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Direct impact of mindset on reading-based outcomes in upper elementary students with reading difficulties

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Mindset involves an array of beliefs related to the malleability of certain attributes, including intelligence. One's *growth* mindset comprises a variety of cognitive and motivational factors (e.g., learning goals, effort beliefs) and the perception that skill attainment and outcome in any domain are tethered to personal effort. A *fixed* mindset encompasses goals, beliefs, and perceptions that skill level is not malleable or impacted by effort. Structural equation models tested investigated direct and indirect pathways of mindset and motivational variables (i.e., learning goals, effort beliefs) with reading outcomes (i.e., word reading, fluency, reading comprehension) in a diverse sample of fourth grade students ($n = 408$) with reading difficulties. Results revealed a direct impact of fixed mindset (-0.21 to -0.36) and effort beliefs ($0.18-0.31$) on all standardized, reading-based outcomes. There were no significant mediating pathways. Results are juxtaposed to other research in this area, and practical implications are discussed. Growth mindset appears a robust predictor of positive academic outcomes, and it may be beneficial to facilitate growth mindset in classrooms.

KEYWORDS

mindset, growth mindset, reading, effort beliefs, literacy

Introduction

Research and practice related to mindset has attracted broad attention. For instance, in the past decade the White House Office of Science and Technology Policy assembled key personnel, including researchers and policymakers, to examine future directions in the exploration and application of growth mindset in academic contexts (Shankar and Kalil, 2013). Along the same lines, the *Every Student Succeeds Act* allows states to use social and behavioral outcomes such as student engagement and school climate for accountability purposes (Every Student Succeeds Act, 2016). Increasing national attention is also evidenced by articles in the popular media (e.g., Atlantic, New York Times) focusing on social and emotional factors in academic contexts (e.g., Zinshteyn, 2015; Duckworth, 2016). Notwithstanding emergent interest in mindset and related psychosocial factors, as well as the theoretical and applied advancements in mindset research, there remains gaps in this line of research which have important implications for the dimensionality of mindset, if and how it is linked with educational outcomes, and differences which exist (if any) across age groups, and level of reading proficiency.

Mindset

A fundamental premise of mindset is related to how messages of "effort" are transmitted to and adopted by children, and subsequently, how these internalized messages impact task engagement and achievement (Dweck, 2008). In other words, a child's perceptions of effort may be critically important to how they approach and engage new tasks and material, as well as handle setbacks. A milieu of related attitudes and cognitions related to effort and learning may be viewed as "mindset." Consequently, children may adopt and maintain a *fixed* or *incremental* mindset. They may view certain attributes (e.g., athletic ability, intelligence) as a relatively stable entity not impacted by effort (i.e., fixed), or they may view these same attributes as malleable and continually built as a function of effort and experience (i.e., incremental). In this way, mindset may be deeply embedded in the messages transmitted to children. The incremental (or growth) mindset may facilitate a variety of desirable attitudes, thoughts, motivations, and behaviors which are otherwise associated with performance gains. In these ways, children develop their own 'theory' of growth in developmental domains, existing on a continuum spanning from fixed to growth mindset. The adopted theory impacts how the learner will approach certain learning situations, manage mistakes, and handle setbacks.

To illustrate, in a study involving very young children, researchers demonstrated the type of parental praise of their children's effort at the ages of 14–38 months predicted a growth mindset at 7–8 years (Gunderson et al., 2013). Other studies have corroborated the finding that when children as young as pre-school age are praised for their efforts on non-academic tasks, they will later demonstrate greater effort, persistence, and enjoyment in subsequent tasks (e.g., Cimpian et al., 2007). Thus, a sense of competence and effort beliefs are important considerations in young children as they are linked with ways they view challenges and approach academic and non-academic challenges and tasks.

Mindset in educational settings

Most research and practice with mindset is within educational settings, with primary outcome variables being related to academic and intellectual achievement. In a series of six studies, Mueller and Dweck (1998) revealed that praising fifth graders for effort on a task, as compared to praise for intelligence, increased task persistence, perceived enjoyment, and their subsequent endorsement of a growth mindset. In another experimental study, seventh grade students receiving a growth mindset mentoring session achieved significantly higher reading and math achievement scores than the control groups (Good et al., 2003).

In a seminal study, a growth mindset predicted an upward trajectory in academic achievement over 2 years of middle school, while a fixed mindset predicted a flat trajectory over that same time span (Blackwell et al., 2007). This study also revealed interesting mediational pathways as associations emerged between growth mindset and educational outcomes (i.e., mathematics). Specifically, there were numerous mediating variables linking the predictor and outcome variables, including learning goals (i.e., perceived value of learning); positive effort beliefs (i.e., relative endorsement of belief in link between effort and positive outcomes); positive strategies (i.e.,

effort- and avoidant-based); and helpless attributions (i.e., belief in links between ability and failure). This study was important in terms of better understanding mindset, *how* and *why* it may be related to educational outcomes, as well as supportive of the notion that intervention efforts are successful in terms of enhancing growth mindset and academic achievement.

In a more recent review of the mindset-academic achievement literature, Sisk et al. (2018) performed a two-part meta-analysis. In the first meta-analysis, the relation between mindset and academic achievement was examined, with researchers reporting an average weak correlation ($r = 0.10$) between mindset and outcome variables. In the second meta-analysis, the impact of mindset interventions was examined, with researchers again reporting an overall low effect sizes for mindset interventions upon academic achievement. Sisk et al. do note, however, that students who are academically at-risk or economically disadvantaged may realize academic gains from such interventions. Overall, though, the presence of weak or null effects across studies prompted the researchers to conclude mindset may not have a reliable impact upon academic achievement and that mindset interventions may be more effective when tethered to other interventions. Together, there is equivocal evidence that mindset and effort beliefs may generally promote desirable educational outcomes.

