subjects. Furthermore, several studies also indicate the domain-specific nature of mindsets. A growth orientation is nevertheless predominant despite the different background factors, even though some differences can be seen. Although this is an encouraging finding, it may also be viewed as an overly positive result partly connected to the ITI scale, which is based on teachers' self-reports. The scale perhaps guides teachers to answer in socially desirable ways and prevents some teachers from responding according to their actual views. Educated and ethical teachers know how they should think, and they might answer according to this knowledge rather than their implicit beliefs. This might also explain, at least partly, the complexity of the results connected to the manifestations of and influences on teachers' mindsets.

Second, it is essential to remember that most studies presented in this review were conducted in Western countries. As educational and cultural contexts differ widely, it is necessary to acknowledge that we still possess little knowledge of teachers' mindsets elsewhere in the world, for example in developing countries. The few studies that exist and were included in this review indeed indicate the presence of cultural differences (Asbury et al., 2015; Ilhan-Beyaztas and Dawson, 2017; Zhang et al., 2020).

Third, the studies reviewed employ various research designs, ranging from large-scale quantitative studies to qualitative case studies. Even though many of these studies used Dweck's implicit theories of intelligence (ITI) scale, the additional measures employed in them varied considerably, and researchers often supplemented their design with qualitative observation and interviews. Thus, the studies in this review are not always comparable. Furthermore, for this reason, we have included no effect sizes in the review. However, the inclusion of different kinds of studies can also be considered a strength of this review. Different studies complement each other and create a more comprehensive picture of teachers' mindsets, growth-oriented practices, and why they matter. However, caution is required when interpreting the results. Table 1 aims to help the reader in this respect by highlighting the type of research (QN, QL, or QN + QL) in question, the target population, and the sample size.

Fourth, we limited our literature review to published journal articles, thereby excluding book chapters and doctoral dissertations, for example. This means that we have not covered all the research related to teachers' mindsets published within the years 2012–2023. Connected to this, although we strived for accuracy in our article searches, it is possible that some articles were overlooked because of the selected keywords. However, we have attempted to be as transparent as possible concerning our search process, and we used backtracking references to minimize this risk. Furthermore, the review does not include articles from the end of 2023, as the last article searches were performed in October 2023.

4.3 Implications for teacher education, policy, and future research

Together, the studies in our review indicate that teachers' mindsets and growth-oriented practices matter. However, it should be acknowledged that what is important is not solely teachers' self-reported mindsets but, rather, the manifestation of these mindsets in the classroom and their influence on students. As some recent large-scale studies (e.g., Ramirez et al., 2018; Tan and Maeda, 2021) illustrate, students' experiences of their teachers' practices and

mindsets do matter as well. Our review included quantitative, qualitative, and mixed-method studies to present as comprehensive a picture of the phenomenon as possible. The quantitative studies provided evidence of the different relationships between teachers' mindsets and variables such as students' mindsets and achievement, while the qualitative studies demonstrated how mindsets appear in everyday school life and in teachers' pedagogical thinking. Both quantitative and qualitative studies are also required in the future to provide complementary findings and guide future research and teacher education in the right direction.

Based on the review, both teachers' growth mindset and, more importantly, their growth-oriented behavior can be seen as *enablers* that can produce far-reaching positive effects on students' mindsets, learning experiences, and school achievement. Teachers' growth-mindset pedagogy can be especially helpful for at-risk students, allowing them to study in the best possible school environment with trust in their capacities to learn and develop. Conversely, teachers' fixed mindset and, more importantly, their fixed-mindset-oriented behavior can be seen as *risk factors* that can lead to far-reaching negative consequences for students' mindsets, learning experiences, and achievement. Even though, according to our review, growth mindsets predominate among teachers, some educators continue to hold fixed mindsets and/or exhibit fixed-oriented classroom behaviors, thus representing a risk to students' learning and development. In their recent article, Murphy et al. (2021, p. 9) insightfully discuss growth-mindset cultures, which include teachers' intentions and implementations and students' perceptions and experiences. More specifically, classroom culture is growth oriented when teachers intend to adhere to growth mindset beliefs, when this intention is manifested in their teaching practices, and when students also perceive and experience this supportive growth-mindset culture (Murphy et al., 2021).

