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META-ANALYSIS

Blending Teacher Autonomy Support and Provision of Structure in the Classroom for Optimal Motivation: A Systematic Review and Meta-Analysis

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Abstract

Teacher autonomy support and provision of structure are crucial for students' learning and motivation, yet it is unclear how to best blend them. Research describes autonomy support and structure as independent but mutually supportive, equivalent, and even opposite. These contradictions jeopardize the generalizability of findings across studies and hamper classroom implementation. Our meta-analysis aims to disentangle the dynamics between autonomy support and structure by synthesizing their definitions, relationships, and effects on students. Following PRISMA guidelines, 94 studies and 110 effect sizes were identified through databases (PsycINFO, ERIC, Education Research Complete, Psychology and Behavioral Sciences Collection, Teacher Reference Center, ProQuest Education Database, and ProQuest Theses & Dissertations) and forward reference searches. Dissertations and peer-reviewed articles examining teacher autonomy support and structure were included. Our synthesis revealed intertwined conceptualizations and plentiful operationalizations of autonomy support and structure. Autonomy support and structure reinforced each other, with a large effect size. This relationship was moderated by the data collection method and school level and appears to be universal. Autonomy support and structure both elevated students' motivation, engagement, and need satisfaction with moderate to large effect sizes. Teachers who facilitate autonomy and structure were motivated to teach and felt effective as teachers. Our findings suggest blending autonomy support and structure for optimal growth of students and teachers.

Keywords Autonomy support · Structure · Competence · Need-supportive teaching · Self-determination · Meta-analysis

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Introduction

According to Ryan and Deci's (2000, 2017) self-determination theory, humans strive to satisfy their inner psychological needs for autonomy, competence, and relatedness. These needs are integral to fostering optimal functioning in all aspects of life, including education (Ryan & Deci, 2017). Strong empirical evidence demonstrates the benefits of teachers' support of students' psychological needs for students' motivation (Bureau et al., 2022; Eakman et al., 2019; Filak & Sheldon, 2008; Vasconcellos et al., 2020), well-being (Ferguson et al., 2011; Stanley et al., 2021; Wang et al., 2021a, b), effort (Hardré & Sullivan, 2008; Hein et al., 2018), and engagement (Chen, 2005; Klem & Connell, 2004; Okada, 2023). It also improves teachers' well-being and satisfaction with their jobs (Cheon et al., 2020; Slemp et al., 2020). However, controversies about the definitions and relationship between autonomy support and the provision of structure to foster competency hamper the generalizability of findings across studies and leave teachers guessing how to best blend supports for these two needs in their classrooms. This systematic literature review and meta-analysis focus specifically on autonomy support and the provision of structure to synthesize definitions and identify effect sizes of the relationship among those constructs and their impact on students' learning. We aim to provide clarity about the dynamics between autonomy support and the provision of structure to aid classroom implementation and future research.

Autonomy support and provision of structure are theoretically grounded in Ryan and Deci's (2000, 2017) self-determination theory. Self-determination theory is a contemporary motivation theory describing both the quantity and quality of motivation arising from intrinsic and extrinsic sources (Ryan et al., 2022). The theory explains how motivation develops, shifts, and influences behavior, specifically how students can transition from extrinsic rewards to intrinsic motivation (Ryan & Deci, 2017). This process, known as internalization, enables individuals to transform external values, rules, and norms into personal beliefs and behaviors, motivating them to act because these behaviors align with their sense of self. Intrinsic motivation is engaging in an activity for its own enjoyment or interest. It represents the optimal form of motivation. This empirically bolstered theory emphasizes the importance of supporting students' psychological needs for autonomy and competence for optimal growth. In education, teachers play a significant role in supporting students' sense of autonomy and competency. Evidence-based instructional strategies for autonomy support and the provision of structure to elevate students' competence allow teachers to practice need-supportive teaching in their classrooms.

Teacher Autonomy Support

Teachers' autonomy support aims to facilitate students' sense of autonomy. Autonomy is the need for self-regulation and ownership over one's own experiences and actions. Autonomous students pursue their goals and behaviors in

alignment with their true interests, fully embracing and endorsing them as their own (Reeve & Cheon, 2021; Ryan & Deci, 2017). Autonomy support can be reflected in a teacher's instructional approach and empathetic tone. Autonomy-supportive teachers strive to understand and nurture students' interests, preferences, and emotional well-being, creating an environment where students are motivated to engage willingly and meaningfully in classroom activities. Essentially, teachers who facilitate students' autonomy encourage students to take initiative, make decisions, and actively participate in their own learning (Reeve, 2016).

Aelterman et al. (2019) further distinguish between participative and attuning autonomy-supportive teacher behaviors. A participative teacher engages students in conversation to understand their interests, invites input, offers meaningful choices, and adapts to their pace to support learning. An attuning teacher enhances students' interests by making tasks engaging, validating their emotions, and understanding their perspectives. This teacher allows students to work at their own pace and offers clear, meaningful explanations. These instructional strategies are geared toward nurturing students' autonomous motivation, where students are intrinsically driven to engage in their learning (Ahmadi et al., 2023).

Autonomy-supportive teachers are approachable and offer guidance as needed. Facilitating students' autonomy goes beyond merely encouraging independence. Both autonomous and independent students believe they are the origin of their own actions, but the role of the facilitator differs (Ryan & Deci, 2000). Independence means functioning individually without relying on others for support or help (Chirkov et al., 2003), while autonomous students can choose to rely on the care and support of others (e.g., Deci & Ryan, 2008; La Guardia et al., 2000).

Teacher autonomy support elevates students' learning. Empirical evidence consistently demonstrates that autonomy-supportive teaching is predictive of students' well-being (Ferguson et al., 2011), autonomous motivation (Hagger et al., 2005; Ryan et al., 2022), and engagement in class (Okada, 2023; Reeve & Cheon, 2021). Students in autonomy-supportive learning environments also report feeling competent (Guay et al., 2001), engaging in self-regulated learning (Vansteenkiste et al., 2012), and showing resiliency when facing challenging tasks (Reeve et al., 2020). This positive effect was found across school levels—elementary (Domen et al., 2020), secondary (Cheon et al., 2012), and post-secondary education (Jang et al., 2016) and cultural contexts (Guay et al., 2013; Haerens et al., 2015; Hagger et al., 2015; Yoo, 2015). The consistent benefits of teachers' autonomy support across contexts emphasize its importance for students' learning and development.

Provision of Structure

Teachers provide structure to support students' need for competence. Ryan and Deci (2017) conceptualize competence as the basic need to feel capable and effective in navigating important areas of life. Teachers play a crucial role in fostering students' sense of competence. They can provide structure by tailoring tasks to students' developing skills, offering support, and giving actionable feedback to help them feel competent

to engage in classroom activities (Grolnick & Pomerantz, 2009; Vansteenkiste et al., 2020; Vansteenkiste & Soenens, 2015). Aelterman et al. (2019) further distinguish instructional strategies from a teacher's interpersonal tone when providing structure in offering guidance and clarifications. A guiding teacher offers assistance as needed, demonstrating key steps to help students work independently while remaining available for questions. Through constructive reflection on mistakes, the teacher helps students identify areas for improvement and build their skills. A clarifying teacher clearly communicates expectations to students, providing an overview of the lesson and tracking their progress in meeting those expectations. In providing structure, teachers create a clear roadmap to academic success and provide students with the strategies and scaffolding to get there. These instructional strategies allow students to feel capable of achieving their academic goals and experience competence (Jang et al., 2010; Skinner & Belmont, 1993; Vansteenkiste et al., 2020).

Providing structure is different from control. Teachers implement structure in their classrooms by offering students clear and explicit directions to successfully complete an academic task (Jang et al., 2010). While structure is a way to foster students' sense of competence, control takes it away. Control is an interpersonal instructional behavior where teachers do not take students' perspectives into consideration and instead pressure them to think, feel, or behave in a certain way (Grolnick & Pomerantz, 2009; Reeve, 2009). A controlling instructional style induces stress (Assor et al., 2005), controlled motivation, and fear of failure (Bartholomew et al., 2018). This undermines students' academic motivation, engagement, and performance (Bartholomew et al., 2018; Filippello et al., 2020; Reeve, 2009). Because of those features, Deci and colleagues (1981) originally postulated motivation style as a spectrum, positioning autonomy-supportive strategies at one extreme and controlling approaches at the other. Contemporary discourse has conceptually distinguished control from both autonomy support and the provision of structure (Bartholomew et al., 2018; Grolnick & Pomerantz, 2009; Haerens et al., 2015). Although some teachers mistake controlling strategies for a way to "provide students with sufficient structure" (Hornstra et al., 2015), Empirical evidence suggests students benefit most when a structure is provided in an autonomy-supportive rather than a controlling manner (Hornstra et al., 2021; Vansteenkiste et al., 2012).

Structure empowers students to reach their academic goals. It gives them the skill set to actively pursue academic success and understand how to avoid negative learning outcomes (Skinner & Belmont, 1993). Strong empirical evidence demonstrates that teachers' provision of structure positively predicts students' autonomous motivation, study effort, engagement, academic performance, and well-being (Hospel & Galand, 2016; Mouratidis et al., 2018; Vansteenkiste et al., 2012). Providing structure is thus crucial for students' learning and academic success.

Blending Teacher Autonomy Support and Provision of Structure

Controversies about the interplay between teachers' autonomy support and the provision of structure hamper effective classroom implementation. Autonomy support and structure are both beneficial for students (Bureau et al., 2022;

Hornstra et al., 2021; Howard et al., 2021; Mammadov & Schroeder, 2023) and teacher outcomes (Cheon et al., 2014; Ryan et al., 2022; Slemp et al., 2020). Efforts have been made to transfer this research into practice through instructional strategies and interventions (Ahmadi et al., 2023; Su & Reeve, 2011). Yet, researchers do not agree on how to best blend autonomy support and the provision of structure in the classroom. In the literature, teacher autonomy support and provision of structure have been described as opposite (e.g., Vansteenkiste et al., 2012), equal (e.g., Domen et al., 2020; Wang et al., 2024), and independent but mutually supportive (e.g., Jang et al., 2010).

Are teacher autonomy support and provision of structure opposites? When autonomy support is conceptualized as laissez-faire, it is often described as a lack of guidance and structure (Vansteenkiste et al., 2012). For example, Hornstra and colleagues (2015) found some teachers describe autonomy support and structure as opposite dimensions. Those teachers emphasized the need for less autonomy support and more structure in the classroom. Teachers also describe taking control over autonomy-supportive environments by providing students with structure (Reeve, 2009).

Are autonomy support and provision of structure independent but complement each other? Different instructional strategies have been developed and tested to facilitate the implementation of either construct in the classroom (Ahmadi et al., 2023). Researchers started comparing teaching styles based on the emphasis on either autonomy support or structure. For example, Vansteenkiste and colleagues (2012) compared four teaching profiles classifying teachers as mildly versus highly autonomy-supportive and structured. They found autonomy support and structure are two distinct aspects of teaching styles. Teachers can provide high or low levels of both dimensions. The optimal learning environment to engage students is described as providing structure being provided in an autonomy-supportive way (Jang et al., 2010).

Are autonomy support and provision of structure intertwined? Some researchers do not distinguish autonomy support and provision of structure. Instead, they focus on need-supportive teaching as a whole (e.g., Haw & King, 2022). According to Katz et al. (2009), students generally do not distinguish among practices to support individual needs and perceive all the need-supportive practices globally (Katz et al., 2009). Stroet et al. (2013) even found that a global measure of need-supportive teaching predicted better students' learning outcomes. Empirical evidence shows teacher autonomy support does not only foster students' autonomy but also their sense of competence (Jang et al., 2016; Lochbaum & Jean-Noel, 2016; Okada, 2023) and scholars spotlight autonomy support as a way to satisfy all basic psychological needs (Ryan & Deci, 2017; Ryan et al., 2022).

To capture the nature of the interplay between autonomy support and structure and derive sensible recommendations for research and practice, influence factors such as the socio-cultural context and method of inquiry need to be taken into consideration.