However, Petscher et al. (2021) noted that in the Sisk et al. (2018) meta-analysis, less than 20% involved elementary school samples. A significant portion of the research linking mindset and academic achievement is with adolescent and collegiate samples (e.g., Wilson and Linville, 1982; Blackwell et al., 2007; Hulleman and Harackiewicz, 2009; Farrington et al., 2012; Silva and White, 2013; Romero et al., 2014). Moreover, Petscher et al. (2017) asserted that even among mindset-based studies with elementary school samples, there is a general paucity of those involving standardized outcomes, usage of latent factors for predictor and outcome variables, and consideration of key developmentally appropriate educational outcomes, such as literacy measures. Together, the state of mindset research in younger children, including those with reading difficulties, is underdeveloped.

The purpose of the current study was to build upon the Blackwell et al. (2007) work by examining pathways between mindset, motivational variables, and educational outcomes in upper elementary grades in a sample of students with reading difficulties. Blackwell et al. (2007) examined mindset as it related to mathematics achievement in students transitioning to middle school. Some questions arise to the generalizability of the investigation. That is, do some of the same pathways reported also exist in a younger student sample of low performing readers? It is likely the messages and learning experiences in the years leading up to a middle school transitional stage are critically important to the development of beliefs inherent in mindset. Thus, links between mindset and achievement will be apparent in younger upper elementary students. Also, to what extent does mindset impact reading achievement? Mathematics and reading education are distinct in content, strategies, and educational approaches and interventions. Therefore, distinct relations with mindset and other motivational factors may also exist. Such research will accelerate what is known about how mindset may be linked with reading achievement in an elementary school population. Consequently, this may inform literacy intervention programs.

Mindset and reading

Mindset-based research with elementary grades is critically important given that fundamental attitudes toward learning and foundational skills may have longstanding implications (Gunderson et al., 2013; Stanley et al., 2017). Moreover, as noted by Petscher et al. (2017), reading may be the most significant academic skill developing throughout the elementary and secondary school years (Language and Reading Research Consortium, 2015; Tighe et al., 2015). Given its salience in elementary school and implications for future success in reading, reading development and outcomes may be a critical area for growth mindset intervention and research. A growth mindset may facilitate future reading success by promoting student resilience particularly for students who have reading difficulties as they encounter increasingly challenging vocabulary and text.

Some recent work has delved more deeply in mindset and reading for elementary students. In one study, Petscher et al. (2017) revealed that in addition to a general mindset, a *reading-specific* mindset was associated with core literacy outcomes (i.e., reading comprehension) in fourth-grade students. This reading-specific mindset and reading comprehension relation was most evident in readers with high comprehension skills. A follow-up study demonstrated distinct profiles of students, including those students labeled as 'fixed mindset-high effort" with a profile consisting of the lowest reading comprehension and vocabulary scores, and students with a 'growth mindset-high effort' profile consisting of the highest comprehension and vocabulary scores (Petscher et al., 2021).

Pertinent to students struggling to read or otherwise at risk for reading difficulties, a series of studies have revealed links between mindset and outcomes in struggling readers. For instance, Cho et al. (2015) demonstrated that students at risk for reading difficulty (i.e., less than 25th percentile on reading comprehension measures) had lower self-efficacy than peers reading at a typical level. A subsequent study revealed struggling readers with higher levels of reading competence maintained enhanced word reading and comprehension scores. In this same study, it was also apparent that a mastery 'climate' in the classroom was linked positively with reading comprehension (Cho et al., 2018). More recently, Cho et al. (2019) demonstrated the effects of mindset on engagement and reading comprehension were mediated by mastery and performance-avoidance goal orientations. In addition, these goal orientations were indirectly related to reading comprehension via emotional engagement (or the self-reported positive affects elicited during reading tasks). These findings hold important practical implications in terms of fostering mastery orientations, interest, and enjoyment of reading. Together, some recent research has indicated mindset is linked with reading achievement, including for students with reading difficulties. However, more research is warranted which examines links between growth mindset and associated constructs, and literacy-based outcomes in early elementary school.

Research questions

In the current study, we examined the nature of mindset and reading in a sample of elementary school students with reading difficulties. These research questions are aimed at better understanding the dimensionality of mindset, as well as the degree to which it may be associated with standardized reading outcomes in a sample of young students at risk for reading difficulties. More specifically, researchers investigated how mindset is linked with reading achievement through a short-term longitudinal design focusing on a couple of core research questions:

Research Question 1. What are the direct effects of mindset and motivational variables (i.e., learning goals, effort beliefs) on reading outcomes (i.e., word reading, fluency, reading comprehension) in fourth grade students with reading difficulties?

Research Question 2. Do motivational factors (i.e., learning goals, effort beliefs) mediate the links between mindset and reading outcomes (i.e., word reading, fluency, reading comprehension) in fourth grade students with reading difficulties?