Accordingly, both pre- and in-service teacher education should find ways to educate teachers to adopt a growth mindset in learning and embrace more growth-oriented teaching strategies. First, teacher education should offer teachers the possibility to assess and reflect on their own mindsets (Tirri and Laine, 2017). Second, as the studies we reviewed illustrate, the connection between teachers' growth mindset and growth-oriented behavior is far from unambiguous. For instance, we know that teachers with the same growth mindset might adopt different teaching strategies (i.e., Zhang et al., 2020). Thus, it is crucial to help teachers develop teaching practices in line with growth-mindset pedagogy. From early on, teachers should be educated to use teaching strategies that are known to support students' mindset development. These include such strategies as mastery- and process-focused teaching, normalizing challenges and mistakes in learning, and feedback and assessments that concentrate on process and effort instead of targeting performance and personal abilities. As Haimovitz and Dweck (2017) have also argued, it is insufficient merely to target teachers' mindsets; instead, the focus should be on how teachers can adopt growth-oriented teaching strategies to support their students' mindset development. The research evidence supports this perspective, as it indicates that teachers' mindsets can be changed and developed. However, the danger also exists that teachers who have not fully internalized growth-mindset ideas and how to act accordingly might communicate a false growth mindset to their students (i.e., Rissanen et al., 2019; Zeeb et al., 2020; Murphy et al., 2021) by, for example, praising effort alone or viewing mindsets as purely dichotomous and inherent characteristics of students. A false growth mindset refers to the oversimplified interpretation and application of a growth mindset (Aus et al., 2020), a situation where a person claims to hold a growth mindset but fails to manifest this in concrete action (Dweck, 2015). As this type of false growth mindset is found among students as well (Aus et al., 2020), it is essential that teachers receive education on how to increase the visibility of their growth mindset in the classroom and enhance students' explicit awareness of how to put their growth mindset into action. More generally, teachers should be offered growth-mindset training to help them eventually build growth-mindset classroom cultures that emphasize every student's potential to learn and improve instead of stressing that only some students possess the potential to develop to the highest levels (Trzesniewski et al., 2021). Furthermore, teachers should be educated on the holistic development and learning of all students, especially those at risk of dropping out of formal education. However, this kind of successful professional development is a long-term process, and teachers require space and time to truly reflect on their beliefs and share their experiences and ideas (Anderson et al., 2018).

Nevertheless, it is insufficient merely to educate teachers about growth mindsets and growth mindset pedagogy. In order to achieve wider change, possible barriers, such as the existing demands and constraints on teachers, should be targeted and overcome (Zilka et al., 2019; Bryan et al., 2021). Furthermore, classroom culture is necessarily part of the wider context of school, regional, and national cultures (Murphy et al., 2021), which should always be considered. As the review results indicate, the prevailing educational environment and policy limitations and requirements might hamper teachers' efforts to act according to their growth mindset (i.e., Tiekstra and Minnaert, 2017; Sun, 2019). In Finland, where educational policy conforms in many ways to the principles of GMP (i.e., Rissanen et al., 2021), it is easier to develop teachers' mindsets and GMP-based teaching strategies and engage them in the process of change. However, this task is considerably more challenging in countries where, for example, educational policy stems from collectivism, distinguishes more readily between students, utilizes streaming, and targets success in formal testing from very early on. Thus, where there is the political will to develop students' mindsets and improve their achievement and well-being by educating teachers about growth-mindset pedagogy, the wider context of teachers' work should also be considered. The characteristics of the current system should be assessed from the perspective of how they either support or limit teacher change. Policy-level support should then aim to minimize the number of limiting factors and increase those which support the desired direction. This also concerns the school level and the support that teachers receive from their nearest work community and management. For example, studies with exemplar principals from Finland and Estonia have provided evidence of the importance of principals' growth mindset for providing learning opportunities for the whole school community and for meeting current educational challenges with a future orientation (Tirri et al., 2021).

The results of the studies presented in this review indicate that even though we already know slightly more about teachers' mindsets and growth-oriented practices than we did 10 years ago, new research is still necessary to better understand the connection between teachers' mindsets and growth-oriented practices, on the one hand, and students' mindsets and learning, on the other. Based on the review, there are a few obvious research gaps that require more attention.

First, international comparative and non-Western studies are scarce. Nonetheless, the few studies that have been conducted already indicate that differences might exist between teachers from distinct cultural backgrounds in their mindsets and their manifestation. Interestingly, a recent World Bank publication (Sabarwal et al., 2021) supports this suggestion. The study illustrated for the first time that a fixed mindset might be more prevalent in some developing countries and may even predominate in others (Sabarwal et al., 2021). Thus, we require more cross-cultural research related to teachers' mindsets and their effects to plan such effective teacher interventions that are compatible with the specific cultural context and that acknowledge both the prevailing beliefs of teachers and the educational environment, with its enablers and inhibitors. Thus, as Murphy et al. (2021) note, growth-mindset classrooms will eventually differ from one cultural setting to another.

