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REFLECTION ON THE FIELD

Learning Styles, Preferences, or Strategies? An Explanation for the Resurgence of Styles Across Many Meta-analyses

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Abstract

The persistence of learning styles as a concept in educational discourse and research is paradoxical, given the overwhelming evidence discrediting the matching hypothesis, the notion that aligning teaching methods with students' preferred learning styles enhances achievement. This paper examines the resurgence of learning styles across meta-analyses and proposes an explanation for their enduring appeal. Drawing on 17 meta-analyses, we distinguish between studies testing the matching hypothesis (effect size $d = .04$) and correlational studies (average correlation $r = .24$), revealing that the latter often conflates learning styles with learning strategies. Much of the research is flawed, and the argument is that there needs to be a shift away from matching learning styles toward teaching students adaptable and effective learning strategies that align more closely with task complexity and learning goals.

Keywords Learning strategies · Learning styles · Matching hypothesis · Meta-analysis

"How Does One Learn?"

> This was a question that I contemplated recently while procrastinating on a task I was supposed to be completing. Urgently.
> Thinking took me back to one of the studies I completed for my PhD. This study drew upon Robert Brennans' Generalizability Theory, a complex theory that allows one to decompose sources of variance across multiple facets.
> I had to make sense of what was almost an impenetrable text to learn the skills needed to apply Generalizability Theory.

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My response to the question thus was: "I like to take my time and read through a text, underlining as I go, making notes, and then follow up by practicing what I am learning while referring back to worked examples."
But then I thought, in the context of writing this paper:
"Is that my preference for learning, my learning style, or simply the strategies I use?"

This procrastination happened while we were working on this paper aiming to understand the pervasive, seductive, ever-enduring belief that knowing a student's learning style and then aligning teaching approaches accordingly can, and does, improve learning. Although numerous studies have discredited the matching hypothesis of learning styles, meta-analyses summarizing research on the topic suggest the opposite. Based on the seventeen studies captured by the Visible Learning Meta^{X} database (www.visiblelearningmetax.com), the effect of matching teaching strategies with learning styles is not inconsequential ($d = 0.40$). The Meta^{X} database includes (an annual) updating of 2500 meta-analyses relating to achievement outcomes covering influences from the student, home, school, classroom, curriculum, teaching, learning, technology, and out-of-school influences. The average from these 2500 meta-analysis is 0.40—thus merging all learning styles studies can be considered an 'average' effect, which makes it well worth considering—but.

This paper examines the enduring appeal of learning styles despite overwhelming evidence discrediting the matching hypothesis—the idea that students learn best when instruction aligns with their preferred learning style. We begin by tracing the historical evolution of learning styles theories, from early classifications to widely adopted models such as VAK/VARK and experiential learning (and note that Fallace, 2023 has provided a much more comprehensive overview). Next, we analyze the apparent resurgence of learning styles in meta-analyses, revealing a critical distinction between studies testing the matching hypothesis, which show negligible effects, and correlational studies, which report modest relationships but do not establish causation nor relate to the matching hypothesis. We identify eight major confounding factors that contribute to the persistence of the learning styles myth, including the conflation of learning styles with learning strategies, the appeal of individualization, and the influence of commercial and institutional promotion. Finally, we argue that instead of tailoring instruction to student preferences, educators should focus on teaching students how to select and apply adaptive learning strategies, which have a demonstrable positive impact on learning. This paper aims to redirect the conversation toward more effective, research-informed approaches to student learning by disentangling myths from evidence.

Learning Styles

The notion of learning styles relates to the diverse spectrum of theories that purport to account for differences between individual learners and how they learn. Meumann (1913) integrated earlier notions of learning styles into three "types" of learners. First, auditory learners are those who hear auditory images of words. Second,

motor learners have a mental revival of the muscular sensation. Third, visual learners see the visual images of written or printed words. Many have made claims about these multiple learning modalities and argued that preferences for these should be matched with specific forms of teaching.