School Level

Should autonomy support and structure be tailored to students' development? Each school level comes with unique goals and expectations, which influence the dynamics of teacher-student interactions. Students also vary in cognitive development and self-regulation across school levels (Bjorklund, 2000). Students might thus benefit from need-supportive instructional strategies sensitive to their capacities and skills. Bjorklund (2000), for example, found that students of different age groups need different levels of autonomy support and structure because of their developmental stages. Donald et al.'s (2021) meta-analysis found age differences in autonomy support, reflecting developmental effects. Recognizing age-specific differences can aid teachers in adapting their teaching strategies to the evolving needs of students in their academic journey from elementary to post-secondary education.

School Subjects

Should autonomy support and structure vary across school subjects? Students engage differently in their school subjects because of varying goals and levels of interest (Smith & Fouad, 1999). Different subjects also present unique challenges and require subject-specific instructional approaches (Lindblom-Ylänne et al., 2006). Erturan-İlker and colleagues (2018) found that the level of autonomy support affects students' basic need satisfaction, engagement, and concentration differently in math, English, and physical education classes. Researchers also call for examining the effects of school subjects such as STEM to disentangle gender effects of autonomy support (Mammadov & Schroeder, 2023). Understanding how school subject affects students' needs for autonomy support and structure affords to tailor instructional strategies sensitive to the demands of each subject.

Cultural Context

Should the blend of autonomy support and structure reflect the socio-cultural context? Meta-analytic evidence shows culture does not moderate the relationship between autonomy support and need satisfaction (Slemp et al., 2018) or teacher outcomes (Slemp et al., 2020). Satisfying needs for autonomy and competence also aids well-being across cultural contexts (Serie et al., 2021). On the other hand, culture-specific attitudes, values, and beliefs about education influence teachers' perceptions and implementation of autonomy support and structure (Reeve et al., 2018). Chirkov and colleagues (2003) found that autonomy support is less valued in collectivistic than individualistic cultures. Japanese teachers, for example, expressed concerns about the applicability of evidence-based autonomy-supportive strategies established in western cultures to their classrooms (Oga-Baldwin & Nakata, 2015). These conflicting views suggest that teacher autonomy support and provision of structure

may depend on contextual factors. Teaching strategies sensitive to contextual influence factors can cater to the needs of diverse learners.

Data Collection Method

Does the method of data collection affect perceptions of autonomy support and structure? Autonomy support and structure have been measured using a variety of methods, including surveys and observations. Meta-analyses found evidence for data collection approaches affecting how self-determination influences well-being (Bradshaw et al., 2021) and student learning (Howard et al., 2021). For example, outcomes related to autonomy support and structure differ among surveys developed for teachers versus students (Domen et al., 2020; Reeve, 2009). Autonomy support was positively associated with structure and predicted student engagement when measured using a student-report survey (Hornstra et al., 2021). The opposite occurred when teacher reports were used, which warrants further investigation into the role of data collection methods in blending autonomy support and structure.

The Present Study

Research examining how to blend teacher autonomy support and provision of structure for optimal growth of students and teachers is needed. Existing meta-analyses have focused on teacher and student autonomous motivation (Bureau et al., 2022; Slemp et al., 2020), and the effectiveness of interventions designed to satisfy basic psychological needs (Burke et al., 2020; Gillison et al., 2019; Su & Reeve, 2011). Other scholars meta-analyzed the relationship between teacher autonomy support and student learning (Mammadov & Schroeder, 2023) and motivation (Lochbaum & Jean-Noel, 2016; Okada, 2023). Ryan and colleagues (2022) even summarized meta-analytic findings on self-determination and related theories. Although numerous meta-analyses synthesized research on teacher autonomy support and provision of structure, no synthesis exists on the blend of the two constructs, and their effects on student and teacher outcomes.

Controversial conceptualizations of autonomy support and provision of structure jeopardize the generalizations of findings across studies. Examining how different stakeholders define and perceive autonomy support and structure can facilitate classroom implementation. To foster need-supportive instructional strategies sensitive to diverse students, it is important to understand how factors such as grade level, school subject, and cultural context affect perceptions of autonomy support and structure. The purpose of this study is to synthesize and meta-analyze the relationship between autonomy support and the provision of structure in the classroom. Reconciling controversial perspectives about those constructs is crucial for clear recommendations of evidence-based practices. We thus address the following research questions:

1. How are teachers' autonomy support and provision of structure conceptually and operationally defined?

2. How does empirical research describe the relationship between teachers' autonomy support and provision of structure?
3. How are teachers' autonomy support and provision of structure associated with students' learning and teacher characteristics?

Self-determination theory posits optimal growth when psychological needs for autonomy, competence, and relatedness are satisfied (Ryan & Deci, 2017). Extensive research highlights the benefits of need-supportive teaching strategies. For example, teacher autonomy support and provision of structure are associated with increased student motivation (Bureau et al., 2022; Eakman et al., 2019; Filak & Sheldon, 2008; Vasconcellos et al., 2020), student well-being (Ferguson et al., 2011; Stanley et al., 2021; Wang et al., 2021a, b), and desirable teacher characteristics, e.g., well-being and job satisfaction (Cheon et al., 2020; Slemp et al., 2020). Particularly teacher autonomy support has been highlighted as an effective means of fulfilling psychological needs (Ryan & Deci, 2017; Ryan et al., 2022). Research indicates that when teachers offer autonomy support, students often experience an enhanced sense of competence (Guay et al., 2001; Jang et al., 2016; Lochbaum & Jean-Noel, 2016; Okada, 2023), a feeling typically cultivated through the provision of structure (Jang et al., 2010; Skinner & Belmont, 1993; Vansteenkiste et al., 2020). This is echoed by research indicating greater benefits for students when teachers provide autonomy support along with structure (Hornstra et al., 2021; Vansteenkiste et al., 2012), implying interconnection between the two constructs. We thus propose the following hypotheses:

1. Conceptual and operational definitions overall position teacher autonomy support and provision of structure as independent but mutually supportive constructs.
2. Increased teacher autonomy support is associated with a greater provision of structure across studies.
3. The strength of the relationship between teacher autonomy support and the provision of structure differs among school levels, school subjects, cultural contexts, and data collection methods.
4. Both needs-supportive strategies (i.e., autonomy support and provision of structure) contribute to desirable student outcomes and teacher characteristics, independent of the other strategy.

Method

Literature Search

This meta-analysis and systematic literature review of teachers' autonomy support and provision of structure follows the guidelines for Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Page et al., 2021), see Fig. 1 for details. To identify relevant studies, we searched the databases Eric, Education Research Complete, PsycINFO, Psychology and Behavioral Sciences Collection,

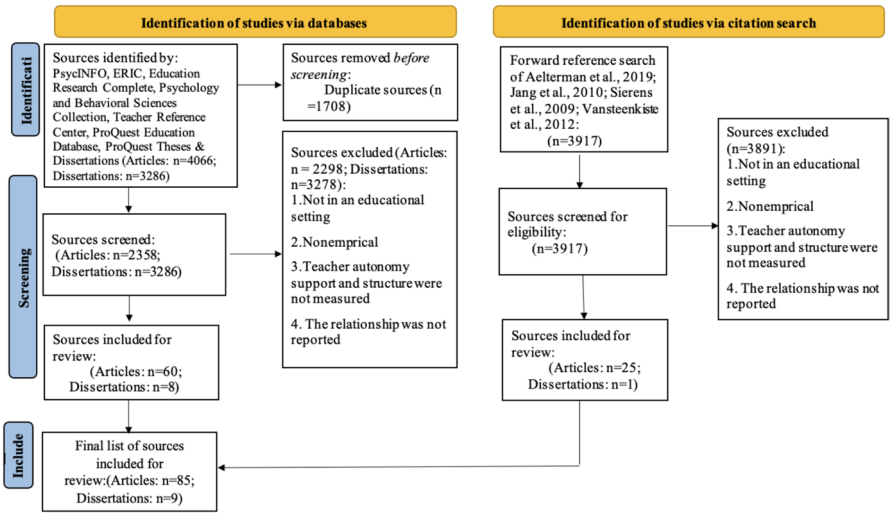

Fig. 1 PRISMA flow chart

Teacher Reference Center, ProQuest Education Database, and ProQuest Theses & Dissertations. We searched for variations and combinations of the terms: need support, autonomy, self-determination, structure, and competence in titles and abstracts. Since structure is frequently described using various terms in the literature, we employed the OR Boolean operator to search for sources that use any of the following terms to refer to structure: expectation, rule, guidance, goal, scaffold, direction, monitoring, feedback, and clarity. A forward reference search was conducted in Google Scholar for the three most cited articles: Jang et al., 2010; Sierens et al., 2009; Vansteenkiste et al., 2012. We conducted another forward search in Google Scholar for Aelterman et al. (2019) to identify studies using the Situations in School Questionnaire because it uses different terms to describe teacher autonomy support and provision of structure, terms not included in our initial search. Additional studies were identified from reference lists. All searches were conducted on September 10, 2024. These search methods yielded 11269 results, which were further reviewed against inclusion and exclusion criteria.

Selection and Coding Process

Studies considered for inclusion are (1) written in English, (2) empirical, (3) peer-reviewed journal articles or dissertations, (4) conducted in an educational setting, and (5) reporting the relationship between teacher autonomy support and provision of structure. We reached out to authors of studies that measured but did not report the relationship between teacher autonomy support and structure to meet inclusion criteria.

Relevant studies were identified through a rigorous multi-phase screening process (see Fig. 1). First, the titles of all articles were screened for relevancy. Second, abstracts were thoroughly examined against inclusion criteria. Third, the full text of

each study was analyzed to further cull for relevancy. We screened studies against inclusion criteria and reached a consensus through discussion.

The following variables were coded for the included studies: (1) study design (i.e., cross-sectional, longitudinal, and experimental), (2) sample size, (3) school level (i.e., elementary, secondary, and post-secondary), (4) school subject (e.g., social sciences, STEM, physical education, general, and not specified), (5) country the study was conducted in, (6) definitions of autonomy support and structure, (7) measures of autonomy support and structure, (8) data collection method (i.e., teacher report, student report, observation), (9) other outcome variables (e.g., motivation, academic performance), and (10) correlation coefficients. Questions regarding the coding process were resolved through discussion among the authors.

When autonomy support and structure were measured at multiple time points such as in longitudinal or intervention studies, we coded the pretest correlation coefficient to control for intervention or maturation effects (e.g., Mouratidis et al., 2018). We computed mean correlations for studies assessing structure before and during a lesson (Van den Berghe et al., 2013) or reporting multiple dimensions of either autonomy support or structure (e.g., Mouratidis et al., 2022). Studies amalgamating multiple school subjects (e.g., Archambault et al., 2020) were coded as "general". Hofstede's (2001) individualism score of each country was referred to operationalize cultures.

Sample

A total of 94 studies (i.e., 85 journal articles, 9 dissertations) and 280 effect sizes were included in our sample. Effect sizes include correlations between autonomy support and structure ($n = 110$) and correlations with student learning outcomes ($n = 170$; i.e., 85 correlations with autonomy support, 85 correlations with structure). The overall sample size was 592,553, including 17,776 teachers and 574,777 students. We operationalized sample size as the number of participants but used the number of schools for Adams and Khojasteh (2018) as they only reported school-level correlation coefficients. For observation studies, we used the number of observation sessions as a metric for sample size. Because Wang and colleagues (2021) examined the Program of International Student Assessment (PISA) data, their sample accounts for a large proportion of student participants ($n = 513{,}295$). Most studies were conducted in secondary schools in highly individualistic cultural contexts and collected data through student-reported autonomy support and structure across school subjects. See Table 1 for details about sample characteristics.