Second, teachers' mindsets and pedagogy are even more important for students from marginalized groups, as a growth mindset has been found to benefit them in particular (e.g., Yeager and Dweck, 2020). However, we require more research on teachers' mindsets and the effects of their practices on marginalized students' mindsets, achievement, and well-being. Currently, such research is scarce.

The third research gap concerns interventions, both those targeting students and those focused on developing teachers' mindsets and growth-oriented practices. These both represent a relatively newly emergent research area. As this review suggests, teacher-led interventions for students can be effective and influence students' mindsets and learning. However, more research is required to reveal the most effective interventions and approaches for developing students' mindsets to benefit their learning. Concerning interventions that aim to develop teachers' mindsets and growth-oriented practices, more research is necessary on the means to achieve these ends and on the impact on students. These interventions should be carefully designed (see Bryan et al., 2021), and researchers should ensure that these interventions and their effects are described in as much detail as possible. In line with teacher intervention studies, researchers should study more closely the possibilities for also implementing these interventions in pre-service teacher education. Teacher education offers a promising context for developing future teachers' mindsets and, especially, growth-oriented practices at an early stage of teacher development, and thus more research in this area is necessary to illuminate how this aim can be achieved. Furthermore, all types of research – quantitative, qualitative, and mixed-method – are essential to acquire a better overall picture of the nuances and effects of teachers' mindsets and growth-oriented practices.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Anderson, R. K., Boaler, J., and Dieckmann, J. A. (2018). Achieving elusive teacher change through challenging myths about learning: a blended approach. *Educ. Sci.* 8:98. doi: 10.3390/educsci8030098

Aronson, J., Fried, C. B., and Good, C. (2002). Reducing the effects of stereotype threat on African American college students by shaping theories of intelligence. *J. Exp. Soc. Psychol.* 38, 113–125. doi: 10.1006/jesp.2001.1491

Asbury, K., Klassen, R., Bowyer-Crane, R., Kyriacou, C., and Nash, P. (2015). National differences in mindset among students who plan to be teachers. *Int. J. Sch. Educ. Psychol.* 4, 158–164. doi: 10.1080/21683603.2015.1075164

Aus, K., Kuusisto, E., Arro, G., and Tirri, K. (2020). False, limited, and authentic growth mindsets in learning: preliminary findings from fourth-grade students in Estonia and Finland. *Int. J. Talent Develop. Creativity* 7, 125–140.

Barger, M. M., Xiong, Y., and Ferster, A. E. (2022). Identifying false growth mindsets in adults and implications for mathematics motivation. *Contemp. Educ. Psychol.* 70:102079. doi: 10.1016/j.cedpsych.2022.102079

Blackwell, L. S., Trzesniewski, K. H., and Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: a longitudinal study and an intervention. *Child Dev.* 78, 246–263. doi: 10.1111/j.1467-8624.2007.00995.x

Bonne, L., and Johnston, M. (2016). Students' beliefs about themselves as mathematics learners. *Think. Skills Creat.* 20, 17–28. doi: 10.1016/j.tsc.2016.02.001

Bostwick, K. C. P., Collie, R. J., Martin, A. J., and Durksen, T. L. (2020). Teacher, classroom, and student growth orientation in mathematics: a multilevel examination of growth goals, growth mindset, engagement, and achievement. *Teach. Teach. Educ.* 94:103100. doi: 10.1016/j.tate.2020.103100

Bryan, C. J., Hecht, C. A., Blazar, D., Kraft, M. A., and Solheim, J. (2021). Global mindset initiative working paper 2: Designing an intervention to motivate growth mindset-supportive teaching practices. SSRN. Available at: https://ssrn.com/abstract=3911995

Buehl, M. M., and Beck, J. S. (2015). "The relationship between teachers' beliefs and teachers' practice" in *International handbook of research on teachers' beliefs*. eds. H. Fives and M. G. Gill (UK: Routledge), 66–84.