Method

Participants

Participants were 408 fourth grade students from the Southeast region of the US, comprised of 40.40% female students ($n = 165$), 36.0% male students ($n = 147$), and 23.5% not reporting this variable ($n = 96$). Moreover, participants included 34.1% Hispanic ($n = 139$), 10.3% non-Hispanic White ($n = 42$), 35.5% non-Hispanic Black ($n = 145$), 1.2% reporting other ($n = 5$), and another 19.6% not reporting this variable ($n = 80$). Among 39.71% of participants who responded to their English proficiency ($n = 162$), 35.19% of participants ($n = 57$) were designated as English Language Learner (ELL) or Limited English Proficiency (LEP). Additionally, respondents indicating special education status ($n = 26$) represented 6.4% of the overall sample.

Procedure

The sample was drawn from a larger intervention study (Wanzek et al., 2021). In that study, two cohorts of students were recruited for participation. Researchers recruited students including those identified with or at-risk for reading disability who scored below the 30th percentile on a screening test, the Test of Word Reading Efficiency-2; TOWRE-2, Torgesen et al. (2012). Thereafter, students were assigned to one of groups: (1) a reading intervention; (2) reading and mindset intervention; (3) typical school services. Student participants were assessed for reading and mindset measures at pre-test (i.e., September) and post-test (i.e., April) intervals, approximately capturing an academic school year (Wanzek et al., 2021). This sample and data from the non-intervention group (i.e., typical school services) was used in the current analysis and study.

It should be noted the data has been used in one other scholarly work (Petscher et al., 2021) in which psychometric properties of a mindset scale were analyzed and reported. Compared to the intervention study and psychometric analysis, in the current study a short-term longitudinal approach was undertaken, with analysis more explicitly linking mindset, motivational factors, and reading outcomes.

Measures

Student participants were assessed on predictor variables (i.e., mindset, learning goals, effort beliefs) in the beginning of the Fall term and the outcome reading achievement measures (i.e., word reading, fluency, reading comprehension) at the end of the Spring term in an academic school year.

Mindset, learning goals, and effort beliefs measures

To assess predictor variables of mindset, learning goals, and effort beliefs, an adapted version of the *Student Mindset Survey* (Blackwell et al., 2007) was used. The adaptation was made to generate age appropriate for younger grades (Wanzek et al., 2021). Students rated these items on a Likert-type scale ranging from 1 = disagree a lot, 2 = disagree, 3 = disagree a little, 4 = agree a little, 5 = agree, and 6 = agree a lot. The adapted survey includes eight items related to perceptions of effort and learning goal orientation. One fixed factor assessed mindset in the current analysis, whereas multiple items factored into learning goals (3 items) and effort beliefs (4 items). Petscher et al. (2017) performed a psychometric analysis on the Student Mindset Survey, with the eight general mindset items demonstrating $\alpha = 0.76$.

Reading measures

Reading comprehension

Reading comprehension measures were assessed using the Passage Comprehension (WJPC) subtest of Woodcock Johnson IV Tests of Achievement (WJ-IV ACH; Schrank et al., 2014) and the comprehension subtest of the Gates-MacGinitie Reading Test (GMRT; MacGinitie and MacGinitie, 2006). On the WJPC, students are asked to identify words that would be appropriate for blank spaces within the passage. On the comprehension subtest of GMRT, students respond to multiple-choice comprehension questions about passages after reading them. The passage comprehension subtest of the WJ-IV has demonstrated split-half reliability estimates of 0.83–0.96 for elementary age students (i.e., 5–11 years of age). For the GMRT, internal consistency reliability estimates ranging from 0.91 to 0.96 have been reported in fourth grade (Wanzek et al., 2021).

Word reading

Word reading was assessed with the Letter Word identification (LWID) subtest and Word Attack (WA) subtest of Woodcock Johnson IV Tests of Achievement (WJ-IV ACH; Schrank et al., 2014). The LWID and WA are untimed measures for assessing students' ability to read words. Students read real words in the LWID and decodable pseudowords in the WA subtest. Internal consistency estimates have demonstrated a range of 0.90–0.99 (Wanzek et al., 2021), and test–retest reliabilities for the LWID are 0.81 (Petscher et al., 2017). The median reliability coefficient for LWID and WA is 0.94 and 0.90, respectively (McGrew et al., 2014).

Fluency

Reading fluency was assessed with measures of word reading fluency and oral reading fluency. We specifically used Test of Word Reading Efficiency-2 (TOWRE-2; Torgesen et al., 2012) subtests for sight word efficiency (SWE) and phonemic decoding efficiency (PDE)

for measuring word reading fluency. Students read a list of real words in the SWE and a list of decodable pseudowords in the PDE in the limited time. The average test–retest reliability of the TOWRE-2 is estimated at 0.87 (Wanzek et al., 2021). We also used the oral reading fluency (ORF) subtest in the sixth edition of Dynamic Indicators of Basic Early Literacy Skills (DIBELS-6) to assess ORF, where students read three stories for 1 min each. The ORF scores were calculated separately for each story based on the number of words correctly read by the students in the minute. The median across scores of three stories, which is practically used for screening purposes, were used in this study. The test–retest reliability estimates range from 0.92 to 0.97 for elementary school students.