Data Analysis Procedures

We addressed the research questions using a combination of systematic literature review and meta-analysis of effect sizes. To address Research Question 1, we systematically reviewed the included studies to synthesize conceptual and operational definitions of teacher autonomy support and provision of structure. In the systematic review, we identified key themes and patterns in instructional

Table 1 Sample characteristics

Coding category	Code	*N*
Study design	Cross-sectional	78
	Experimental	2
	Longitudinal	14
School level	Elementary	12
	Secondary	63
	Postsecondary	15
	Multiple school levels	4
Subject	Social Sciences	11
	Physical education	25
	STEM	10
	Not specified	9
	General	42
Data collection	Observations	9
	Student report	56
	Teacher report	25
	Teacher and student report	4

Stauderman (2024) analyzed multiple subjects and was therefore coded under multiple subject categories

strategies used to define autonomy support and structure. We also extracted and analyzed operational definitions of these constructs across studies, offering insights into measurement methods, triangulation approaches, and consistency of operationalizations.

For Research Question 2, we conducted a meta-analysis of the relationship between autonomy support and structure and performed moderation analyses using the R Metaphor package (Viechtbauer, 2010). Moderators included data collection methods (e.g., teacher report, student report, observation), student school level (elementary, secondary, post-secondary), school subject (e.g., social sciences, physical education, STEM), and individualism scores of the cultural context.

To answer Research Question 3 on the associations between autonomy support and structure with student learning, we performed a meta-analysis of effect sizes that assessed the relationships between student learning outcomes and each of these variables individually. Additionally, we computed partial correlations to explore how autonomy support influences student learning when the effect of structure is removed, and conversely, how structure impacts student learning when the effect of autonomy support is removed.

Regarding teacher antecedents in relation to autonomy support and structure, we found that the sample size was insufficient for meta-analysis. Thus, we conducted a systematic review of these studies and synthesized the findings. Only ten studies explored teacher antecedents related to autonomy support or structure, each focusing on different antecedents, leading to small sample sizes (1–3 studies per antecedent). As a result, we synthesized and reported the findings from these studies. We extracted and reported correlations between teacher antecedents and autonomy

support, as well as structure, to provide a comprehensive overview of findings and common themes across these studies.

Results

We drew on a combination of systematically reviewing the literature and meta-analyzing effect sizes to synthesize conceptual and operational definitions of autonomy support and structure and examine the relationship among those constructs, their effects on student learning outcomes, and teacher antecedents.

Conceptual Definitions of Teacher Autonomy Support and Provision of Structure

Autonomy Support

Researchers in our sample conceptualized autonomy support as teachers' effort to support students' need for autonomy, spotlighting instructional strategies to achieve this goal. A detailed analysis of definitions among the reviewed studies yielded ten distinct components of autonomy support (see Table 2). Autonomy support was most commonly defined as *providing students with choices*—offering students alternative options or courses of action—and *providing explanatory rationales*—offering students explanations as to why a particular course of action might be useful (Hospel & Galand, 2016; Vansteenkiste et al., 2012). Other components include *acknowledging negative feelings*, i.e., showing empathy for students expressing negative emotions, and *taking students' perspective* i.e., trying to see things as a student and taking students' needs into consideration. We also categorized similar strategies. For instance, we grouped strategies aimed at welcoming students' input, creating space for their voices, and encouraging initiative and independent problem-solving under the umbrella of "promoting students' voice." Teacher behaviors less frequently referenced when conceptualizing autonomy support include, for example, *communicating with students using a non-pressuring tone* and *treating them with respect* (Hornstra et al., 2021; Jang et al., 2010),

Even though those components are used somewhat consistently across studies, their definitions are not. When *offering choices* for example, some researchers emphasize choices should be "aligned with students' interest and goals" (Mouratidis et al., 2018; *p.*437), while others ask for a "meaningful choice," not specifying what that entails (Archambault et al., 2020; *p.*430). Most studies only referred to "offering choice" without elaboration.

Provision of Structure

Most studies in our sample conceptualized the provision of structure as the strategies teachers use to foster students' understanding of course materials and sense of competency to meet expectations. The most common ways to provide structure in the reviewed studies were offering guidance, clarifying expectations, giving

Table 2 Components defining teacher autonomy support

Strategy	*N*	Citation
Offer choice	62	Adams and Khojasteh (2018); Ahn (2021); Archambault et al. (2020); Behzadnia (2021); Bloem et al. (2024); Burgueño et al., (2024a, b); Caleon et al. (2017); Catalán et al. (2018); Chiu (2021); Cilalı et al. (2024); Chen et al. (2021); Chan et al. (2023); Cohen et al. (2022); De Loof et al. (2021); Domen et al. (2020); Dupont et al. (2014); Feng et al. (2019); Franco et al. (2023); González-Peño et al. (2021); González et al. (2018); Haerens et al. (2013); Hellebaut et al. (2023); Hornstra et al. (2020); Hornstra et al. (2021); Hospel and Galand (2016); Huić et al. (2024); Iglesias García et al. (2020); Jackson-Kersey and Spray (2016); Kiefer and Pennington (2016); Knight (2016); Leenknecht et al. (2017); Leflot et al. (2010); Leo et al. (2022); Liu and Chung (2017); Lietaert et al. (2015); Lombardero Posada et al. (2024); Moè and Katz (2020); Moè and Katz (2021); Moe and Katz (2022); Moè et al. (2022); Mouratidis et al. (2018); Olivier et al. (2020); Olivier et al. (2021); Reymond et al. (2023); Sierens et al. (2009); Teraoka et al. (2024); Tucker et al. (2002); Tvedt et al. (2021); Tzokova-Vladimirova (2017); Van den Berghe et al. (2013); Vansteenkiste et al. (2012); Vermote et al. (2020); Vermote et al., (2023a, b); Wang and Eccles (2013); Wang et al., (2021a, b); Yang (2014); Zhang et al. (2012); Zhang et al. (2020)
Provide explanatory rationales	35	Ahn (2021); Archambault et al. (2020); Behzadnia (2021); Burel et al. (2021); Burgueño et al., (2024a, b); Cilalı et al. (2024); Cohen et al. (2022); De Loof et al. (2021); González et al. (2018); Hornstra et al. (2020); Hospel and Galand (2016); Huić et al. (2024); Iglesias García et al. (2020); Jackson-Kersey and Spray (2016); Jeon (2007); Kiefer and Pennington (2016); Leflot et al. (2010); Leenknecht et al. (2017); Liu and Chung (2017); Lombardero Posada et al. (2024); Moè and Katz (2021); Mouratidis et al. (2018); Mouratidis et al. (2024); Olivier et al. (2020); Sierens et al. (2009); Stauderman (2024); Taylor and Ntoumanis (2007); Tucker et al. (2002); Van den Berghe et al. (2014); Vansteenkiste et al. (2012); Vermote et al. (2020); Vermote et al., (2023a, b); Wang and Eccles (2013)
Acknowledge students' negative feelings	23	Ahn (2021); Aelterman et al. (2019); Catalán et al. (2018); Burel et al. (2021); Domen et al. (2020); Escriva-Boulley et al. (2021); González et al. (2018); Hornstra et al. (2020); Huić et al. (2024); Iglesias García et al. (2020); Jackson-Kersey and Spray (2016); Jeon (2007); Lavrijsen et al. (2024); Leenknecht et al. (2017); Liu and Chung (2017); Moè and Katz (2020); Moè and Katz (2021); Moe and Katz (2022); Mouratidis et al. (2018); Mouratidis et al. (2022); Mouratidis et al. (2024); Stauderman (2024); Wang et al., (2021a, b)

Table 2 (continued)

Strategy	*N*	Citation
Take students' perspective	17	Behzadnia (2021); Caleon et al. (2017); Cohen et al. (2022); González et al. (2018); González-Peño et al. (2021); Haerens et al. (2013); Hospel and Galand (2016); Iglesias García et al. (2020); Jang et al. (2010); Lavrijsen et al. (2024); Mouratidis et al. (2024); Olivier et al. (2021); Reymond et al. (2023); Sierens et al. (2009); Taylor and Ntoumanis (2007); Van den Berghe et al. (2013); Vermote et al., (2023a, b)
Promote students' voice	16	
Welcome students' input	6	Aibar et al. (2021); Bloem et al. (2024); Leo et al. (2022); Mouratidis et al. (2022); Stauderman (2024); Vermote et al., (2023a, b)
Encourage students to take the initiative	4	Ahn (2021); Chen et al. (2021); Lietaert et al. (2015); Olivier et al. (2021)
Encourage independent problem-solving	3	Adams and Khojasteh (2018); Feng et al. (2019); Olivier et al. (2020)
Make space for students' voices	3	Chan et al. (2023); Stauderman (2024); Van den Berghe et al. (2014)
Invite students to pursue their interests	14	
Support students' interests	9	Aelterman et al. (2019); Escriva-Boulley et al. (2021); Franco et al. (2023); Hellebaut et al. (2023); Huić et al. (2024); Jang et al. (2010); Teraoka et al. (2024); Van Doren et al. (2023); Vermote et al., (2023a, b)
Tailor learning activities to students' values	5	Adams and Khojasteh (2018); Bloem et al. (2024); Domen et al. (2020); Hospel and Galand (2016); Jang et al. (2010)
Set meaningful learning goals	2	Hospel and Galand (2016); Jang et al. (2010)
Use invitational language	13	
Use informational language	11	Adams and Khojasteh (2018); Burel et al. (2021); Caleon et al. (2017); De Loof et al. (2021); Hornstra et al. (2021); Jeon (2007); Lavrijsen et al. (2024); Olivier et al. (2021); Sierens et al. (2009); Stauderman (2024); Vansteenkiste et al. (2012)
Communicate in a tone of understanding	2	Escriva-Boulley et al. (2021); Vermote et al., (2023a, b)
Provide learning activities in need-satisfying ways	8	Archambault et al. (2020); Berger and Girardet (2021); Burel et al. (2021); Cohen et al. (2022); Haerens et al. (2013); Hornstra et al. (2020); Jeon (2007); Mouratidis et al. (2018)
Display patience	7	
Display patience	4	Moè and Katz (2020); Moe and Katz (2022); Mouratidis et al. (2024); Stauderman (2024)

Table 2 (continued)

Strategy	*N*	Citation
Allow students to work at their own pace	3	Chiu (2021); Olivier et al. (2021); Van den Berghe et al. (2014)
Show respect	7	Feng et al. (2019); Hornstra et al. (2021); Leenknecht et al. (2017); Liu and Chung (2017); Mouratidis et al. (2022); Olivier et al. (2020); Tzokova-Vladimirova (2017)

Table 3 Components defining teacher provision of structure

Strategy	*N*	Citation
Offer guidance	95	
Provide guidance	54	Aelterman et al. (2019); Ahn (2021); Burel et al. (2021); Burgueño et al., (2024a, b); Chan et al. (2023); Chen et al. (2021); Chiu (2021); Cilalı et al. (2024); Cohen et al. (2022); De Loof et al. (2021); Domen et al. (2020); Dupont et al. (2014); Escriva-Boulley et al. (2021); Franco et al. (2023); González et al. (2018); Haerens et al. (2013); Hellebaut et al. (2023); Hornstra et al. (2020); Hornstra et al. (2021); Hospel and Galand (2016); Huić et al. (2024); Iglesias García et al. (2020); Jackson-Kersey and Spray (2016); Jang et al. (2010); Jeon (2007); Kiefer and Pennington (2016); Lavrijsen et al. (2024); Leflot et al. (2010); Leo et al. (2022); Leenknecht et al. (2017); Lietaert et al. (2015); Liu and Chung (2017); Lombardero Posada et al. (2024); Moè and Katz (2020); Moè and Katz (2021); Moe and Katz (2022); Moè et al. (2022); Mouratidis et al. (2022); Mouratidis et al. (2024); Olivier et al. (2021); Reymond et al. (2023); Sierens et al. (2009); Sypré et al. (2023); Temple (2012); Teraoka et al. (2024); Tzokova-Vladimirova (2017); Van den Berghe et al. (2013); Van Doren et al. (2023); Vansteenkiste et al. (2012); Vermote et al. (2020); Vermote et al., (2023a, b); Yang et al. (2024)
Provide informational feedback	40	Ahn (2021); Adams and Khojasteh (2018); Archambault et al. (2020); Behzadnia (2021); Burel et al. (2021); Burgueño et al., (2024a, b); Catalán et al. (2018); Chan et al. (2023); Chiu (2021); Cohen et al. (2022); De Loof et al. (2021); Dupont et al. (2014); González-Peño et al. (2021); González et al. (2018); Haerens et al. (2013); Hornstra et al. (2020); Hornstra et al. (2021); Hospel and Galand (2016); Iglesias García et al. (2020); Jeon (2007); Knight (2016); Lazarides and Rubach (2017); Leenknecht et al. (2017); Leo et al. (2022); Lietaert et al. (2015); Liu and Chung (2017); Lombardero Posada et al. (2024); Reymond et al. (2023); Rocchi and Lennox-Terrion (2023); Sierens et al. (2009); Stauderman (2024); Teraoka et al. (2024); Tvedt et al. (2021); Van den Berghe et al. (2013); Vansteenkiste et al. (2012); Vansteenkiste et al. (2012); Vermote et al. (2020); Vermote et al., (2023a, b); Wang et al. (2021); Yang et al. (2024); Yang (2014)
Monitor learning	5	Burgueño al. (2024); Moè et al. (2022); Kiefer and Pennington (2016); Mouratidis et al. (2024); Temple (2012)
Provide learning strategies	4	Aelterman et al. (2019); Feng et al. (2019); Moè and Katz (2020); Sypré et al. (2023)
Provide and clarify expectations	61	