Burgoyne, A. P., Hambrick, D. Z., and Macnamara, B. N. (2020). How firm are the foundations of mind-set theory? The claims appear stronger than the evidence. *Psychol. Sci.* 31, 258–267. doi: 10.1177/0956797619897588

Cai, J., Wen, Q., Qi, Z., and Lombaerts, K. (2023). Identifying core features and barriers in the actualization of growth mindset pedagogy in classroom. *Soc. Psychol. Educ.* 26, 485–507. doi: 10.1007/s11218-022-09755-x

Cartwright, T. J., and Hallar, B. (2018). Taking risks with a growth mindset: long-term influence of an elementary pre-service after school science practicum. *Int. J. Sci. Educ.* 40, 348–370. doi: 10.1080/09500693.2017.1420269

De Kraker-Pauw, E., Van Wesel, F., Krabbendam, L., and Van Atteveldt, N. (2017). Teacher mindsets concerning the malleability of intelligence and the appraisal of achievement in the context of feedback. *Front. Psychol.* 8:1594. doi: 10.3389/fpsyg.2017.01594

DeLuca, C., Coombs, A., and LaPointe-McEvan, D. (2019). Assessment mindset: exploring the relationship between teacher mindset and approaches to classroom assessment. *Stud. Educ. Eval.* 61, 159–169. doi: 10.1016/j.stueduc.2019.03.012

Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality, and development*. UK: Psychology Press.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. US: Random House.

Dweck, C. S. (2010). Even geniuses work hard. *Educ. Leadersh.* 68, 16–20.

Dweck, C. S. (2015). Carol Dweck revisits the growth mindset. Education Week. Available at: https://www.edweek.org/ew/articles/2015/09/23/carol-dweck-revisits-the-growth-mindset.html

Dweck, C. S., and Yeager, D. S. (2019). Mindsets: a view from two eras. *Perspect. Psychol. Sci.* 14, 481–496. doi: 10.1177/1745691618804166

Francome, T., and Hewitt, D. (2020). "My math lessons are all about learning from your mistakes": how mixed-attainment mathematics grouping affects the way students experience mathematics. *Educ. Rev.* 72, 475–494. doi: 10.1080/00131911.2018.1513908

Fraser, D. (2018). An exploration of the application and implementation of growth mindset principles within a primary school. *Br. J. Educ. Psychol.* 88, 645–658. doi: 10.1111/bjep.12208

Frondozo, C. E., King, R. B., Nalipay, M. J. N., and Mordeno, I. G. (2020). Mindsets matter for teachers, too: growth mindset about teaching ability predicts teachers' enjoyment and engagement. *Curr. Psychol.* 41, 5030–5033. doi: 10.1007/s12144-020-01008-4

Gandhi, J., Watts, T. W., Masucci, M. D., and Raven, C. C. (2020). The effects of two mindset interventions on low-income students' academic and psychological outcomes. *J. Res. Educ. Effectiveness* 13, 351–379. doi: 10.1080/19345747.2019.1711272

Gero, G. P. (2013). What drives teachers to improve? The role of teacher mindset in professional learning (Publication No. 3605669) [Doctoral dissertation, The Claremont Graduate University]. ProQuest Dissertations Publishing.

Gill, M. G., and Fives, H. (2015). "Introduction" in *International handbook of research on teachers' beliefs* (UK: Routledge), 1–10.

Gleason, S. M. (2018). Investigation of Teacher Mindset and Classroom Practices (Publication No. 10252310) [Doctoral dissertation, William James College]. ProQuest Dissertations Publishing.

Good, C., Aronson, J., and Inzlicht, M. (2003). Improving adolescents' standardized test performance: an intervention to reduce the effects of stereotype threat. *J. Appl. Dev. Psychol.* 24, 645–662. doi: 10.1016/j.appdev.2003.09.002

Gouëdard, P. (2021). Can a growth mindset help disadvantaged students close the gap? *Pisa in Focus*. 112. doi: 10.1787/20922f0d-en

Graham, S., Ciullo, S., and Collins, A. (2023). Do special and general education teachers' mindset theories about the malleability of writing and intelligence predict their writing practices. *J. Learn. Disabil.* doi: 10.1177/00222194231181915

Griful-Freixenet, J., Struyven, K., and Vantieghem, W. (2021). Toward more inclusive education: an empirical test of the universal design for learning conceptual model among preservice teachers. *J. Teach. Educ.* 72, 381–395. doi: 10.1177/0022487120965525

Gutshall, C. A. (2013). Teachers' mindsets for students with and without disabilities. *Psychol. Sch.* 50, 1073–1083. doi: 10.1002/pits.21725

Gutshall, C. A. (2016). Student perceptions of teachers' mindset beliefs in the classroom setting. *J. Educ. Develop. Psychol.* 6, 135–142. doi: 10.5539/jedp.v6n2p135

Haimovitz, K., and Dweck, C. S. (2017). The origins of children's growth and fixed mindsets: new research and a new proposal. *Child Dev.* 88, 1849–1859. doi: 10.1111/cdev.12955

Hattie, J. (2009). *Visible learning: A synthesis of over 800 Meta-analyses relating to achievement*. UK: Routledge.