Mills (1956) developed the Learning Method Test, which is based on methods of teaching—visual, auditory, kinesthetic (VAK), or a combination. Drawing upon the results of his experimental work, with 58 students broken into nine groups based on intelligence (as measured by the Wechsler Intelligence Scale for Children) and age/grade level, Mills concluded that his results "showed conclusively that different children learn to recognize words more efficiently by different teaching methods and that no one method is best for all children" (p. 223–224). He concluded with the strong assertion that "this research indicates the need for the concentration of energies on finding out which method is best for which children rather than developing a recipe or "a best method" that will serve for all children all the time" (p. 225). Fallace (2023, p. 340) argued that Mills was "the first educator to assess the effectiveness of aligning specific VAK-based methods with specific students" and was responsible for creating "an intellectual hierarchy of learning methods aligned with intelligence that placed visual learning at the top of the scale and kinesthetic learning at the bottom" (p. 340).

Dunn and Dunn (1975) became the major promoters of matching styles to teaching and developed their Learning Style Inventory (LSI), which is still among the most widely used measures. Originally comprised of eighteen elements across four diverse stimuli, the Dunn and Dunn model has grown to encompass five stimuli and twenty one elements. Embedded within these elements are the physiological-perceptual elements focused on auditory, visual, and kinesthetic or tactile learning preferences. Others have modified the Dunn model over the years with a proliferation of names and more nuanced definitions of styles. Their message was clear: teach to the student's strengths, that is, their preferred mode of learning.

Barbe et al. (1981) have argued that students differ in terms of learning modalities: auditory (they like to talk it through), visual (they like to see words written down), and tactile-kinesthetic (they like to be up and doing). They developed a 14×3 observation checklist to determine each child's strengths—the Swassing Barbe Modality Indicator (SBMI) is focused solely on the VAK modalities, and unlike the Dunn and Dunn LSI, the SBMI is not based on individual student preferences but instead on teacher observation, as they considered student self-reported preferences to be suitably unreliable. Further, they were strong advocates for students being taught to their strengths. While they acknowledged that there was a lack of evidence, "it is true that no incontestable evidence has yet been produced to justify modality-based instruction" (Barbe et al., 1981, p. 262), they contended that it was "still too early to abandon the concept of teaching through modality strengths. Although no clear-cut evidence has been produced to support this practice, those who oppose it have not been able to muster proof that it is not useful" (p. 266). Not a ringing endorsement.

Kolb's (1984) experiential learning theory is based on the view that "learning is the process whereby knowledge is created through the transformation of experience" (p. 38). Kolb's experiential learning theory incorporates two key elements:

(1) a learning cycle, and (2) a model of four distinct learning styles: concrete learning, reflective observation, abstract conceptualization, and active experimentation. Concrete learning is when a learner has a new experience or reinterprets a previous experience. Reflective observation is when a learner reflects on an experience to make sense of what it means. Abstract conceptualization is when a learner adapts their existing thinking or constructs new thinking based on their experiences and reflection. Active experimentation is when a learner applies new thinking and ideas. In addition to the experiential learning cycle, Kolb defined four learning styles based on these four phases of learning, which he termed diverging, assimilating, converging, and accommodating. Kolb's work formed the basis for the Kolb Learning Style Inventory which has been updated regularly and now includes nine distinct learning styles (Kolb & Kolb, 2013).

Fleming and Mills (1992; Fleming & Baume, 2006) created the VARK model of learning styles based on four distinct learning styles: visual, auditory, a preference for reading or writing, and kinesthetic. They developed a 13-item measure that students could complete so that the results could "stimulate reflection and discussion," and therefore they claimed, "testing for construct validity and reliability was unnecessary and inappropriate" (Fleming & Mills, 1992, p. 140). Fallace (2023) noted that "due to its simplicity, the Fleming VARK model quickly became one of the most popular learning style typologies in the world." The measures are still available on the internet with claims about extensive usage and include items such as: "I prefer a presenter or a teacher who uses: question and answer, talk, group discussion, or guest speakers; demonstrations, models or practical sessions; diagrams, charts, maps or graphs; and, handouts, books, or readings" (see https://vark-learn.com/the-vark-questionnaire/).