Analysis

To address our research questions, a series of analyses were conducted with *Mplus* 8.4. We first established measurement models of mindset, learning goals, effort beliefs, and literacy outcomes for structural equational modeling (SEM) using confirmatory factor analyses (CFA). The latent variables of mindset, learning goals, and effort beliefs were constructed with the associated items. The measurement models were a replication of confirmatory factor analysis model conducted in Petscher et al. (2021). The latent variable of mindset was established with a single-item indicator. To do so, the factor loading was fixed to 1.0 and residual variance was calculated based on the formula of $(1 - \alpha) \times \sigma^2$ where α is the reliability of the assessment and σ^2 is sample variance. After constructing latent variables, three CFA models: a 1-factor model, a bi-factor model, and a 3-factor model, were estimated with the three factors of mindset, learning goals, and effort to understand the relations among the variables. The 1-factor model had a single factor including all the items of fixed mindset, learning goals, and effort beliefs without the distinction between variables. This 1-factor model reflected the adapted version of *Student Mindset Survey* which includes all three constructs in a single measure. The bi-factor model was constructed with a general factor loaded by all items with three factors of mindset, learning goals, and effort beliefs. The 3-factor model indicated three correlated factors of mindset, learning goals, and effort beliefs. Regarding outcome literacy measures, we also tested and compared several CFA models (i.e., 1-factor, 3-factor, bi-factor). The 1-factor model was a unidimensional model including all items across different literacy measures. The 3-factor model included three correlated literacy latent variables: reading comprehension (GATES RC and WJPC), word reading (WJLW and WJWA), and reading fluency (SWE, PDE, and DIBELS). The bi-factor model was constructed with a general reading factor loaded by all items in addition to uncorrelated three factors. Raw scores of literacy measures were used and standardized for analyses to avoid convergence issues. Based on the individual measurement models determined in the previous analyses, we established an integrated measurement model including all latent variables in order to explore their relationships. After that, structural equation modeling (SEM) was employed to examine the predictive impact of mindset, learning goals, and effort beliefs on literacy outcomes (Model 1), as well as the potential mediating impact of learning goals and effort beliefs on the relation between mindset and literacy outcomes (Model 2). Model 1 and Model 2 were designed based on Blackwell et al. (2007) where fixed mindset negatively

impacted mathematics achievement among 7th grade through learning goals and positive beliefs about effort. We replicated the mediation model with reading achievement of elementary school students.

Each model was evaluated and compared using χ^2 based model fit indices: the comparative fit index (CFI), Tucker-Lewis Index (TLI), and the root mean square error of approximation (RMSEA). The model demonstrated CFI and TLI equal to or above 0.95, and RMSEA equal to or below 0.05, all of which are commensurate with having a good model fit (Hu and Bentler, 1999). Different estimators were used depending on types of items (i.e., categorical vs. continuous variables). Maximum likelihood (ML) was used for estimating CFA models for literacy measures. Weighted least square mean and variance adjusted (WLSMV) was used for the rest of the analyses (i.e., CFA or SEM models including mindset, learning goals, or effort beliefs).

Results

Descriptive statistics

Mindset, learning goals, and effort beliefs demonstrated less than 2% of missing data. However, literacy measures had approximately 12.25% missing data (Gates Reading Comprehension: $n = 50$; WJLW: $n = 49$; WJPC: $n = 49$; WJWA: $n = 49$; *TOWRE Sight Word Efficiency*: $n = 49$; TOWRE Phonetic Efficiency: $n = 49$; DIBELS: $n = 50$). The missing data were completely at random (Little's MCAR test: $\chi^2 = 204.82$, $p = 0.09$). All missing data were handled with Full Information Maximum Likelihood (FIML). Descriptive statistics and correlations among primary study variables are indicated in Table 1, which indicates that students endorsed mixed mindset ($M = 3.75$, $SD = 1.98$), higher learning goal ($M = 4.65$, $SD = 1.21$), and more positive belief about effort ($M = 4.83$, $SD = 0.97$) in average. Consistent with their screening eligibility for the study, students showed various, but generally lower levels of reading achievement. Average raw scores

of each reading measure indicated approximately half of the students were at or lower than the 5th–25th percentile depending on literacy measures (i.e., Gates Reading Comprehension ≤ 21st percentiles; WJLW ≤ 16th percentile; WJPC ≤ 5th percentile; WJWA ≤ 24th percentile; TOWRE Sight Word Efficiency ≤ 19th percentiles; TOWRE Phonetic Efficiency ≤ 16th percentiles; DIBELS $\leq$ *at risk*). Literacy measures demonstrated strong associations with one another ($r = 0.46 \sim 0.83$, ps < 0.01). Except for WJPC, all literacy measures were positively correlated with learning goals ($r = 0.13 \sim 0.23$, ps < 0.05) and effort beliefs ($r = 0.19 \sim 0.27$, $p < 0.01$) with a small effect size. Fixed mindset showed a negative significant correlation with all literacy measures ($r = -0.20 \sim -0.12$, ps < 0.05) except for TOWRE Sight word efficiency ($p > 0.10$). Learning goals and effort beliefs had a strong correlation ($r = 0.48$, $p < 0.01$); however, there were no significant correlations between fixed mindset and effort beliefs and between fixed mindset and learning goals (ps > 0.10).

The measurement model

Mindset, learning goals, and effort beliefs

The bi-factor model for fixed mindset, learning goals, and effort beliefs was not identified. On the other hand, the 1-factor model and the 3-factor model (Table 2) did provide reasonable model fits (1-factor model: $\chi^2(20) = 56.60$, RMSEA = 0.067 90% C.I. [0.047, 0.088], CFI = 0.96, TLI = 0.94; the 3-factor model: $\chi^2(18) = 45.60$, RMSEA = 0.061 90% C.I. [0.039, 0.084], CFI = 0.97, TLI = 0.95). The 3-factor model was chosen for measurement model of mindset, learning goals, and effort beliefs based on chi-square difference test [$\Delta\chi^2(2) = 11$, $p < 0.05$] and theoretical evidence supporting three factors in the measurement.