Heyder, A., Steinmayr, R., and Cimpian, A. (2023). Reflecting on their mission increases presearvice teachers' growth mindset. *Learn. Instr.* 86:101770. doi: 10.1016/j.learninstruc.2023.101770

Huang, J.-C. (2023). Detecting the relationship of teachers' growth mindset, grit, and receptivity in curriculum reform responding to PISA key-competence areas. *Soc. Psychol. Educ.* 26, 1543–1563. doi: 10.1007/s11218-023-09803-0

Ilhan-Beyaztas, D., and Dawson, E. (2017). A cross-national study of student teachers' views about intelligence: similarities and differences in England and Turkey. *Univ. J. Educ. Res.* 5, 510–516. doi: 10.13189/ujer.2017.050324

Inbar-Furst, H., and Gumpel, T. P. (2015). Factors affecting female teachers' attitudes toward help-seeking or help-avoidance in coping with behavioral problems. *Psychol. Sch.* 52, 906–922. doi: 10.1002/pits.21868

Jones, B. D., Bryant, L. H., Snyder, J. D., and Malone, D. (2012). Preservice and inservice teachers' implicit theories of intelligence. *Teach. Educ. Q.* 39, 87–101.

Jonsson, A.-C., and Beach, D. (2012). Predicting the use of praise among pre-service teachers: the influence of implicit theories of intelligence, social comparison and stereotype acceptance. *Educ. Inq.* 3, 259–281. doi: 10.3402/edui.v3i2.22033

Jonsson, A.-C., Beach, D., Korp, H., and Erlandson, P. (2012). Teachers' implicit theories of intelligence: influences from different disciplines and scientific theories. *Eur. J. Teach. Educ.* 35, 387–400. doi: 10.1080/02619768.2012.662636

Jorif, M., and Burleigh, C. (2020). Secondary teachers' perspectives on sustaining growth mindset concepts in instruction. *J. Res. Innov. Teach. Learn.* 15, 23–40. doi: 10.1108/JRIT-04-2020-0020

Laine, S., Kuusisto, E., and Tirri, K. (2016). Finnish teachers' conceptions of giftedness. *J. Educ. Gift.* 39, 151–167. doi: 10.1177/0162353216640936

Lee, S. L., Chan, H. S., Tong, Y. Y., and Chiu, C. Y. (2023). Growth mindset predicts teachers' life satisfaction when they are challenged to innovate their teaching. *J. Pac. Rim Psychol.* 17. doi: 10.1177/18344909231167533

Levin, B. B. (2015). "The development of teachers' beliefs" in *International handbook of research on teachers' beliefs*. eds. H. Fives and M. G. Gill (UK: Routledge), 48–65.

Li, Y., and Bates, T. C. (2019). You can't change your basic ability, but you work at things, and that's how we get hard things done: testing the role of growth mindset on response to setbacks, educational attainment, and cognitive ability. *J. Exp. Psychol. Gen.* 148, 1640–1655. doi: 10.1037/xge0000669

Makkonen, T., Lavonen, J., and Tirri, K. (2019). General and physics-specific mindsets about intelligence and giftedness: a study of gifted Finnish upper-secondary-school students and physics teachers. *Int. J. Talent Develop. Creativity* 7, 39–52.

Mascret, N., Roussel, P., and Cury, F. (2015). Using implicit measures to highlight science teachers' implicit theories of intelligence. *Eur. J. Psychol. Educ.* 30, 269–280. doi: 10.1007/s10212-015-0249-6

Meierdirk, C., and Fleischer, S. (2022). Exploring the mindset and resilience of student teachers. *Teach. Dev.* 26, 263–278. doi: 10.1080/13664530.2022.2048687

Mesler, R. M., Corbin, C. M., and Martin, B. H. (2021). Teacher mindset is associated with development of students' growth mindset. *J. Appl. Dev. Psychol.* 76:101299. doi: 10.1016/j.appdev.2021.101299

Murphy, M. C., Fryberg, S. A., Brady, L. M., Canning, E. A., and Hecht, C. A. (2021). Global mindset initiative paper 1: growth mindset cultures and teacher practices. *SSRN*. doi: 10.2139/ssrn.3911594

Nalipay, M. J. N., King, R. B., Mordeno, I. G., Chai, C.-S., and Jong, M. S.-Y. (2021). Teachers with a growth mindset are motivated and engaged: the relationships among mindsets, motivation, and engagement in teaching. *Soc. Psychol. Educ.* 24, 1663–1684. doi: 10.1007/s11218-021-09661-8

Pajares, M. F. (1992). Teachers' beliefs and educational research: cleaning up a messy construct. *Rev. Educ. Res.* 62, 307–332. doi: 10.3102/00346543062003307