In addition to the above, many other styles and preference models have emerged, including the 4MAT (McCarthy, 1987), the Honey-Mumford (1982) Learning Styles Model, the Gregorc (1984) Style Delineator, and so on. See Cassidy (2004) for a more extensive overview of theory, models and measures related to learning styles.

The Fundamental Claims of Learning Styles

Fallace's (2023) history shows the many twists and turns in the definition and usage of learning styles in the available literature and related notions of: learning modalities, learning preferences, thinking styles, mind styles, and/or cognitive styles. A major argument of this article is that they are still twisting and turning even as the negative evidence accumulates. Three fundamental claims in this literature can be identified. First, the essence of learning styles is visual, auditory, kinesthetic, and read/write, with many modifications to what each means. Second, the theory is premised on the notion that we all have a style of learning through which we learn best. Third, matching teaching to learning through one's style will be more efficient and effective than teaching and learning through a less compatible style. For example, visual learners learn best by viewing images, diagrams, and videos; auditory learners learn best by listening to lectures and absorbing verbal explanations of

things; read/write learners learn best through writing and reading; and kinesthetic learners learn best by doing, building, or interacting physically with things.

The Controversial Challenge of Learning Styles

While this article does not intend to comprehensively re-review the literature on learning styles, we want to highlight some of the key dangers of pursuing a discredited notion. Google Scholar returns over 7 million references to a search using "learning styles" or "learning preferences" or "learning patterns". The NGram for "learning styles" shows a marked increase from 1960 to 2002, a sudden dip over the next ten years, then a re-spurt to now exceed the 2002 citation rate.

There are many articles, reviews, and empirical studies showing the poverty of the matching hypothesis (e.g., Cuevas, 2015; Fowler & Snyder, 2021; Husmann & O'Loughlin, 2019; Khazan, 2018; Knoll et al., 2017; Krätzig & Arbuthnott, 2006; Rogowsky et al., 2015; Riener & Willingham, 2010; Willingham et al., 2015). Among the most cited reviews are Pashler et al. (2008) paper 'Learning Styles: Concepts and Evidence,' which has, according to Scholar, been cited over 4000 times. A key conclusion of Pashler et al. was that there is "no adequate evidence base to justify incorporating learning style assessments into general educational practice" (p. 105). This is echoed by Willingham et al.'s (2015) comment that there "is reason to think that people view learning styles theories as broadly accurate, but, in fact, scientific support for these theories is lacking" (p. 266). They further asserted, "we suggest that educators' time and energy are better spent on other theories that might aid instruction" (p. 266). It seems ironic that there has been an upsurge in published articles using the term "learning styles" since Pashler et al.'s article in 2008 (see Newton, 2015). Nancekivell, Shah, and Gelman (2019) noted "that there has been no evidence that matching or meshing instruction to someone's self-reported learning style positively affects their ability to learn new information" (p. 221). They also note the wasted time, the misconceptions, and the opportunity costs (from not introducing more effective teaching methods), but they are fascinated by why the myth continues to appeal, be promoted, and we add, what it would take to finally move beyond it.

Despite what some might consider to be an overwhelming sense that learning styles are a discredited notion it persists. For example, a recent paper showed over 90% agreed that "individuals learn better when they receive information in their preferred learning style" (Dekker et al., 2012). Newton and Salvi (2020) completed a systematic review of research into educators' belief in and use of learning styles. They identified 37 studies from 2009 to early 2020, which captured the insights of 15,405 educators from 18 countries. In summary, 89% of teachers agreed that students learn better when taught with their preferred learning style. They also found no evidence that teacher beliefs in matching learning styles have declined—perhaps alarmingly, they identified that "the total percentage of pre-service teachers who believe in Learning Styles (95%) was higher than the percentage of qualified teachers (88%)" (p. 6). Dekker et al. (2012) reported 93% of UK and 96% of Dutch teachers endorsed learning styles, Grospietch and Mayer (2019) reported 93% of science

teachers endorsed learning styles, and MacDonald et al. (2017) reported 93% of the general public endorsed learning styles. Horvath et al. (2018) reported that 84% of award-winning educators endorsed learning styles, and Brown's (2023) review concluded that there is an '"overwhelming belief in the veracity of a neuroscientific fable" (p. 5).