Literacy

Model fit of literacy CFA model was indicated in Table 2. Although all models did not initially present good model fit to data (1-factor:

TABLE 1 Descriptive statistics and correlations for observed measures.

	FM	LG	Effort	GMRTC	WJPC	WJLW	WJWA	SWE	PDE	DIBELS
FM	–	0.01	−0.04	−0.20**	−0.12*	−0.13*	−0.17**	−0.09	−0.14**	−0.17**
LG		–	0.48**	0.13*	0.07	0.19**	0.23**	0.23**	0.20**	0.20**
Effort			–	0.21**	−0.02	0.19**	0.27**	0.23**	0.26**	0.26**
GMRTC				–	0.47**	0.58**	0.55**	0.54**	0.54**	0.67**
WJPC					–	0.69**	0.53**	0.55**	0.46**	0.52**
WJLW						–	0.79**	0.74**	0.76**	0.76**
WJWA							–	0.66**	0.82**	0.71**
SWE								–	0.76**	0.83**
PDE									–	0.81**
DIBEL										–
N	405	408	407	358	359	359	359	359	359	358
M	3.75	4.65	4.83	20.56	25.36	48.38	18.04	58.09	25.50	89.41
SD	1.93	1.21	0.97	9.35	4.27	7.49	6.28	13.59	12.71	38.26

FM, Fixed Mindset; LG, Learning Goals; Effort, Effort Beliefs GMRTC, Gates Reading Comprehension; WJPC, Woodcock-Johnson Passage Comprehension; WJLW, Woodcock-Johnson Letter-Word Identification; WJWA, Woodcock-Johnson Word Attack; SWE, TOWRE Sight Word Efficiency; PDE, TOWRE Phonemic Decoding Efficiency.
**$p < 0.01$, *$p < 0.05$.

TABLE 2 Model fit for measurement models.

Model	χ^2	df	RMSEA			Value of p	CFI	TLI
			Estimate	LB	UB			
CFA models of fixed mindset, learning goals, and effort beliefs								
1-factor model	56.60	20	0.067	0.047	0.088	0.081	0.96	0.94
3-factor model	45.60	18	0.061	0.039	0.084	0.182	0.97	0.95
bi-factor model			*This model was not identified*					
CFA models of literacy measures								
1-factor model	239.66	14	0.212	0.189	0.236	0.000	0.90	0.84
Rev. 1-factor model	29.24	8	0.086	0.054	0.121	0.034	0.99	0.97
3-factor model	181.78	11	0.208	0.182	0.235	0.000	0.92	0.85
Rev. 3-factor model	13.55	7	0.051	0.000	0.092	0.427	1.00	0.99
bi-factor model	159.70	7	0.247	0.214	0.280	0.000	0.93	0.79

Rev. 1-factor model = 1-factor model + residual covariance; Rev. 3-factor model = 3-factor model + residual covariance. The bi-factor model for mindset, learning goals and effort beliefs was not identified.

$\chi^2(14) = 239.66$, RMSEA = 0.212 90% C.I. [0.189, 0.236], CFI = 0.90, TLI = 0.84; 3-factor: $\chi^2(11) = 181.78$, RMSEA = 0.208 90% C.I. [0.182, 0.235], CFI = 0.92, TLI = 0.85; bifactor: $\chi^2(8) = 159.70$, RMSEA = 0.247 90% C.I. [0.214, 0.280], CFI = 0.93, TLI = 0.79), the 1-factor model and 3-factor model could be appropriately improved with the guidance of modification indices. For the revised 1-factor model, six residual covariance (WJPC and WJLW, DIBELS and SWE, DIBELS and GATES RC, DIBELS and PDE, PDE and WJWA, PDE and SWE) was added to the 1-factor model. The revised 3-factor model was refined by including additional four residual covariance (PDE and WJWA, DIBELS and GATES_RC, WJPC and WJLW, PDE and WJLW). The revised 1-factor model showed reasonable model fit ($\chi^2(8) = 29.24$, RMSEA = 0.086 90% C.I. [0.054, 0.121], CFI = 0.99, TLI = 0.97); however, the revised 3-factor model provided a better model fit to the data ($\chi^2(7) = 13.55$, RMSEA = 0.051 90% C.I. [0.000, 0.092], CFI = 1.00, TLI = 0.99). The chi-square of the revised 3-factor model is significantly different from that of the revised 1-factor model ($\Delta\chi^2(1) = 15.69$, $p < 0.01$). Therefore, the revised 3-factor model was chosen for further analysis.
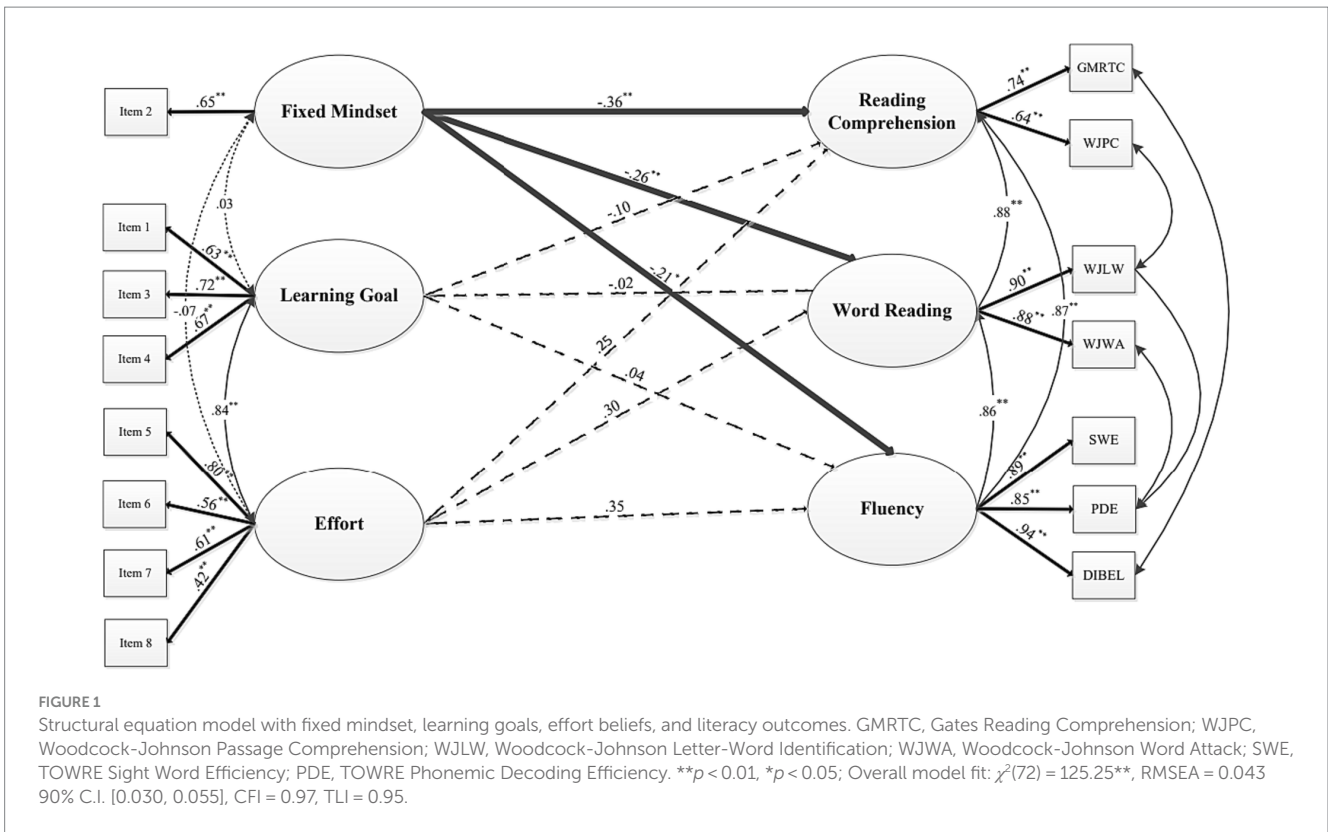
Integrated measurement model