Park, D., Gunderson, E. A., Tsukayama, E., Levine, S. C., and Beilock, S. L. (2016). Young children's motivational frameworks and math achievement: relation to teacher-reported instructional practices, but not teacher theory of intelligence. *J. Educ. Psychol.* 108, 300–313. doi: 10.1037/edu0000064

Patrick, S. K., and Joshi, E. (2019). "Set in stone" or "willing to grow"? Teacher sensemaking during a growth mindset initiative. *Teach. Teach. Educ.* 83, 156–167. doi: 10.1016/j.tate.2019.04.009

Patterson, M. M., Kravchenko, N., Chen-Bouck, L., and Kelley, J. A. (2016). General and domain-specific beliefs about intelligence, ability, and effort among preservice and practicing teachers. *Teach. Teach. Educ.* 59, 180–190. doi: 10.1016/j.tate.2016.06.004

Paunesku, D., Walton, G. M., Romero, C., Smith, E. N., Yeager, D. S., and Dweck, C. S. (2015). Mindset interventions are a scalable treatment for academic underachievement. *Psychol. Sci.* 26, 784–793. doi: 10.1177/0956797615571017

Pintrich, P. R. (2000). Multiple goals, multiple pathways: the role of goal orientation in learning and achievement. *J. Educ. Psychol.* 92, 544–555. doi: 10.1037/0022-0663.92.3.544

Porter, T., Catalán Molina, D., Cimpian, A., Roberts, S., Fredericks, A., Blackwell, L. S., et al. (2022). Growth-mindset intervention delivered by teachers boost achievement in early adolescents. *Psychol. Sci.* 33, 1086–1096. doi: 10.1177/09567976211061109

Ramirez, G., Hooper, S. Y., Kersting, N. B., Ferguson, R., and Yeager, D. (2018). Teacher math anxiety relates to adolescent students' math achievement. *AERA Open* 4, 1–13. doi: 10.1177/2332858418756052

Rattan, A., Good, C., and Dweck, C. S. (2012). "It's ok – not everyone can be good at math": instructors with an entity theory comfort (and demotivate) students. *J. Exp. Soc. Psychol.* 48, 731–737. doi: 10.1016/j.jesp.2011.12.012

Rau, A. (2016). Exploring the influence of teacher language on fourth grade students' mindsets: a multi-case study. *Qual. Rep.* 21, 1684–1707. doi: 10.46743/2160-3715/2016.2213

Rissanen, I., Kuusisto, E., Hanhimäki, E., and Tirri, K. (2018a). Teachers' implicit meaning systems and their implication for pedagogical thinking and practice: a case study from Finland. *Scand. J. Educ. Res.* 62, 487–500. doi: 10.1080/00313831.2016.1258667

Rissanen, I., Kuusisto, E., Hanhimäki, E., and Tirri, K. (2018b). The implications of teachers' implicit theories for moral education: a case study from Finland. *J. Moral Educ.* 47, 63–77. doi: 10.1080/03057240.2017.1374244

Rissanen, I., Kuusisto, E., Tuominen, M., and Tirri, K. (2019). In search of a growth mindset pedagogy: a case study of one teacher's classroom practices in a Finnish elementary school. *Teach. Teach. Educ.* 77, 204–213. doi: 10.1016/j.tate.2018.10.002

Rissanen, I., Laine, S., Puusepp, I., Kuusisto, E., and Tirri, K. (2021). Implementing and evaluating growth mindset pedagogy – a study of Finnish elementary school teachers. *Front. Educ.* 6:753698. doi: 10.3389/feduc.2021.753698

Ronkainen, R., Kuusisto, E., and Tirri, K. (2019). Growth mindset in teaching: a case study of a Finnish elementary school teacher. *Int. J. Learn. Teach. Educ. Res.* 18, 141–154. doi: 10.26803/ijlter.18.8.9

Sabarwal, S., Adu-Jawdeh, M., and Kapoor, R. (2021). Teacher beliefs: why they matter and what they are. *World Bank Res. Obs.* 37, 73–106. doi: 10.1093/wbro/lkab008

Sarrasin, J. B., Nenciovici, L., Brault Foisy, L.-M., Allaire-Duquette, G., Riopel, M., and Masson, S. (2018). Effects of teaching the concept of neuroplasticity to induce growth mindset on motivation, achievement, and brain activity: a meta-analysis. *Trend. Neurosci. Educ.* 12, 22–31. doi: 10.1016/j.tine.2018.07.003

Schmidt, J. A., Shumov, L., and Kackar-Cam, H. (2015). Exploring teacher effects for mindset intervention outcomes in seventh-grade science classes. *Middle Grades Res. J.* 10, 17–32.