Even more concerning, a review by Cuevas (2015) of teacher education texts found that they all had sections on learning styles and, possibly more concerningly, championed them. Worse still, not one of the texts commented on the lack of supporting literature or cited studies in defense of learning styles (Cuevas, 2015). Indeed, the textbooks conveyed the information as if the hypothesis had been validated, promoting the use of teaching methods that align classroom instruction with students' learning styles. Similar findings regarding the prevalence of learning styles in textbooks were shown by Wininger et al. (2019), who found that 80% of introductory texts in education and educational psychology included a discussion of learning styles. The learning styles claims are still used to defend policy, such as a presentation to the Tennessee Senate defended the "Science of Reading" Bill because literacy instruction should integrate auditory, visual, and kinesthetic activities because 'that is how the brain works' (Aydarova, 2023, p. 365).

What Does Meta-Research Reveal—a Tale with Two Stories

Currently, in the Visible Learning Meta^{x} database, there are 17 meta-analyses centered on summarizing the relation between learning styles and achievement (see Table 1). These capture almost 700 studies, of which about 10–15% of the studies are in common, summarizing results from approximately 100,000 + students. The average effect size in summarizing the results of these 17 meta-analyses is 0.40—which is precisely the average effect size from 400 influences (based on 2500 meta-analyses, 100,000 + studies, and 30–40 million students).

On the surface, the message seems clear. On average, matching teaching to learning styles is a worthwhile decision. A closer examination, however, reveals a more complex reality.

Within the database, there are two distinct types of meta-analyses on learning styles: (1) those that test the matching hypothesis (i.e., the impact of matching or meshing a student's learning style with the teacher's pedagogical approach) and (2) those that evaluate the correlates of learning styles (i.e., the relationship between students' scores on a learning style inventory and achievement). These two groups of studies effectively measure different things: do students do better when taught to their preferred learning style (the d-studies), or is there a correlation between a learning style and academic outcomes (the r-studies)? As we will see, there is little support from the meta-analyses for the matching hypothesis, but there are higher correlations with achievement.

While it is possible to translate correlations into Cohen's d effect-sizes and all the effects in Visible Learning Meta^{X} are d's, in this article, the d's will be used for the

Table 1 Meta-analyses relating to learning styles, with summary statistics, and brief description of the focus of the meta-analysis