Table 3 (continued)

Strategy	*N*	Citation
Clarify expectations	46	Ahn (2021); Berger and Girardet (2021); Burel et al. (2021); Burgueño et al., (2024a, b); Caleon et al. (2017); Chiu (2021); clear expectation, guidance, and feedback; Cohen et al. (2022); De Loof et al. (2021); Domen et al. (2020); Franco et al. (2023); González-Peño et al. (2021); González et al. (2018); Haerens et al. (2013); Hellebaut et al. (2023); Hofer et al. (2022); Hornstra et al. (2020); Hospel and Galand (2016); Huić et al. (2024); Iglesias García et al. (2020); Jang et al. (2010); Jeon (2007); Kiefer and Pennington (2016); Lavrijsen et al. (2024); Leenknecht et al. (2017); Leflot et al. (2010); Leo et al. (2022); Lietaert et al. (2015); Liu and Chung (2017); Lombardero Posada et al. (2024); Moè and Katz (2021); Moè et al. (2022); Mouratidis et al. (2018); Mouratidis et al. (2022); Mouratidis et al. (2024); Olivier et al. (2021); Reymond et al. (2023); Sierens et al. (2009); Sypré et al. (2023); Taylor and Ntoumanis (2007); Teraoka et al. (2024); Tzokova-Vladimirova (2017); Van den Berghe et al. (2013); Van Doren et al. (2023); Vansteenkiste et al. (2012); Vermote et al. (2020); Vermote et al., (2023a, b); Wang and Eccles (2013); Wang et al., (2021a, b); Yanfei Yang et al. (2024)
Behave in a consistent way	9	Ahn (2021); Bloem et al. (2024); Chen et al. (2021); Jackson-Kersey and Spray (2016); Jeon (2007); Mouratidis et al. (2018); Sierens et al. (2009); Tucker et al. (2002); Wang and Eccles (2013)
Provide clear and consistent rules and expectations	4	Bloem et al. (2024); Chen et al. (2021); Chan et al. (2023); Vansteenkiste et al. (2012)
Explain the consequences of rule-breaking	2	Archambault et al. (2020); Taylor and Ntoumanis (2007)
Encourage	32	
Encourage students	15	Aibar et al. (2021); Behzadnia (2021); Bloem et al. (2024); Burgueño et al., (2024a, b); De Loof et al. (2021); Hornstra et al. (2020); Hornstra et al. (2021); Iglesias García et al. (2020); Lavrijsen et al. (2024); Leenknecht et al. (2017); Leo et al. (2022); Leo et al. (2023); Sierens et al. (2009); Temple (2012); Vermote et al. (2020)
Adjust instruction and materials to students' ability level	16	Ahn (2021); Adams and Khojasteh (2018); Aibar et al. (2021); Catalán et al. (2018); Cilalı et al. (2024); González et al. (2018); Hornstra et al. (2020); Iglesias García et al. (2020); Knight (2016); Lazarides and Rubach (2017); Leo et al. (2022); Leo et al. (2023); Vermote et al. (2023a, b); Wang and Eccles (2013); Yang et al. (2024)

informational feedback, and offering encouragement (see Table 3). Other components referenced by multiple studies are behaving in a consistent way, adjusting instruction and materials to students' ability levels, providing learning strategies, and explaining the consequences of rule-breaking behaviors. We identified three key themes within instructional strategies to provide structure: Offer guidance, provide and clarify expectations, and encourage students.

Discrepancies exist in the conceptualization of those components across the studies reviewed. For example, *informational feedback* was also described as "positive" (Behzadnia, 2021; Haerens et al., 2013), "competence-relevant" (Lietaert et al., 2015), "growth-oriented" (Burgueño et al., 2024a, b; Vermote et al., 2020) or "concrete" feedback (Archambault et al., 2020). Most studies referenced "informational" feedback without further explanation. *Providing encouragement* was also not consistently defined and appears to overlap with other components such as *providing positive feedback*. The lack of clarity in defining the strategies may cause ambiguity in teacher application.

Autonomy Support and Provision of Structure

Conceptual definitions of autonomy support and structure overlap. Not all defining components of autonomy support and provision of structure clearly distinguish the two constructs. For example, *providing optimal challenges* was conceptualized as an autonomy-supportive instructional component by Jang et al. (2010) but a defining feature of the provision of structure by Hospel and Galand (2016). *Offering rationales* was described as a way to provide structure by Mouratidis et al. (2018) while it is most commonly used to conceptualize autonomy support (see Table 2). Sixteen studies did not conceptually define autonomy support or provision of structure. Instead, the authors described relationships between autonomy support and structure with other variables (e.g., Stornes et al., 2008). This lack of consistency and granularity of conceptual definitions hampers generalizability and clouds the understanding of autonomy support and the provision of structure.

Operational Definitions of Teacher Autonomy Support and Provision of Structure

Student-report surveys were the most frequently used way to measure autonomy support and structure ($n = 56$), followed by teacher reports ($n = 25$) and observations ($n = 9$). Four studies used both teacher and student reports to assess autonomy support and structure. The most frequently used measures in our sample are the Teacher as Social Context Questionnaire (TASC; Belmont et al., 1988) and the Situations in School Questionnaire (Aelterman et al., 2019) (see Table 4 for a full list of measures used).

The Teacher as Social Context Questionnaire (TASC; Belmont et al., 1988) has been used as both student and teacher reports in our sample (see Table 4). The TASC comprises 41 items and three sub-scales: teacher autonomy support (12 items), structure (15 items), and involvement (14 items). Sample items for student reports include "My teacher listens to my ideas" (autonomy support)

Table 4 Measures of teacher autonomy support and provision of structure

Method	Measure	Citation	Number of studies measuring	
			Autonomy support	Structure
Student report	Teacher as Social Context Questionnaire	Belmont et al. (1988)	26	25
	Situations-in-School (SIS) Questionnaire	Aelterman et al. (2019)	4	4
	Autonomy-Enhancement Scale	Assor et al. (2002)	1	0
	Learning Climate Questionnaire	Williams and Deci (1996)	5	0
	Teaching Interpersonal Style Questionnaire	Leo et al. (2022)	4	0
	Basic Psychological Need Support in Physical Education Questionnaire	Sánchez-Oliva et al. (2013)	1	0
	Perceived Mathematics Teacher Support for Middle School Students	Chai and Gong (2013)	1	1
	PISA Items		1	
	Perceptions of Learning Environment	Müller and Louw (2004)	1	1
	Interpersonal Behavior Questionnaire	Rocchi et al. (2017)	2	2
	Competence Support Scale	Chen and Jang (2010)	0	2
	Adapted by existing items	Stornes et al. (2008)	3	4
	Self-Developed	Chen and Jang (2010)	2	4
	Health-Care Climate Questionnaire	Williams et al. (1996)	2	1
	The School Environment Measure	Midgley et al. (1998)	1	1
	Need-Support Items	Rakoczy (2008)	1	1
	Perspectives of Parent Scale	Grolnick et al. (1991); Robbins (1994)	1	1
Teacher report	Teacher as Social Context Questionnaire	Belmont et al. (1988)	14	19
	Situations-in-School (SIS) Questionnaire	Aelterman et al. (2019); Vermote et al. (2020)	17	17
	Adapted Problems in School Questionnaire	Deci et al. (1981); Pelletier et al. (2002)	1	0
	Interpersonal Behaviors Questionnaire	Rocchi et al. (2017)	1	
	Need-Supportive Teaching Style Scale	Soini et al. (2014)	1	1

Table 4 (continued)

Method	Measure	Citation	Number of studies measuring	
			Autonomy support	Structure
Observation	Observation Rating Scale for Teachers' Autonomy Support and Structure	Jang et al. (2010); Reeve et al. (2004)	5	4
	Observational Rating Scale in PE	Haerens et al. (2013)	3	3
	Multidimensional Motivational Climate Observation System (MMCOS)	Smith et al. (2015)	1	1
	Situations-in-School (SIS)-PE-Coder	Van Doren et al. (2023)	1	1

and "My teacher makes sure I understand before they move on" (structure). Teacher report sample items are "I let my students make a lot of their own decisions regarding schoolwork" (autonomy support) and "I talk with the students of this class about my expectations for them" (structure). Items are answered on a 5-point rating scale ranging between 1 (*completely disagree*) and 5 (*completely agree*). High reliability was reported with Cronbach's alpha ranging from 0.66 to 0.90 for the student-report version (Leenknecht et al., 2017; Maulana et al., 2016) and 0.73 to 0.90 for the teacher-report version (Hornstra et al., 2021; Kurdi et al., 2018). Studies in our sample varied in the number of items used to operationalize autonomy support (ranging from 1 to 12) and structure (ranging from 1 to 15). For example, Hornstra et al. (2020) only used two teacher report items about student choices (i.e., autonomy support) and guidance provided to the students (i.e., structure).

The Situations in School Questionnaire (SIS; Aelterman et al., 2019) is a vignette-based questionnaire designed for student and teacher reports. The SIS aims to measure the extent to which teachers are identifying and nurturing students' interests, preferences, and feelings (i.e., autonomy support), and the extent to which teachers are providing students with strategies, help, and guidance (i.e., structure) along with their opposites—control and chaos. Fifteen vignettes describe various situations such as when students face a difficult lesson that requires a lot of effort. Upon reading each vignette, students or teachers are asked to respond to four items with one on autonomy support, structure, control, and chaos respectively. Sample items include "I/my teacher try to find ways to make the lesson more interesting and enjoyable for the students" (i.e., autonomy support) and "I/my teacher say, 'Because this lesson is extra difficult, I will provide you with extra help and extra assistance if needed'" (i.e., structure). Items are answered on a 7-point rating scale ranging from 1 (*does not describe me/my teacher at all*) to 7 (describes me/my teacher extremely well). The SIS is reliable with Cronbach's alpha ranging from 0.80 to 0.92 for the student-report version (Cohen et al., 2022; Tilga et al., 2023) and 0.73 to 0.85 for the teacher-report version (Burgueño et al., 2024a; Moè & Katz, 2022). Studies in our sample used 10 to 15 of the vignettes to operationalize autonomy support and structure.

Numerous self-report measures have been only used by one or two studies, like the School Environment Measure. In addition, some studies also adapted items based on existing strategies or even self-developed additional items to assess teacher autonomy support and structure (e.g., Diseth et al., 2012).

Nine studies collected data about autonomy support and structure through observations. Most relied on the Observation Rating Scale for Teacher Autonomy Support and Structure (Jang et al., 2010) as an observation protocol. Observers using this scale rate several autonomy-supportive (e.g., "providing explanatory rationales") and structure strategies (e.g., "providing clear directions") on a rating scale (e.g., 7-point Likert scale). Other observers adapted existing self-report measures as an observation protocol. For example, Haerens et al. (2013) developed items observers of physical education classes rated for autonomy support (e.g., "The PE teacher offers choice to all pupils") and structure (e.g., "The PE teachers gives clear instructions").