Based on the measurement model of predictors (fixed mindset, learning goal, effort beliefs) and outcome (literacy measures), the integrated measurement model was established to investigate factor correlations between all latent variables. Fixed mindset was negatively correlated with three literacy measures ranging from a weak to moderate degree: reading comprehension ($\psi = -0.38$, $p < 0.01$), word reading ($\psi = -0.28$, $p < 0.01$), and reading fluency ($\psi = -0.24$, $p < 0.01$). Learning Goals showed positive and weak correlation with word reading ($\psi = 0.23$, $p < 0.01$) and reading fluency ($\psi = 0.25$, $p < 0.01$) although there was no significant correlation between learning goals and reading comprehension ($\psi = 0.10$, $p > 0.05$). Effort beliefs had weak to moderate correlation with reading comprehension ($\psi = 0.19$, $p < 0.01$), word reading ($\psi = 0.30$, $p < 0.01$), and reading fluency ($\psi = 0.33$, $p < 0.01$). The factor correlations between three literacy and between learning goals and effort were strong ($\psi = 0.84 \sim 0.89$, $ps < 0.01$). Fixed mindset was not significantly correlated with learning goals and effort ($\psi = -0.07 \sim 0.03$, $ps > 0.05$).

Structural equation model (SEM)

Model 1 tested the direct effects of mindset, learning goals, and effort beliefs on the three literacy outcomes. Model 1 had a good overall model fit ($\chi^2(72) = 125.25$, RMSEA = 0.043 90%C.I.[0.030, 0.055], CFI = 0.97, TLI = 0.95). However, despite the factor correlations between two literacy outcomes (i.e., Word Reading, Reading Fluency) and learning goals (Word Reading: $\psi = 0.23$, $p < 0.01$; Reading Fluency: $\psi = 0.25$, $p < 0.001$) and between all literacy outcomes and effort beliefs (Reading Comprehension: $\psi = 0.19$, $p < 0.01$; Word Reading: $\psi = 0.30$, $p < 0.001$; Reading Fluency: $\psi = 0.33$, $p < 0.001$) in the integrated measurement model, learning goals and effort beliefs did not predict any literacy outcomes ($p > 0.05$), after controlling for the effect of other predictor variables on literacy outcomes in Model 1 (Figure 1). This result might indicate a suppression effect resulting from the high correlations ($\psi = 0.84$, $p < 0.001$) between the two exogenous variables: learning goals and effort beliefs. Therefore, the learning goals factor was excluded in the Model 1 considering its lower correlations with literacy outcomes in comparison with effort beliefs. Without learning goals in the model, the sample size was reduced to 407 because a case responded only to items in the learning goals variable. This revised Model 1 also had a good overall model fit ($\chi^2(41) = 71.92$, RMSEA = 0.043 90%C.I.[0.026, 0.059], CFI = 0.97, TLI = 0.96). Effort beliefs predicted three literacy outcomes (Reading Comprehension: $\gamma = 0.18$, $p < 0.05$; Word Reading: $\gamma = 0.28$, $p < 0.001$; Reading Fluency: $\gamma = 0.31$, $p < 0.001$). Fixed mindset also showed its predictive negative effect on literacy outcomes (Reading Comprehension: $\gamma = -0.36$, $p < 0.01$; Word Reading: $\gamma = -0.26$, $p < 0.01$; Reading Fluency: $\gamma = -0.21$, $p < 0.05$).