Matching	Year	No. studies	Est No. people	No. effects	ES	d	Claimed Focus
Garlinger & Frank	1986	7	1,531	7	−0.03	−0.01	Field independence/dependence on achievement
Kavale & Forness	1987	39	3,087	318	0.13	0.06	Modality testing and teaching
Phillips, Fletcher, Marks & Hine	2016	89	17,704	68	0.22	0.11	Reflection thinking styles on performance
					−0.18	−0.09	Intuition thinking styles on performance
Peterson & Meissel	2015	15	1,381	15	0.16	0.08	Verbal-imagery vs holistic thinking
Correlates							
Tamir	1985	54	4,970	13	0.02	0.01	Cognitive preference
Iliff	1994	101	9,296	486	0.33	0.16	Kolb Learning Style matched to achievement
Dunn, Griggs, Olson, Beasley & Gorman	1995	36	3,181	36	0.76	0.35	Interventions to enhance matching learning style on achievement
Sullivan	1993	36	3,181	36	0.76	0.35	Dunn and Dunn Learning styles matched to achievement
Slemmer	2002	48	5,908	51	0.13	0.06	Learning styles in hyper/technology environments
Mangino	2004	47	8,661	386	0.54	0.26	Dunn and Dunn Learning styles for adults
Lovelace	2005	76	7,196	168	0.67	0.32	Dunn and Dunn Learning styles matched to achievement
Salvione	2007	34	7,093	677	0.28	0.14	Dunn and Dunn learning styles for students
Ay	2017	60	26,391	60	0.47	0.23	Learning styles
Mohammadi, Sayehmiri, Tavan, & Mohammadi	2013	10	920	10	0.25	0.12	Correlates of various styles with achievement
Kanadli	2016	30	2,761	30	1.03	0.46	Correlates of various styles with achievement
Takase & Yoshida	2021	9	1,830	10	0.51	0.26	Deep learning with achievement
Erdem & Kaf	2023	18	1465	19	0.78	0.36	Learning styles
Matching (N = 4)	2006	143	22,172	401	0.08	0.04	
Correlates (N = 13)	2006	559	82,853	1982	0.50	0.24	
Total (N = 17)	2006	702	105,024	2383	0.40	0.19	

matching studies as they are between-group comparisons., and the correlations (r) will be used when discussing the correlation meta-analyses. (Note, $d = 2r/(1\text{-}r^2)^{.5}$.)

Matching Studies Overview

The matching or meshing hypothesis suggests that if individuals are taught in their preferred modality or style, they will have improved learning outcomes compared to those in a non-preferred modality or style. If designed well, studies focused on the matching hypothesis have the potential to provide evidence that supports learning styles. Pashler et al. (2008) provided criteria for appropriate study design required to support the effectiveness of matching learning styles with teaching style: they divide learners into two or more groups based on an appropriate learning style measure; learners within each learning style group are assigned randomly to a different learning method; all learners are assessed using the same achievement test; and, the results must show that the method that enhances student achievement of one learning style group is different from the method that enhances the student achievement of a second learning style group. Alas, studies that satisfy these criteria are seldom to be found.

There are currently four meta-analyses in the Visible Learning database that specifically address the matching hypothesis relative to academic outcomes (see Table 1). These meta-analyses capture findings from 143 studies and summarize 401 effects with an overall effect size of $d = 0.04$ (se = 0.21).

In the earliest study, Garlinger and Frank (1986) identified seven studies related to field-dependent and field-independent cognitive styles and achievement when exploring the matching hypothesis. Individuals with a field-dependent cognitive style depend on external factors, such as the teacher or peers, when receiving and processing information. On the other hand, those with a field-independent cognitive style are more autonomous and less dependent on others. The effect sizes, summarizing five of the studies, were close to zero. Note that two studies were excluded as they only provided combined data, making no distinction of the cognitive style. For matched field-dependent students compared to mismatched field-dependent students, the effect size was $d = -0.03$. For matched field-independent students compared to mismatched field-independent students, the effect size was $d = 0.04$. And, for combined matched compared to combined mismatched, the effect size was $d = 0.03$. The key takeaway of Garlinger and Frank's study is that there is no impact for matching learning styles with teaching.

Kavale and Forness (1987) used 39 studies that specifically addressed modality assessment and training. They compared those identified by learning preferences and modality-matched instruction to a control group who received "regular" instruction irrespective of their preferred learning style. They commented that "the groups seemingly differentiated on the basis of modality preferences actually revealed considerable overlap; it was doubtful whether any of the presumed preferences could really be deemed preferences." The effect size gain was 0.13 (auditory 0.14, visual 0.09, kinesthetic 0.18), which they noted only results in a 6-percentile rank improvement. Additionally, 35% of the effects were negative, highlighting that

"over one-third of subjects receiving instruction matched to their preferred learning modality actually scored less well than control subjects receiving no special instruction" (p. 233). They also noted the logical problem: "Consider the case where a subject may reveal a pattern of high modality score (e.g., auditory), and lower modality score (e.g., visual), and be termed an auditory learner, while an individual who scores low on the same auditory modality but even lower on the visual modality would be similarly classified as an auditory learner. It is not logical to assume that subjects exhibiting such preference patterns would reveal similar learning patterns and strategies" (p. 237). Thus, Kavale and Forness concluded, "the modality concept holds little promise for special education, and the present findings provide the necessary basis for no longer endorsing the modality model, since learning appears to be really a matter of substance over style" (p. 238).