Relationship Between Teacher Autonomy Support and Provision of Structure

We systematically reviewed the literature and drew on meta-analytic findings to examine the relationship between autonomy support and structure.

Systematic Literature Review

Autonomy support and structure reinforce each other. The majority of studies (86 out of 94 studies) described the two constructs as two independent but positively related aspects of teachers' instructional approaches (e.g., Connell & Wellborn, 1991; Skinner & Belmont, 1993; Tucker et al., 2002). Correlations between autonomy support and structure ranged from $r=0.01$ to $r=0.87$. Autonomy support and structure are antagonistic to each other (Vansteenkiste et al., 2012). Eight studies reported negative correlations between autonomy support and structure, ranging from $r=-0.01$ to $r=-0.43$. Notably, five of those studies were based on teacher reports (Archambault et al., 2020; Domen et al., 2020; Hornstra et al., 2020, 2021; Kurdi et al., 2018).

Autonomy support and structure are equivalent. Domen et al. (2020) and Oga-Baldwin and Nakata (2015) factor analyzed student-report items of the TASC (Belmont et al., 1988) and eight self-developed items based on focus group interviews, respectively. The items assessing autonomy support and structure loaded on the same factor, suggesting autonomy support and structure are one construct.

Meta-Analysis

We applied random effects models (Hedges & Vevea, 1998) because they take possible differences in effect sizes among the included studies into account. Pearson correlations were computed to determine the relationship between autonomy support and structure and various student learning outcomes. As Cohen's (1988) effect size benchmarks do not reflect effect size distributions in psychological and educational research, we refer to Funder and Ozer (2019) and Gignac and Szodorai (2016) to gauge the strength of our findings. Based on the 25th and 75th percentiles of this distribution, correlations up to 0.19 are considered small, between 0.2 and 0.29 are deemed moderate, and 0.3 or more are considered large effects.

Publication bias occurs when publication decisions of studies are based on the statistical significance of results, which can sway effect sizes of meta-analyses (Rothstein et al., 2005). We computed three tests to examine whether publication bias impacts our effect size estimation. The funnel plot showed an uneven distribution of the 110 effect sizes (see Fig. 2). The Trim and Fill method revealed no missing studies on the right side of the plot, but suggested the potential absence of 25 studies on the left side. This suggests that studies with small or negative effect sizes may be underrepresented, potentially due to non-publication of unfavorable findings. However, Egger's regression analysis did not find statistically significant asymmetry ($b=0.50$, $Z=1.00$, $p=0.32$). Based on this analysis, the funnel plot does not exhibit strong asymmetry, implying that publication bias may not be a significant concern in this meta-analysis.

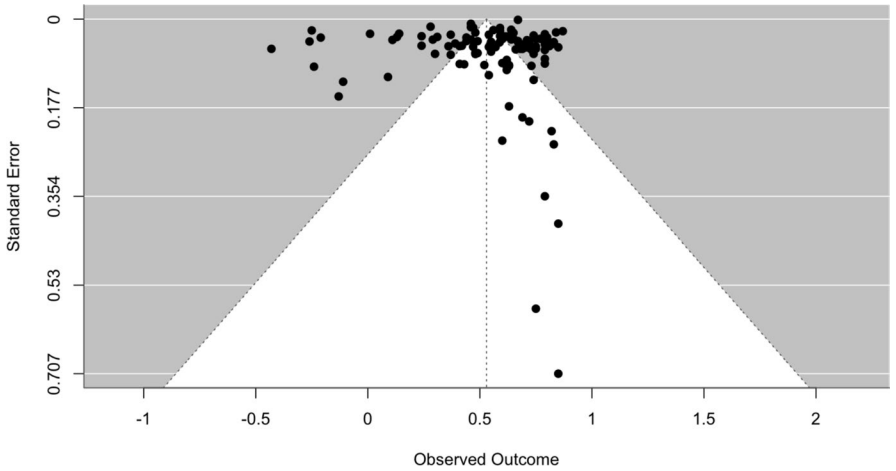

Fig. 2 Funnel plot of effect sizes (correlations between autonomy support and structure)

Statistical heterogeneity, which reflects the variability in results across the studies included in the meta-analysis, was assessed using Cochran's Q-test, which revealed statistically significant heterogeneity among the 110 effect sizes ($Q = 6871.79$, $df = 109$, $p < 0.001$). This indicates that the results from the individual studies vary more than would be expected by chance alone, suggesting substantial heterogeneity. To further explore this, we computed additional statistics from the random-effects model. The value of $\tau^2 = 0.07$ ($SE = 0.01$) suggests moderate variability in the true effect sizes across the studies, while $I^2 = 98.94\%$ indicates that almost 99% of the total variation is due to true heterogeneity rather than random error, meaning the studies differ significantly in their outcomes. Additionally, $H^2 = 94.34$ shows that the variability in effect sizes is much larger than would be expected if all studies estimated the same true effect. Overall, these findings suggest that the studies are highly heterogeneous, likely due to differences in study populations, measurement, methodologies, or other factors. The random-effect model appropriately accounts for this heterogeneity by assuming that each study estimates a different, but related, true effect size.

Main Effect Analysis The main effect analysis was conducted using a random effect model with maximum likelihood estimation due to the existence of study level variability (Lipsey & Wilson, 2001). The analysis revealed a statistically significant, positive correlation between teacher autonomy support and structure with $r = 0.53$, $SE = 0.03$, [0.48, 0.58], $p < 0.001$. See Table 5 for effect sizes, 95% confidence intervals, and sample sizes of each study. The forest plot (Figs. 3 and 4) graphically displays the variability of effect sizes across studies.

Moderation Analysis Mixed effect models with restricted maximum likelihood (REML) estimation were used in the moderation analysis considering the heterogeneity identified (Tanriver-Ayder et al., 2021). The moderation analysis showed

Table 5 Sample sizes, effect sizes, and 95% confidence intervals for correlations between autonomy support and structure

Study	Sample size (*n*)	Effect size (*r*)	95% confidence interval
Random-Effects Model	**592553**	.53	[.478, .581]
Adams and Khojasteh (2018)	71	.74	[.502, .978]
Aelterman et al. (2019)	1332	.65	[.596, .704]
Aelterman et al. (2019)	1735	.87	[.823, .917]
Ahn (2021)	29	.69	[.306, 1.074]
Ahn (2021)	581	.79	[.708, .872]
Aibar et al. (2021)	1118	.79	[.731, .849]
Archambault et al. (2020)	67	− .11	[− .355, .135]
Behzadnia (2021)	328	.54	[.431, .649]
Berger and Girardet (2021)	154	.62	[.461, .779]
Bloem et al. (2024)	78	.09	[− .136, .316]
Bloem et al. (2024)	114	− .24	[− .426, − .054]
Burel et al. (2021)	864	.24	[.173, .307]
Burgueño et al. (2024a)	1441	.84	[.788, .892]
Burgueño et al. (2024a)	473	.83	[.740, .920]
Burgueño et al. (2024a)	654	.77	[.693, .847]
Burgueño et al. (2024b)	478	.72	[.630, .810]
Caleon et al. (2017)	398	.79	[.691, .889]
Caleon et al. (2017)	397	.82	[.721, .919]
Cañabate et al. (2021)	128	.41	[.235, .585]
Catalán et al. (2018)	584	.11	[.029, .191]
Chan et al. (2023)	601	.29	[.210, .370]
Chen and Jang (2010)	267	.79	[.669, .911]
Chen et al. (2021)	466	.59	[.497, .679]
Chiu (2021)	426	.39	[.295, .485]
Cilalı et al. (2024)	348	.81	[.772, .845]
Cohen et al. (2022)	472	.83	[.739, .921]
Cunningham (2022)	118	.73	[.547, .913]
De Loof et al., (2021)	27	.72	[.320, 1.120]
Diseth et al. (2012)	240	.55	[.423, .677]
Domen et al. (2020)	506	− .26	[− .347, − .173]
Dupont et al. (2014)	331	.47	[.362, .578]
Escriva-Boulley et al. (2021)	345	.36	[.254, .466]
Feng et al. (2019)	666	.75	[.674, .826]
Franco et al. (2023)	83	.54	[.321, .759]
Iglesias García et al. (2020)	410	.68	[.583, .777]
González et al. (2018)	842	.61	[.542, .678]
González-Peño et al. (2021)	358	.24	[.136, .344]
Haerens et al. (2013)	740	− .21	[− .282, − .138]
Hellebaut et al. (2023)	838	.62	[.552, .688]
Hofer et al. (2022)	221	.49	[.357, .623]

Table 5 (continued)

Study	Sample size (*n*)	Effect size (*r*)	95% confidence interval
Hornstra et al. (2020)	1975	− .25	[− .294, − .206]
Hornstra et al. (2021)	287	.68	[.564, .796]
Hornstra et al. (2021)	287	− .43	[− .546, − .314]
Hospel and Galand (2016)	744	.60	[.528, .672]
Huić et al. (2024)	130	.79	[.715, .847]
Jackson-Kersey and Spray (2016)	162	.79	[.635, .945]
Jang et al. (2010)	133	.60	[.428, .772]
Jeon (2007)	490	.55	[.461, .639]
Kiefer and Pennington (2016)	209	.48	[.343, .617]
Knight (2016)	751	.80	[.728, .872]
Kurdi et al. (2018)	45	− .13	[− .432, .172]
Lavrijsen et al. (2024)	3586	.47	[.437, .503]
Lazarides and Rubach (2017)	746	.44	[.368, .512]
Leenknecht et al. (2017)	609	.64	[.560, .720]
Leflot et al. (2010)	570	.71	[.628, .792]
Leo et al. (2022)	2087	.56	[.517, .603]
Leo et al. (2023)	654	.65	[.573, .727]
Leon (2024)	2229	.64	[.614, .664]
Lietaert et al. (2015)	385	.71	[.610, .810]
Liu and Chung (2017)	605	.46	[.380, .540]
Lombardero Posada et al. (2024)	409	.72	[.670, .764]
Maulana et al. (2016)	4396	.28	[.250, .310]
Mendoza et al. (2022)	796	.31	[.240, .380]
Moè and Katz (2020)	318	.71	[.600, .820]
Moè and Katz (2021)	290	.75	[.634, .866]
Moe and Katz (2022)	341	.75	[.643, .857]
Moè et al. (2022)	949	.74	[.676, .804]
Mouratidis et al. (2018)	886	.59	[.524, .656]
Mouratidis et al. (2022)	11848	.46	[.442, .478]
Mouratidis et al. (2024)	3271	.59	[.556, .624]
Müller and Louw (2004)	348	.41	[.304, .516]
Olivier et al. (2020)	1889	.59	[.545, .635]
Olivier et al. (2021)	1193	.14	[.083, .197]
Reymond et al. (2023)	277	.66	[.542, .778]
Rocchi and Lennox-Terrion (2023)	211	.30	[.164, .436]
Sierens et al. (2009)	526	.67	[.584, .756]
Stauderman (2024)	36	.63	[.289, .971]
Stauderman (2024)	6	.75	[− .382, 1.882]
Stauderman (2024)	23	.82	[.382, 1.258]
Stauderman (2024)	11	.79	[.097, 1.483]
Stauderman (2024)	5	.85	[− .536, 2.236]
Stauderman (2024)	19	.83	[.340, 1.320]

Table 5 (continued)