Schnorr, K. (2022). High school teachers describe growth mindset related to teaching pedagogy and students' academic achievement. *Psychology* 13, 994–1008. doi: 10.4236/psych.2022.137068

Seaton, F. S. (2018). Empowering teachers to implement a growth mindset. *Educ. Psychol. Pract.* 34, 41–57. doi: 10.1080/02667363.2017.1382333

Seo, E., and Lee, Y.-K. (2023). Stereotype threat in high school classrooms: how it links to teacher mindset climate, mathematics anxiety, and achievement. *J. Youth and Adoles.* 50, 1410–1423. doi: 10.1007/s10964-021-01435-x

Shim, S. S., Cho, Y., and Cassady, J. (2013). Goal structures: the role of teachers' achievement goals and theories of intelligence. *J. Exp. Educ.* 81, 84–104. doi: 10.1080/00220973.2011.635168

Shoshani, A. (2021). Growth mindset in the maths classroom: a key to teachers' well-being and effectiveness. *Teach. Teach. Theory Pract.* 27, 730–752. doi: 10.1080/13540602.2021.2007370

Snyder, K. E., Makel, M. C., Adelson, J. L., Crawford, B. F., and Barger, M. M. (2021). Concordance and discordance in implicit beliefs about intelligence and giftedness. *Learn. Individ. Differ.* 86:101971. doi: 10.1016/j.lindif.2021.101971

Soleas, E. K., and Hong, J. (2020). The school of hard knocks: pre-service teachers' mindset and motivational changes during their practicum. *Foro de Educación* 18, 237–257. doi: 10.14516/fde.726

Stephens, J. M., Rubie-Davis, C., and Peterson, E. R. (2022). Do preservice teacher education candidates' implicit biases of ethnic differences and mindset toward academic ability change over time? *Learn. Instr.* 78:101480. doi: 10.1016/j.learninstruc.2021.101480

Strahan, D., Hansen, K., Meyer, A., Buchanan, R., and Doherty, J. (2017). Integrating mindset interventions with language arts instruction: an exploratory study with seventh grade students. *Res. Middle Level Educ.* 40, 1–15. doi: 10.1080/19404476.2017.1349986

Sun, K. L. (2019). The mindset disconnect in mathematics teaching: a qualitative analysis of classroom instruction. *J. Math. Behav.* 56:100706. doi: 10.1016/j.jmathb.2019.04.005

Sypré, S., Waterschoot, J., Soenens, B., Verschueren, K., and Vansteenkiste, M. (2022). Do teachers use distinct motivational styles for cognitively gifted learners? The role of effectiveness beliefs, fixed mindset, and misconceptions about giftedness. *Eur. J. Psychol. Educ.* doi: 10.1007/s10212-023-00716-2

Tan, D., and Maeda, Y. (2021). Perceptions of science teachers' growth-mindset practices and U.S. high school students' initial science identity and its development. *Int. J. Sci. Educ.* 43, 2206–2225. doi: 10.1080/09500693.2021.1958021

Tao, V. Y. K., Li, Y., Lam, K. H., Leung, C. W., Sun, C. I., and Wu, A. M. S. (2021). From teachers' implicit theories of intelligence to job stress: the mediating role of teachers' causal attribution of students' academic achievement. *J. Appl. Soc. Psychol.* 51, 522–533. doi: 10.1111/jasp.12754

Tassell, J., Gerstenschlager, N. E., Syzmanski, T., and Denning, S. (2020). A study of factors impacting elementary mathematics preservice teachers: improving mindfulness, anxiety, self-efficacy, and mindset. *Sch. Sci. Math.* 120, 333–344. doi: 10.1111/ssm.12425

Tiekstra, M., and Minnaert, A. (2017). At-risk students and the role of implicit theories of intelligence in educational professionals' actions. *J. Cogn. Educ. Psychol.* 16, 193–204. doi: 10.1891/1945-8959.16.2.193

Tirri, K. (2021). "Growth mindset in learning as teacher's professional ethos" in *The international handbook of teacher ethos: Strengthening teachers, supporting learners*. eds. F. Oser, K. Heinrichs, J. Bauer and T. Lovat (Berlin: Springer), 325–334.

Tirri, K., Eisenschmidt, E., Poom-Valickis, K., and Kuusisto, E. (2021). Current challenges in school leadership in Estonia and Finland: a multiple-case study among exemplary principals. *Educ. Res. Int.* 2021:8855927. doi: 10.1155/2021/8855927

Tirri, K., and Laine, S. (2017). "Teacher education in inclusive education" in *The SAGE handbook of research on teacher education*. eds. D. J. Clandinin and J. Husu (US: SAGE), 761–776.