Phillips et al. (2016) used 89 studies to relate thinking styles to decision making related performance. They were specifically interested in matching tasks favoring reflective or intuitive thinking. They found a correlation of 0.11 ($d=0.22$) when reflective thinking was used for decision-making and $r=-0.09$ ($d=-0.18$) when intuition thinking was used. They noted that "overall, stronger positive relationships between thinking style and decision performance occurred when decision task and processing system were matched" (p. 277). But, it seems that using both is optimal: "individuals with high tendencies to use both thinking styles are likely to excel in a variety of decision-making situations" (p. 284).

Finally, Peterson and Meissel (2015) used 15 studies that used Riding's (1991) Cognitive Style Analysis (CSA) combined with an academic outcome. In the context of CSA, cognitive style as "an individual's preferred and habitual approach to organizing and representing information" (Riding & Rayner, 1998, p. 8) and the CSA measures cognitive style on two key dimensions: verbal–imagery and wholistic–analytic. Peterson and Meissel found "no clear academic achievement advantage" (p. 115) associated with either cognitive style. Again, the key takeaway is that there is no impact for matching learning styles with teaching.

Thus, the overall effect is close to zero across these four matching meta-analyses. There is NO evidence that matching learning styles to teaching styles makes much, if any, positive impact on learning.

The Correlational Meta-analyses

There are 13 meta-analyses in the Visible Learning Meta^{X} database that investigate and summarize the correlates of learning styles; that is, the relationship between students' scores on a learning style inventory and other variables of interest such as achievement. The argument is that relating one or more learning style(s) with achievement provides no insight into matching styles to optimize achievement outcomes and, therefore, fails Pashler et al.'s (2008) design criteria, as they do not divide learners into two or more groups based on a measure and do not randomly assign learners within each learning style group to different learning method.

The earliest is Tamir (1985), who investigated the relationship between four cognitive preferences to engage with scientific information. They include recall

(acceptance of information), questioning (critical questioning of information), application (a focus on the utility or applicability of information), and principles (the acceptance or integration of information on the basis that it represents fundamental scientific principles). Tamir reported correlations with achievement of $r=0.16$ for Principles, $r=0.12$ for Questioning, $r=-0.14$ for Recall, and $r=-0.03$ for Application. None of these correlations are overwhelmingly convincing. Given this, it is perhaps surprising that Tamir concluded that "cognitive preferences make significant contributions to learning" (p. 13). He also noted that lower achievers prefer recall, whereas higher achievers prefer principles, critical questioning, and application—probably pointing to a different direction in the causal claims, that is, that students are higher achievers because they know when to select more optimal strategies. The magnitude of his correlations supports none of these claims.

Iliff (1994) found that no one of the Kolb learning scales predicted learner outcomes better than any other: $r=0.14$ for the diverger, $r=0.14$ for the assimilator, $r=0.14$ for the converger, $r=0.18$ for the accommodator, $r=0.13$ for active experimentation, $r=0.14$ for concrete experience, $r=0.14$ for reflective observation, and $r=0.14$ for abstract conceptualization. Ilif concluded that "since this study found the LSI [learning styles inventory] not to be a predictor of learner outcome and career fields of study, researchers will be advised to stop trying to fit square pegs into round holes" (p. 76).