Study	Sample size (*n*)	Effect size (*r*)	95% confidence interval
Stauderman (2024)	9	.85	[.050, 1.650]
Stauderman (2024)	20	.60	[.125, 1.075]
Stornes et al. (2008)	1171	.01	[− .047, .067]
Sypré et al. (2023)	122	.63	[.450, .810]
Sypré et al. (2023)	122	.52	[.340, .700]
Taylor and Ntoumanis (2007)	787	.64	[.570, .710]
Temple (2012)	522	.49	[.404, .576]
Teraoka et al. (2024)	126	.43	[.276, .563]
Tilga et al. (2023)	320	.85	[.740, .960]
Tucker et al. (2002)	117	.63	[.446, .814]
Tvedt et al. (2021)	1396	.48	[.427, .533]
Tzokova-Vladimirova (2017)	115	.62	[.435, .805]
Van den Berghe et al. (2013)	790	.13	[.060, .200]
Van den Berghe et al. (2014)	201	.37	[.231, .509]
Van Doren et al. (2023)	522	.44	[.354, .526]
Vansteenkiste et al. (2012)	1036	.54	[.479, .601]
Vermote et al. (2020)	357	.42	[.316, .524]
Vermote et al. (2023a)	324	.57	[.461, .679]
Vermote et al. (2023b)	225	.48	[.348, .612]
Vermote et al. (2023b)	482	.67	[.580, .760]
Wang and Eccles (2013)	1039	.37	[.309, .431]
Wang et al., (2021a, b)	513295	.67	[.667, .673]
Yang (2014)	100	.62	[.421, .819]
Yang et al. (2024)	632	.60	[.522, .678]
Zhang et al. (2011)	286	.69	[.573, .807]
Zhang et al. (2012)	273	.73	[.611, .849]
Zhang et al. (2020)	211	.74	[.604, .876]
Zimmermann et al. (2018)	3892	.46	[.429, .491]

that data collection methods significantly moderated the relationship between teacher autonomy support and structure ($QM(df=2)=11.01$; $p<0.001$). The relationship was significantly stronger based on student self-report surveys ($r=0.59$, $SE=0.03$, $p<0.001$) compared to teacher-report surveys ($r=0.45$, $SE=0.05$, $p<0.01$) and observations ($r=0.36$, $SE=0.09$, $p<0.001$). However, there was no significant difference between teacher-report surveys and observations ($p<0.05$). Statistically significant moderation effects were also found for students' grade level ($QM(df=2)=11.95$, $p<0.01$), with the relationship being significantly weaker for elementary school students ($r=0.29$, $SE=0.07$, $p<0.001$). The relationship between autonomy support and structure was similar for college ($r=0.57$, $SE=0.07$, $p<0.001$) and secondary school students ($r=0.56$, $SE=0.03$, $p<0.001$). The relationship between autonomy support and structure was statistically significant across

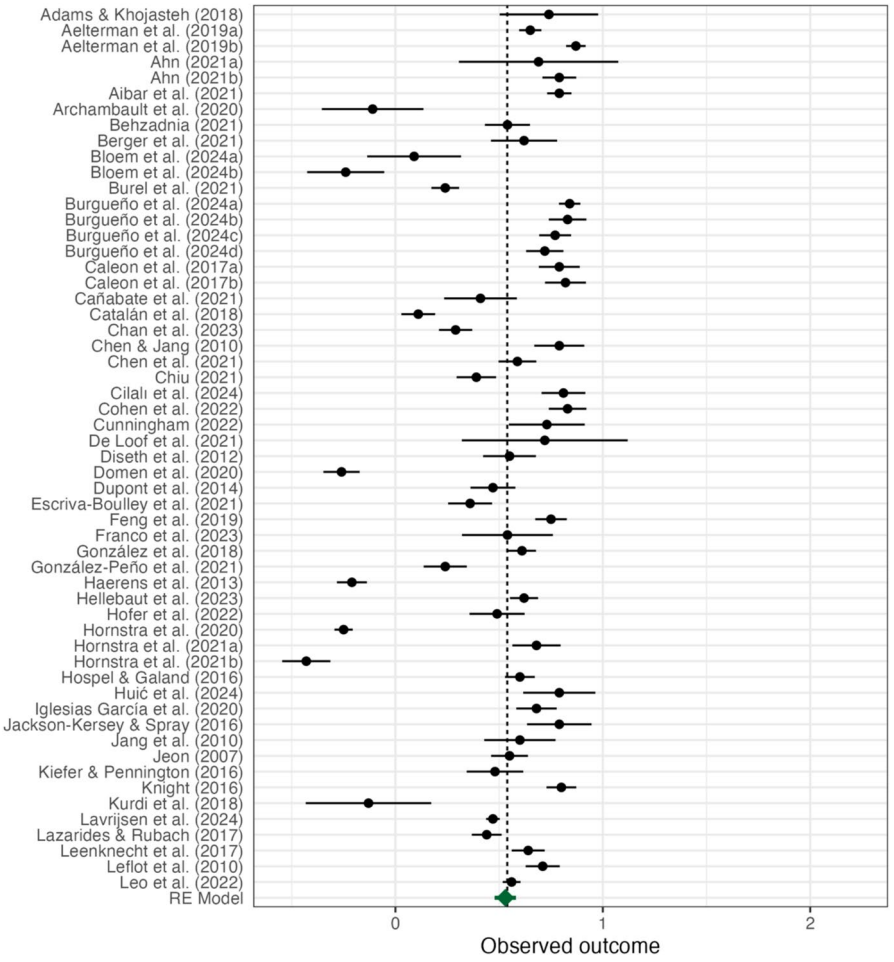

Fig. 3 Forest plot of effect sizes on correlations between autonomy support and structure. Note: The points represent the effect sizes and the horizontal lines on the points represent 95% confidence intervals for each study. The pooled effect size from the random-effects model, along with its 95% confidence interval, is shown in green. The position of the pooled effect size to the right of zero indicates an overall positive effect

subjects but showed no variation between them. Therefore, the subject did not emerge as a statistically significant moderator of that relationship and neither did culture, operationalized as an individualism score ($p > 0.05$). See Table 6 for effect sizes, 95% confidence intervals, and sample sizes of each study.

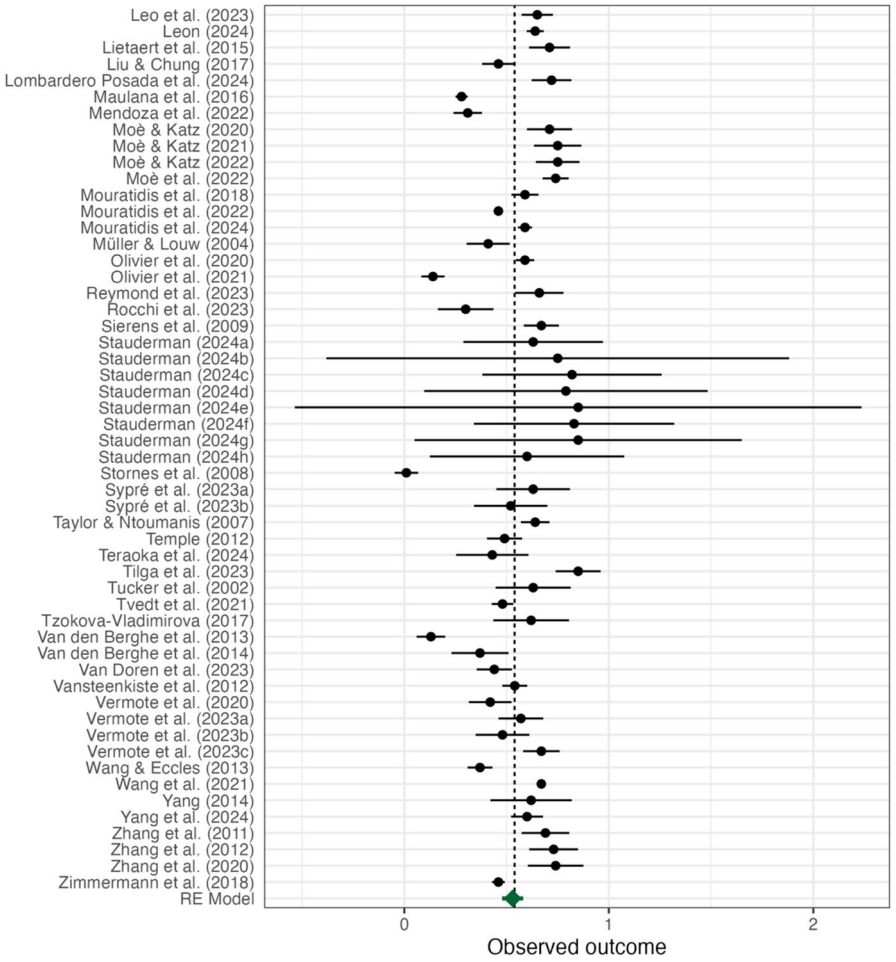

Fig. 4 Forest plot of effect sizes on correlations between autonomy support and structure (continued). Note: The points represent the effect sizes and the horizontal lines on the points represent 95% confidence intervals for each study. The pooled effect size from the random-effects model, along with its 95% confidence interval, is shown in green. The position of the pooled effect size to the right of zero indicates an overall positive effect

Effects on Students' Learning

Main effect analyses were conducted using a random effects model with maximum likelihood estimation to examine how autonomy support and structure are associated with student learning outcomes.

Pearson correlations were calculated to examine the strength and direction of the relationship between autonomy support and student learning outcomes. Autonomy support was strongly correlated with students' sense of autonomy ($r = 0.47$, $p < 0.001$), moderately correlated with students' sense of competence ($r = 0.36$,

Table 6 Sample sizes, effect sizes, and 95% confidence intervals for moderators of correlations between autonomy support and structure

Moderators	Levels	Number of effect sizes	Effect size (*r*)	$CI_{95\%}$	*p*-value
Data collection method	Teacher report	33	.45	[.36, .54]	< .001
	Student report	68	.59	[.53, .66]	< .001
	Observation	9	.36	[.19, .53]	< .001
Grade level	Elementary	14	.29	[.15, .43]	< .001
	Secondary	75	.56	[.49, .62]	< .001
	Post-secondary	16	.57	[.44, .69]	< .001
Subject	General	54	.48	[.41, .55]	< .001
	STEM	12	.57	[.47, .67]	< .001
	Physical education	28	.48	[.41, .55]	< .001
	Social science	16	.64	[.47, .81]	< .001
Culture	Individualism score	107	− .002	[− .004, .007]	.170

$p < 0.001$), and also moderately correlated with academic engagement ($r = 0.35$, $p < 0.001$). However, the relationship between autonomy support and controlled motivation was not statistically significant. For further details, see Table 7.

Partial correlations were then computed to explore the relationship between autonomy support and student learning outcomes when the effect of structure was removed. This approach provides a clearer understanding of the unique contribution of autonomy support. The results showed that the strength of the relationship between autonomy support and student learning outcomes diminished when the effect of structure was removed. For instance, the correlation between autonomy support and students' sense of autonomy decreased from $r = 0.47$ to $r\_partial = 0.29$ after removing the effect of structure. Similarly, the correlation between

Table 7 Pearson correlations between autonomy support and student learning outcomes, and partial correlations between autonomy support and learning outcomes after removing the effect of structure

Learning outcome variables			Pearson correlations			Partial correlations		
	n_{Effect} sizes	n_{Sample} size	*r*	$CI_{95\%}$	*p*-value	*r*	$CI_{95\%}$	*p*-value
Autonomous motivation	14	18,208	.31	[.23, .38]	< .001	.16	[.11, .20]	< .001
Sense of autonomy	7	2650	.47	[.37, .56]	< .001	.29	[.21, .37]	< .001
Sense of competence	9	5082	.36	[.27, .46]	< .001	.16	[.09, .23]	< .001
Engagement	27	14,106	.35	[.30, .41]	< .001	.21	[.16, .26]	< .001
Academic achievement	15	10,440	.15	[.04, .26]	< .01	.08	[.001, .15]	.03
Controlled motivation	13	6292	.02	[− .05, .08]	.62	.01	[− .03, .05]	.63

n_{Effect} sizes refers to the number of effect sizes included in the meta-analysis, while n_{sample} represents the total combined sample size across all studies within each set of constructs. Partial *r* controls for the effect of structure

autonomy support and students' sense of competence dropped to a small effect ($r\_partial = 0.16$), compared to the original Pearson correlation of $r = 0.36$ (see Table 7).