Truax, M. L. (2018). The impact of teacher language and growth mindset feedback on writing motivation. *Literacy Res. Instruction* 57, 135–157. doi: 10.1080/19388071.2017.1340529

Trzesniewski, K., Yeager, D. S., Molina, D. C., Claro, S., Oberle, C., and Murphy, M. (2021). Global mindset initiative paper 3: measuring growth mindset classroom cultures. *SSRN.* doi: 10.2139/ssrn.3911591

Willingham, J. C., Barlow, A. T., Stephens, D. C., Lischka, A. E., and Hartland, K. S. (2021). Mindset regarding mathematical ability in K-12 teachers. *Sch. Sci. Math.* 121, 234–246. doi: 10.1111/ssm.12466

Yeager, D. S., Carroll, J. M., Buontempo, J., Cimpian, A., Woody, S., Crosnoe, R., et al. (2022). Teacher mindset help explain where a growth-mindset intervention does and doesn't work. *Psychol. Sci.* 33, 18–32. doi: 10.1177/09567976211028984

Yeager, D. S., and Dweck, C. S. (2012). Mindsets that promote resilience: when students believe that personal characteristics can be developed. *Educ. Psychol.* 47, 302–314. doi: 10.1080/00461520.2012.722805

Yeager, D. S., and Dweck, C. S. (2020). What can be learned from growth mindset controversies? *Am. Psychol.* 75, 1269–1284. doi: 10.1037/amp0000794

Yeager, D. S., Hanselman, P., Walton, G. M., Murray, J. S., Crosnoe, R., Muller, C., et al. (2019). A national experiment reveals where a growth mindset improves achievement. *Nature* 573, 364–369. doi: 10.1038/s41586-019-1466-y

Yeager, D. S., Romero, C., Paunesku, D., Hulleman, C. S., Schneider, B., Hinojosa, C., et al. (2016). Using design thinking to improve psychological interventions: the case of growth mindset during the transition to high school. *J. Educ. Psychol.* 108, 374–391. doi: 10.1037/edu0000098

Yeager, D. S., Trzesniewski, K., Tirri, K., Nokelainen, P., and Dweck, C. S. (2011). Adolescents' implicit theories predict desire to for vengeance after peer conflicts: correlational and experimental evidence. *Dev. Psychol.* 47, 1090–1107. doi: 10.1037/a0023769

Yeager, D. S., and Walton, G. M. (2011). Social-psychological interventions in education: they're not magic. *Rev. Educ. Res.* 81, 267–301. doi: 10.3102/0034654311405999

Yu, J., Kreijkes, P., and Salmela-Aro, K. (2022). Students' growth mindset: relation to teacher beliefs, teaching practices, and school climate. *Learn. Instr.* 80:101616. doi: 10.1016/j.learninstruc.2022.101616

Zeeb, H., Ibach, A., Voss, T., and Renkl, A. (2023). How does teachers' noticing students' fixed mindset relate to teachers' knowledge, beliefs, and experience? An exploratory study. *Teach. Teach. Educ.* 130. doi: 10.1016/j.tate.2023.104170

Zeeb, H., Ostertag, J., and Renkl, A. (2020). Towards a growth mindset culture in the classroom: implementation of a lesson-integrated mindset training. *Educ. Res. Int.* 2020:8067619. doi: 10.1155/2020/8067619

Zeng, G., Chen, X., Cheung, H. Y., and Peng, K. (2019). Teachers' growth mindset and work engagement in the Chinese educational context: well-being and perseverance of effort as mediators. *Front. Psychol.* 10:839. doi: 10.3389/fpsyg.2019.00839

Zhang, J., Kuusisto, E., and Tirri, K. (2017). How teachers' and students' mindsets in learning have been studied: research findings on mindset and academic achievement. *Psychology* 8, 1363–1377. doi: 10.4236/psych.2017.89089

Zhang, J., Kuusisto, E., and Tirri, K. (2020). Same mindset, different pedagogical strategies: a case study comparing Chinese and Finnish teachers. *Int. J. Learn. Teach. Educ. Res.* 19, 248–262. doi: 10.26803/ijlter.19.2.15

Zilka, A., Grinshtain, Y., and Bogler, R. (2019). Fixed or growth: teacher perceptions of factors that shape mindset. *Prof. Dev. Educ.* 48, 149–165. doi: 10.1080/19415257.2019.1689524