We excluded the variable of learning goals in Model 2 to avoid multicollinearity issues between learning goals and effort beliefs and labeled the model as the revised Model 2. The revised Model 2 tested a mediating effect of effort beliefs on the path from fixed mindset to literacy outcomes. We estimated direct effect of fixed mindset on literacy outcomes and indirect effect of fixed mindset on literacy outcomes through effort beliefs. The revised Model 2 had a good overall model fit, $\chi^2(41) = 71.92$, RMSEA = 0.043 90%C.I.[0.026, 0.059], CFI = 0.97, TLI = 0.96. Fixed mindset and effort beliefs remained direct predictive effects on each literacy outcomes. However, there were no

FIGURE 1
Structural equation model with fixed mindset, learning goals, effort beliefs, and literacy outcomes. GMRTC, Gates Reading Comprehension; WJPC, Woodcock-Johnson Passage Comprehension; WJLW, Woodcock-Johnson Letter-Word Identification; WJWA, Woodcock-Johnson Word Attack; SWE, TOWRE Sight Word Efficiency; PDE, TOWRE Phonemic Decoding Efficiency. **$p < 0.01$, *$p < 0.05$; Overall model fit: $\chi^2(72) = 125.25$**, RMSEA = 0.043 90% C.I. [0.030, 0.055], CFI = 0.97, TLI = 0.95.

indirect effect of mindset on literacy outcomes through effort beliefs (Reading Comprehension: *Estimate* = −0.01, $p > 0.05$; Word Reading: *Estimate* = −0.02, $p > 0.05$; Reading Fluency: *Estimate* = −0.03, $p > 0.05$) because of insignificant coefficient path from fixed mindset to effort ($\gamma = -0.08$, $p > 0.05$) as viewable in Figure 2.

Discussion

The primary research questions for this study included investigation of the presence and extent of associations between predictor (mindset, learning goals, effort beliefs) and reading outcome variables (i.e., reading comprehension, word reading, and fluency) in a sample of a fourth-grade students with reading difficulties. In addition, we examined whether the learning goals and effort beliefs mediated the mindset-reading links. Additional ways in which this study extends the literature base of growth mindset is the consideration of standardized literacy-based measures as outcome variables in a sample of elementary school students with reading difficulties.

To the first research question, there were broad and notable associations between mindset and other primary study variables (as shown in Table 1). More specifically, a growth mindset was associated with scores in higher reading comprehension, word reading, and fluency. When juxtaposed to previous research in this area (e.g., Blackwell et al., 2007; Petscher et al., 2017; Cho et al., 2019; Yeager et al., 2019), this study further corroborates that a growth mindset is a robust predictor of positive outcomes in academic areas. Therefore, school and home environments which foster belief systems and attitudes in relation to the importance of effort and practice may be beneficial for students.

To the second research question, there were no apparent mediating links between mindset and reading outcomes by motivational variables such as effort beliefs and learning outcomes. However, in the final model (Figure 2) effort was maintained as a significant, independent predictor of reading outcomes. These results diverge to some degree from Blackwell et al.'s (2007) findings that mindset and math outcomes were mediated by an array of motivational and behavioral factors in middle school. In the current analysis, effort beliefs and learning goals may have been inextricably linked, but still indicative of a key motivational variable predictive of a positive educational trajectory. These direct pathways linking mindset and effort beliefs upon outcomes may be considered in relation to the sample being analyzed. This study one of a small but emerging set of studies to examine reading in an elementary school sample (e.g., Petscher et al., 2017, 2021), and the subsequent links between mindset, motivational factors, and literacy may be drawn out in unique ways. Over time, and in conjunction with development of increasingly critical and complex cognitive capabilities, a growth mindset may consequently become a more elaborate network of cognitive, motivational, and behavioral factors (as demonstrated by Blackwell et al., 2007). In upper elementary school age children, messages of effort and practice remain important, although may have simpler associations with academic achievement. Future research may also explore these relations in even younger students.