Both autonomy support and structure were positively correlated with students' autonomous motivation, highlighting their collective influence on fostering motivation.

Pearson correlations were computed to evaluate the strength and direction of the relationship between structure and student learning outcomes. Provision of structure was strongly correlated with students' sense of autonomy ($r = 0.43$, $p < 0.001$) and their sense of competence ($r = 0.41$, $p < 0.001$). It was not statistically significantly related to controlled motivation. See Table 8 for further details.

Partial correlations were calculated to investigate the relationship between structure and student learning outcomes, after removing the influence of autonomy support. This method provides a clearer insight into the unique role that structure plays in supporting students' learning. When the effect of autonomy support is removed, the structure shows the strongest correlation with students' sense of competence ($r\_partial = 0.25$). Overall, the results indicate that the correlations between structure and student learning outcomes decrease to moderate or small effects after accounting for the influence of autonomy support. For instance, the correlation between structure and autonomous motivation is reduced from $r\_Pearson = 0.28$ to $r\_partial = 0.15$ once the effect of autonomy support is removed. See Table 8 for further details.

Antecedents of Teacher Autonomy Support and Provision of Structure

Ten out of the 19 teacher-report studies explored the antecedents of teachers' motivating styles. However, since only 1 to 3 studies investigated each of the antecedents,

Table 8 Pearson correlations between structure and student learning outcomes and partial correlations between structure and learning outcomes after removing the effect of autonomy support

Learning outcome variable			Pearson correlations			Partial correlations		
	n_{Effect} sizes	n_{Sample} sizes	*r*	$CI_{95\%}$	*p*-value	*r*	$CI_{95\%}$	*p*-value
Autonomous motivation	14	18,208	.28	[.18, .39]	< .001	.15	[.09, .22]	< .001
Sense of autonomy	7	2650	.43	[.31, .55]	< .001	.21	[.08, .33]	< .001
Sense of competence	9	5082	.41	[.31, .51]	< .001	.25	[.17, .34]	< .001
Engagement	27	14,106	.33	[.25, .40]	< .001	.19	[.14, .24]	< .001
Academic achievement	15	10,440	.12	[.01, .23]	< .05	.07	[.02, .13]	< .05
Controlled motivation	13	6292	.03	[− .03, .09]	.37	.02	[− .03, .06]	.51

n_{Effect} sizes refer to the number of effect sizes included in the meta-analysis, while n_{sample} represents the total combined sample size across all studies within each set of constructs. Partial *r* controls for the effect of autonomy support

the sample size is insufficient for a meta-analytic analysis. Therefore, we present a synthesis of the findings from our systematic literature review instead.

Teacher antecedents of autonomy support and structure spotlighted in the literature include teachers' identity, beliefs, experiences, well-being, and motivation for teaching. See Table 9 for a detailed list of variables and relationships with autonomy support and structure. All variables, except for teacher emotional exhaustion statistically significantly predicted teacher autonomy support and/or provision of structure.

Discussion

Our systematic literature review and meta-analysis aimed to unravel the dynamics between autonomy support and structure to aid research and practice. To do so, we synthesized definitions of autonomy support and structure, their relationship, impact on learning outcomes, and association with teacher antecedents. We caution the reader to interpret effect sizes carefully. Publication bias analyses indicated a potential of 25 missing studies reporting small or negative correlations between autonomy support and structure, suggesting a small risk of effect size overestimation.

Definitions of Teacher Autonomy Support and Provision of Structure are Intertwined

Conceptually, teacher autonomy support was mostly defined as *offering choice*, *providing explanatory rationales*, and *acknowledging students' negative feelings*. Teacher provision of structure was mainly conceptualized as *providing guidance*, *clarifying expectations*, and *giving informational feedbac*k. We also observed significant inconsistencies. Researchers disagreed on whether certain instructional strategies are defining features of autonomy support or provision of structure. For instance, the strategies of *providing rationales* as well as *optimal challenges* were identified as defining features of both autonomy support (Archambault et al., 2020; Jang et al., 2010) and structure (Hospel & Galand, 2016; Mouratidis et al., 2018). Similarly, *showing respect* was recognized as an autonomy-supportive strategy in five of the reviewed studies (see Table 2), yet it is also considered a strategy to facilitate relatedness (Niemiec & Ryan, 2009). These conceptual inconsistencies are concerning because they undermine the generalizability of findings across studies.

Besides those inconsistencies, the instructional strategies used to conceptualize autonomy support and structure in our sample adhere to established definitions of these constructs. Ryan and Deci (2017) define a sense of autonomy as an affordance of *choices* to act congruently with one's authentic *interests*. They describe *guidance* and *offering informational feedback* as key elements of providing structure. The most frequently referenced instructional strategies in our sample mirror Reeve and Cheon's (2021) autonomy-supportive strategies and Aelterman and colleagues' (2019) further categorization of autonomy support. These include participative teacher behaviors (e.g., offering choice) and attuning teacher behaviors (e.g.,

Table 9 Teacher antecedents of autonomy support and provision of structure

Variables	Autonomy	Structure	Citation
Fixed mindset	− .26 to − .11	− .31 to .06	Cilalı et al. (2024); Sypré et al. (2023)
Growth mindset	.01	.26	Vermote et al. (2020)
Burnout	− .17 to − .12	− .25 to − .21	Hellebaut et al. (2023); Moè and Katz (2020)
Teaching experience	.04	.18	Hellebaut et al. (2023)
Need satisfaction	.22 to .31	.27 to .35	Moè and Katz (2020, 2021, 2022); Moè et al. (2022); Vermote et al., (2023a, b)
Autonomous motivation to teach	.37 to .46	.39 to .58	Vermote et al. (2020); Vermote et al., (2023a, b)
Teacher self-compassion	.13	.19	Moè and Katz (2020)
Teacher self-derogation	.02	− .17	Moè and Katz (2020)
Personal accomplishment	.43	.45	Moè and Katz (2020)
Teacher reappraisal	.25	.27	Moè and Katz (2021)
Teacher perceived enthusiasm	.26	.33	Moe and Katz (2022)
Teacher displayed enthusiasm	.13	.09	Moe and Katz (2022)
Efficacy in fostering autonomy and structure	.39 to .46	.37 to .39	Sypré et al. (2023)
Adaptive teacher identity	.58 to .54	.45 to .51	Vermote et al., (2023a, b)
Maladaptive teacher identity	− .15 to − .14	− .19 to − .18	Vermote et al., (2023a, b)
Emotional exhaustion	− .03	− .06	Vermote et al., (2023a, b)
Job satisfaction	.10	.17	Vermote et al., (2023a, b)
Pressure from principal	− .12	− .19	Vermote et al., (2023a, b)
Pressure from colleagues	− .05	− .14	Vermote et al., (2023a, b)
Pressure from students	− .26	− .28	Vermote et al., (2023a, b)

providing explanatory rationales), as well as provision of structure through guidance (e.g., providing guidance) and clarification (e.g., clarifying expectations).

Although the instructional strategies we identified are well grounded in the research literature, we agree with Reeve and Cheon (2021) that they fall short of comprehensively conceptualizing autonomy support and provision of structure. Instructional strategies neither capture the essence of a concept nor do they explain the reasons for applying them or how they might facilitate motivation. Building on their review of autonomy-supportive interventions, Reeve and Cheon developed a conceptual framework that situates these strategies within their underlying origins and the purposes they serve. According to this framework, autonomy-supportive strategy use originates from teachers' basic attitude to focus on students and an instructional tone of understanding. This allows teachers to consider students' perspectives and engage with them in autonomy-supportive ways. They also clarified the purpose of these strategies: to enhance intrinsic motivation and support internalization which are fundamental processes for optimal functioning within self-determination theory (Ryan & Deci, 2017; Ryan et al., 2022). Internalization is the process by which individuals transform external values, rules, and norms into personal beliefs or behaviors, leading students to engage in these behaviors because they align with their sense of self (Ryan & Deci, 2017). It explains how individuals shift from extrinsic to intrinsic motivation. Intrinsic motivation is the highest form in self-determination theory, representing fully self-determined behavior driven by the enjoyment or interest in the activity itself (Ryan et al., 2022).

Our findings both replicate and expand upon the autonomy-supportive instructional strategies identified by Reeve and Cheon (2021). Additionally, they introduce instructional strategies for providing structure, further enriching the framework (see Fig. 5). Building on Reeve and Cheon's strategies of allowing students to pursue their interests and presenting learning activities in a way that satisfies their needs, we propose further promoting student voice and offering choices as additional

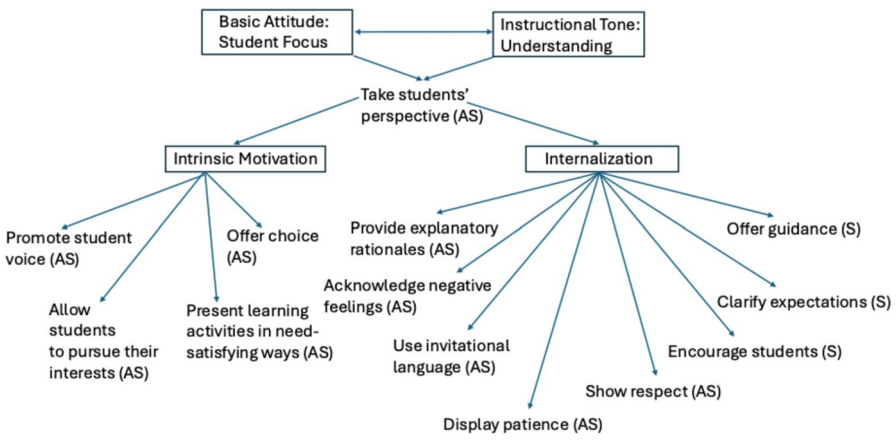

Fig. 5 Conceptual frameworks: Contextualizing Autonomy-Supportive (AS) and Structure-Providing (S) Instructional Strategies—their origins and purpose

autonomy-supportive approaches to enhance intrinsic motivation. These strategies focus on giving students control over their learning, encouraging active participation, and valuing individual preferences and perspectives. When students feel they have the freedom to make choices about their actions, they are more likely to engage in those activities willingly and enthusiastically. Offering choices creates a sense of ownership and personal agency over the task, making it more likely that a student will find the activity intrinsically motivating (Ryan & Deci, 2017).

To facilitate internalization, we concur with Reeve and Cheon's (2021) proposition of autonomy-supportive strategies, which include *providing explanatory rationales*, *acknowledging students' negative emotions*, *using invitational language*, and *demonstrating patience.* Additionally, we propose the autonomy-supportive strategy of *nurturing respect and trust* as well as strategies designed to provide structure with the purpose of internalization. These strategies encompass *offering guidance*, *clarifying expectations*, and *encouraging students.*

Teachers can build a trusting and respectful relationship with students by demonstrating genuine interest in their perspectives and maintaining consistency in their behavior. Offering guidance involves providing support that helps students understand how to succeed, whether through additional assistance during the learning process or by outlining actionable steps to achieve goals and improve skills. Clarifying expectations creates a predictable environment where students know what is expected of them and the standards they need to meet. Encouraging students focuses on recognizing their abilities, adapting instruction to their needs, and promoting independent problem-solving. These strategies collectively foster a positive, supportive classroom dynamic that encourages student growth and success.

Through internalization, students incorporate external expectations into their own beliefs and value systems (Ryan & Deci, 2017). Respect and trust are essential for creating an environment that supports internalization, as they help students feel valued and connected to others. When students feel respected and trust those around them, they are more likely to internalize external expectations in a way that reflects their personal values and identity (Pedler et al., 2022; Rodriguez & Blaney, 2021; Ryan, 1991). Clear expectations further support this process, providing students with a stable framework for understanding what is required of them. This clarity allows them to align external goals with their own values, facilitating the internalization of those expectations (Canning & Harackiewicz, 2015; Mok et al., 2021). Additionally, guidance that builds competence and highlights the personal relevance of tasks encourages students to adopt behaviors and values as their own. By promoting reflection, guidance helps students develop self-awareness and shift from doing tasks out of obligation to engaging with them out of personal motivation. When students understand the significance of a task and how it aligns with their values, they are more likely to internalize the behavior (Walton, 2014; Yeager & Walton, 2011). Encouragement plays a crucial role in reinforcing students' sense of competence; recognizing their strengths and progress fosters a deeper connection to the activity, making it easier for them to internalize its value (Williams & Williams, 2011).

Our findings also provide additional insights into the autonomy-supportive strategies identified by Reeve and Cheon (2021). For instance, we further refine the concept of displaying patience by distinguishing it into key approaches: allowing

students to work at their own pace and refraining from setting deadlines for learning tasks (see Tables 2 and 3 for more details).

Operational definitions of autonomy support and structure are plentiful. Operationally, autonomy support and structure were defined through student- or teacher-report surveys and classroom observations. Besides the two most frequently used student- and teacher-report surveys (TASC: Belmont et al., 1988; SIS: Aelterman et al., 2019), an array of measures was used to quantify the two constructs.

Conceptual and operational definitions of autonomy support and structure are ambiguous. Clearly distinguishing teacher autonomy support, provision of structure, and involvement to support relatedness is crucial for the validity of interpretations based on self-determination research and generalizability of findings across studies. It is also essential for developing and communicating instructional strategies to foster students' psychological needs with teachers.

Teacher Autonomy Support and Provision of Structure Reinforce Each Other

Research paints autonomy support and structure as equals (e.g., Domen et al., 2020), opposites (e.g., Vansteenkiste et al., 2012), and interlaced (e.g., Jang et al., 2010). Those patterns also emerged from our synthesis. Across studies, our meta-analysis demonstrated a positive relationship between the two constructs with a large effect size. This aligns with existing evidence of autonomy support and structure reinforcing each other and both facilitating students' sense of autonomy and competence (Lochbaum & Jean-Noel, 2016; Okada, 2023). We also found moderators of this relationship. Similar to prior research, data collection method affected the strength of the effect size (Bradshaw et al., 2021; Howard et al., 2021), with large effects when student- and teacher-report surveys were used and a moderate effect for observation studies. The relationship between teacher autonomy support and provision of structure was comparably large for college and secondary students and moderate for elementary students. The small sample size and large variability across those studies might explain this finding. School subject and cultural context did not moderate the relationship between teacher autonomy support and provision of structure. The majority of studies in our sample did not specify the subject (see Table 1) which reduces power to detect a possible moderation effect. More fine grained data is needed to examine subject-specificity of teacher autonomy support and provision of structure.

Autonomy support and structure are universally linked. Confirming existing research (Slemp et al., 2018, 2020), the relationship between autonomy support and structure did not vary among individualistic versus collectivistic cultures in our sample. Serie and colleagues (2021) even found evidence for universal wellness benefits of satisfying needs for autonomy, competence, and relatedness. While it is clear that autonomy support and provision of structure are beneficial across cultures (Ryan et al., 2022), there are notable socio-cultural differences in conceptualizing and implementing these constructs into practice (Chirkov et al., 2003; Reeve et al., 2018). For example, Japanese elementary school teachers did not find it appropriate to acknowledge the negative feelings of students or encourage them to ask questions

(Oga-Baldwin & Nakata, 2015), key defining features of autonomy support among reviewed studies in our sample (see Table 2). Because a large body of self-determination research is rooted in western cultures, it is important to understand how the theory applies to other socio-cultural contexts. Further research is needed to examine the universality of definitions and instructional strategies for autonomy support and provision of structure.

Are autonomy support and structure opposites? Mirroring sparse prior research, eight studies in our sample found teacher autonomy support and provision of structure negatively correlated (e.g., Archambault et al., 2020; Domen et al., 2020; Haerens et al., 2013; Hornstra et al., 2020, 2021). Teachers in four of the studies reported viewing structure as a form of control, particularly in the context of working with struggling students (e.g., Reeve, 2009). This emphasizes the misconception that providing structure is a way of taking control, which undermines students' autonomy. Supporting autonomy has also been described as creating distractions and overwhelm students with choices (van Loon et al., 2012), Which may undermine teachers' sense of control over their classrooms and reinforce the negative relationship between autonomy support and structure.

Are autonomy support and structure the same? Our synthesis identified sparse evidence for one construct amalgamating autonomy support and structure, reflecting prior research (e.g., Skinner et al., 2008). Domen et al. (2020), Oga-Baldwin and Nakata (2015), and Wang et al. (2024) factor analyzed survey items to operationalize autonomy support and structure. They found items for autonomy support and structure both loaded on one factor, indicating those items measure one unified construct. Contextual factors or ambiguous definitions of autonomy support and structure may have influenced this outcome.

Teacher Autonomy Support and Provision of Structure is Linked to Student Learning

Both, autonomy support and structure were associated with students' increased autonomous motivation, sense of autonomy and competency, and student engagement, with moderate to large effect sizes across reviewed studies. When the effect of autonomy support was statistically removed from the relationship between structure and student learning outcomes, or vice versa, the impact on student learning outcomes was significantly reduced. This suggests that the combined provision of autonomy support and structure is most beneficial for students. This aligns with the hypothesis that supporting needs for autonomy, competence, and relatedness facilitates autonomous motivation (Ryan & Deci, 2017), which is grounded in meta-analytic evidence across school levels and subject domains (Bureau et al., 2022; Okada, 2023; Vasconcellos et al., 2020). Needs-satisfaction, especially supporting autonomy is also associated with an elevated sense of autonomy and competence (Lochbaum & Jean-Noel, 2016; Okada, 2023; Slemp et al., 2018). Our findings replicate Okada's (2023) meta-analytic evidence of teacher autonomy support facilitating students' engagement and extend this effect to teacher provision of structure, indicating the benefits of supporting both psychological needs.

Does autonomy support and structure undermine controlled motivation? According to organismic integration theory (Ryan & Deci, 2017; Ryan et al., 2022), an extension of self-determination theory, students experience controlled motivation when teachers use an autonomy-thwarting and chaotic instructional approach. Those students feel externally guided through external rewards or punishment, or introjectedly regulated driven by an internal pressure to avoid anxiety. Controlled motivation is hypothesized to emerge when the basic psychological needs are frustrated. The small number of studies examining controlled motivation related to autonomy support and structure in our sample may not have provided sufficient statistical power to detect this hypothesized negative relationship between the constructs.

Autonomy support and structure are indirectly linked with academic achievement. We found small correlations between academic achievement with autonomy support and structure. Prior research describes the nuances of this relationship. Though autonomy support is associated with academic achievement (Eakman et al., 2019), this relationship was mediated by the level of student engagement (Chen, 2005; Mammadov & Schroeder, 2023), their autonomous motivation (Mammadov & Schroeder, 2023), and even the type of measure used to quantify performance (Chen, 2005). Autonomy support and provision of structure also increase intrinsic motivation (Ryan et al., 2022), which is associated with higher performance (Cerasoli et al., 2014; Howard et al., 2021). It is clear that autonomy support and structure benefit student learning outcomes and thus indirectly aid academic achievement. Autonomy support and structure aid students learning through a dynamic interplay of fostering motivations, cognitions, and metacognitive engagement. Disentangling this relationship further warrants further research.

Teachers Facilitating Autonomy and Structure are Motivated to Teach

Slemp and colleagues' (2020) meta-analysis concludes a supportive climate at the workplace facilitates teachers' autonomous motivation. They found autonomously motivated teachers are more supportive of autonomy and competence in the classroom, feel more satisfied with their job, and experience a sense of well-being. Our synthesis confirms those findings. We found moderate to large correlations between autonomy support and provision of structure with teachers' motivation to teach, their sense of self-efficacy for supporting the autonomy and competence of students and feeling effective as teachers. Teachers who provide structure in their classrooms appear to have more teaching experience and believe competence can be developed (i.e., they have a growth mindset). The small number of studies examining teacher antecedents did not allow us to meta-analytically examine these effects. Antecedents of teacher autonomy support and provision of structure warrant further research into the robustness of findings across studies.

Teachers who facilitate autonomy and structure are less stressed. We found evidence for lesser symptoms of burnout, experiences of pressure, and beliefs that ability is fixed among teachers who facilitate the autonomy and competence of students. These findings accord with Slemp et al.' (2020) meta-analytic evidence of autonomously motivated teachers experiencing less stress and burnout. Need-supportive

teachers create a supportive work environment and may also extend their strategies and beliefs to personal goals, further reinforcing their self-determination and accompanying benefits.

Limitations and Directions for Future Research

While our study made novel contributions to the field, limitations should be taken into consideration when interpreting results. Heterogeneity, indicating diversity of effect sizes across studies was observed in our study. We identified three possible sources of variability: (1) study populations featuring different ages, educational and socio-cultural contexts, (2) measures used to quantify autonomy support and structure, varying within the different data collection techniques included in our moderation analysis, and (3) publication bias. While our sample contains doctoral theses, it is possible that the inclusion of file-drawer studies may lead to a more accurate representation of true effect sizes. Further investigations should explore the sources of heterogeneity to enhance the robustness and applicability of findings in this field.

We were unable to identify the hypothesized effects among observation studies, nor the differences between school subjects or the relationships between controlled motivation, autonomy support, and the provision of structure. Further investigation is essential to explore the evidence supporting these hypotheses. Additionally, we advocate for more detailed reporting of school subjects, as most studies in our sample failed to specify the subjects, which diminishes the statistical power to detect potential moderation effects. Future research should aim for more nuanced reporting of school subjects and expand the scope of self-determination research.

Our systematic review unraveled teacher antecedents of autonomy support and provision of structure. Further research is necessary to assess the robustness of these findings across studies. Such inquiry could yield significant implications for teaching practices and teacher education.

Conclusion

Blending support for autonomy and structure is most beneficial for students. According to basic psychological needs theory, facilitating needs for autonomy, competence, and relatedness leads to optimal growth (Ryan & Deci, 2017) and well-being (Serie et al., 2021; Stanley et al., 2021). While evidence-based instructional strategies are available to foster autonomy, competence, and relatedness (Ahmadi et al., 2023), research spotlights teacher autonomy support as a way to satisfy all psychological needs (e.g., Ryan & Deci, 2017; Ryan et al., 2023). Yet, both teacher autonomy support and provision of structure uniquely aid students' learning (Mammadov & Schroeder, 2023; Reeve et al., 2004; Ryan et al., 2022), their intrinsic motivation (Ryan et al., 2022) and engagement (Okada, 2023). Building on this research, we found that both autonomy support and the provision of structure were associated with favorable outcomes for students and teachers, with comparable effect sizes. However, the effects were significantly reduced when either the effect of autonomy

support was statistically removed from the correlation between structure and student learning outcomes, or when the effect of structure was statistically removed from the correlation between autonomy support and student learning outcomes. These findings highlight the unique contributions of each construct and emphasize the importance of integrating both in the classroom to optimize student learning experiences. Our findings suggest blending autonomy support and the provision of structure in the classroom for optimal student learning. We recommend providing structure in an autonomy-supportive way. For example, teachers can offer students choices (autonomy support) and provide an explanatory rational for doing so (provision of structure). A combination of both teaching strategies allows students to engage with activities they judge meaningful and make progress toward their goals.

Our findings underscore the importance of disentangling definitions of autonomy support and structure to ensure the validity and generalizability of findings. Empirical evidence suggests blending autonomy support and provision of structure in the classroom enhances student learning and teacher well-being. We recommend collaboration between researchers and educational practitioners to overcome misconceptions about the provision of structure and facilitate meaningful transfer into practice to optimize the learning experience.

Author Contribution The first author proposed the idea for this review, with contributions from the second author. Together, they conducted the literature search, screening, and coding process. The second author conducted the analysis, guided by the first author, while the first author took primary responsibility for writing and revising the manuscript.

Declarations

Ethics Approval and Consent to Participate This review and meta-analysis used only publicly available data, requiring no ethical approval. All included studies were assessed for ethical compliance, and the findings were reported transparently and responsibly. No ethical conflicts are declared.

Conflict of Interest The authors declare no competing interests.

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