Given the evidence from the current study linking a growth mindset and effort with reading outcomes, and when juxtaposed to research indicating the importance of early interventions for students with reading difficulties (e.g., Solari et al., 2020), it may be critically important for practitioners to facilitate the growth mindset and effort beliefs of young students alongside evidence-based intervention
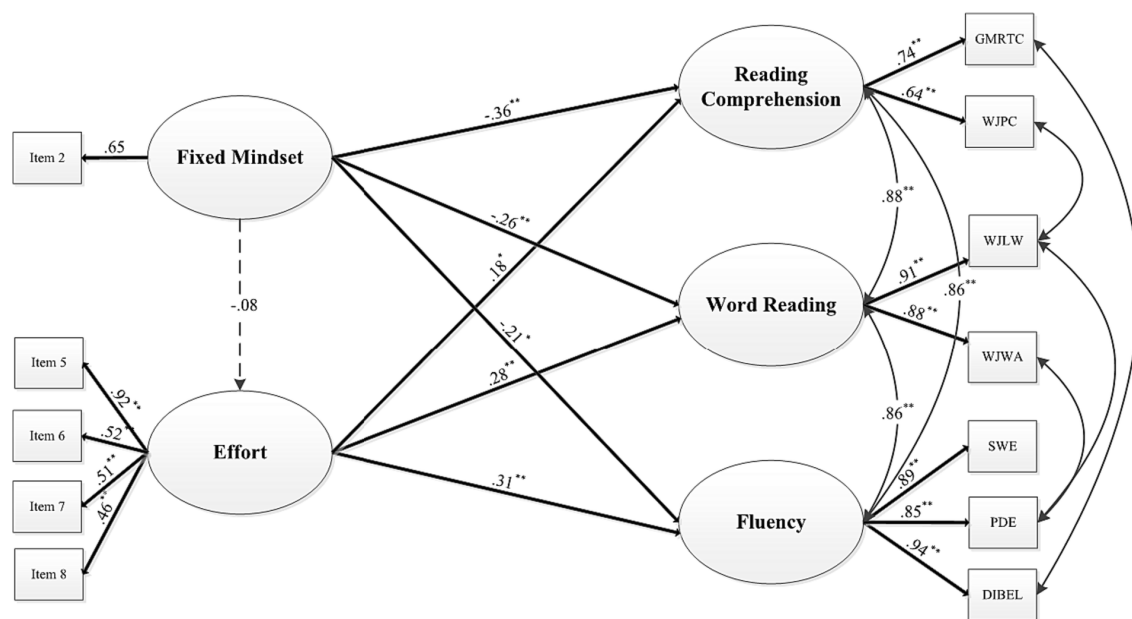
FIGURE 2
The final structural equation model with fixed mindset, effort, and literacy outcomes. Effort = Effort beliefs. GMRTC, Gates Reading Comprehension; WJPC, Woodcock-Johnson Passage Comprehension; WJLW, Woodcock-Johnson Letter-Word Identification; WJWA, Woodcock-Johnson Word Attack; SWE, TOWRE Sight Word Efficiency; PDE, TOWRE Phonemic Decoding Efficiency. **$p < 0.01$, *$p < 0.05$ Overall model fit: $\chi^2(41) = 71.92$**, RMSEA = 0.043 90%C.I.[0.026, 0.059], CFI = 0.97, TLI = 0.96.

strategies. Consistent with Sisk et al's (2018) recommendation that mindset interventions be tethered to other educational interventions; existing effective reading interventions may be supplemented with mindset interventions. Along these lines, Wanzek et al. (2021) compared a reading intervention to a reading intervention supplemented with a mindset intervention in fourth grade students with reading difficulties. The researchers employed the *Brainology* mindset program (Mindset Works, 2016), with findings revealing the mindset intervention did not appear to add consistent value above and beyond the reading intervention. However, in another intervention study, researchers reported that a brief, replicable growth mindset module was linked with math achievement in a national representative sample of high school students (Yeager et al., 2019). Thus, more research appears warranted which isolates how and when mindset may be most effectively introduced in school settings, whether in the general curriculum or within specific interventions for students with reading difficulty.

Related work supports the notion that educational contexts (e.g., classrooms, intervention modules, etc.) can foster non-cognitive skills and associated outcomes (Farrington et al., 2012). Notably, results from a meta-analysis revealed that when compared to control groups, students participating in a social and emotional learning (SEL) intervention program demonstrated an overall 11 percentile-point gain in achievement (Durlak et al., 2011). Mindset may be integrated as one of the competency targets in SEL programs.

Limitations and future directions

The current study included the examination of reading measures in a sample of fourth graders. While these factors represent novel

advancements in scholarship in this area, they may also represent a limitation in generalizability. Our measure involved only self-report by students; future research could include observations or teacher or parent report. More research may investigate reading in students of this age (and younger) to corroborate these findings. Research in younger grades (e.g., kindergarten through third grade) would offer insight into how mindset and beliefs impact the most fundamental aspects of reading, which typically have been attained to some degree by fourth grade. It should also be noted that almost 70% of the sample in this analysis reported a Black or Latinx background with no other reported racial or ethnic group percentage being greater than approximately 10%. Thus, findings may be most applicable to these groups comprising the majority of the sample. Future research may benefit from more balanced representation of other groups to permit multiple group modeling and comparisons. Future research may also examine if there are 'carry over' effects with mindset and effort beliefs in one domain (e.g., athletics, music, art) pervading other areas (e.g., academics).

The effectiveness of interventions may depend on a variety of moderating factors, including how closely aligned the mindset program is with the specific area(s) of need but also the broader 'climate' which exists in the school setting (Yeager et al., 2019). Mindset messages and interventions which are inconsistent with the skills being targeted in the intervention or which otherwise do not seem to cohere with the messages received with the school, impact may be limited. For mindset to be more fully absorbed by students, global and domain specific messages may need to be consistently disseminated over time, across contexts. A variety of individuals (e.g., caregivers, family members, educators, coaches) from core developmental contexts (e.g., home, school, athletics) may offer a steady 'trickle' of messages that may become more fully internalized

by children. Along these lines, a 'funds of knowledge' approach may facilitate broader impacts upon skill-building, including a growth mindset. This approach entails educators understand the social and culture bases of students' lives, which in turn may facilitate educational experiences (Moll, 2019). This approach allows educators to arrange educational settings in personally meaningfully and engaging ways for the student. Aims to create broader environments (e.g., home, school, athletics) which are aligned to consistently engage and empower students may be more useful in impacting change in mindset (and academic achievement) than individualized interventions.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Florida State University Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/ next of kin in accordance with the national legislation and institutional requirements.

Author contributions

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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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