The most well-known meta-analysis is by Dunn et al. (1995). It is noted that this work is mainly based on doctoral dissertations, many supervised by the authors, with mostly attitudinal outcomes and adult samples. A critical observation of this article is that it appears to be a re-working (with the same results) as Sullivan's (1993) doctoral dissertation, but she is excluded in the authorship of the Dunn et al., 1995 article, authored by four of her supervisors. They calculated correlations of learning styles to outcomes and then converted them to d's; hence losing any inference about the matching hypothesis. They reported correlations of $r=0.26$ for emotional, $r=0.23$ for sociological, $r=0.24$ for environmental, and $r=0.46$ for physiological styles relating to achievement; and overall $r=0.35$. They concluded inappropriately that students with strong learning style preferences had greater gains in terms of academic outcomes due to aligned instructional interventions as compared to those with mixed or moderate preferences. It is important to note that despite their claim that "matching students' learning style preferences with educational interventions compatible with those preferences is beneficial to their academic achievement" (p. 353), the studies are not evaluations of the matching hypothesis but correlates of styles and achievement.

There are also some unusual aspects within Dunn et al. Some of the effects are extremely large; Rowan (1988), for example, assigned teachers to in-service courses based on matched and mismatched learning styles and preferences for the time-of-day for instruction. The effect size reported is $d=22.29$! This translates into a correlation between learning styles and achievement of $r=0.996$—which is beyond imaginable. The next largest correlation was the reported $r=0.87$ from LaShell (1986). She assigned 48 students to a control and 42 to a treatment group. Students' reading styles were evaluated, and educational strategies were recommended for each student. Using a measure of reading as the outcome, LaShell used a regression analysis

including grade, treatment or control group, gender, pre-reading score, teacher's years of education, and others. The Multiple R was 0.87, and Dunn et al. mistakenly used this as the correlation; consequently, its use nullified any meaningful claims about the matching claims.

Other studies were based on tiny sample sizes. For example, Zippert (1985) assigned nine adults to courses to match their (unspecified) learning styles and eight to a control course taught by the same instructor. Hutto (1982) asked four teachers to teach three classes where they were asked to match instruction to the students' learning preferences and three where they were not so matched. Although several statistical tests were provided, only one was chosen to be interpreted. In third grade, the matched group exceeded the control group, and only this effect was reported in the meta-analysis. Others included attitude, not achievement outcomes. For example, Ingham (1989) gave 314 employees (sales representatives, mechanics, and management) two lessons—one an auditory strategy with visuals and one a tactual/kinesthetic strategy with visuals. When matched for preferences, there were differences in their attitudes towards the company training programs.

Further, Kavale et al. (1998) reviewed the Dunn et al. meta-analysis. They concluded that the "weak rationale, curious procedures, significant omissions, and circumscribed interpretation should all serve as cautions" (p. 79) and that the study has "all the hallmarks of a desperate attempt to rescue a failed model of learning style" (p. 79). More recently, Klitmøller (2015) reviewed the research specific to the Dunn and Dunn matching model. Findings from 14 studies indicated no significant interaction between instruction and preference. Further, 12 studies had findings that could be interpreted as contradicting the model. He concluded that "there is little evidence supporting matching of perceptual preferences" (p. 18). Further, at least half the studies contradict the model, and most studies are questionable in quality.

Slemmer (2002) was particularly interested in how technology-enhanced learning environments could accommodate students' learning styles. The study used 48 studies with 51 effect sizes drawing upon various learning style measures. On average, Slemmer found a small but nonsignificant" correlation between learning styles and student achievement ($r=0.13$).

Mangino (2004) investigated the correlations of Dunn's learning style scales on several variables focused on adult learning. The overall correlation with achievement was 0.35. Higher achieving students showed larger effects for kinesthetic learning ($r=0.64$), medium effects for formal design ($r=0.47$), a preference to learn sitting up straight with their back at a 90-degree anger ($r=0.47$), no sound ($r=0.40$), auditory (r-$=0.40$), structure ($r=0.38$), tactual ($r=0.34$), learning in several ways ($r=0.31$), and the presence of an authority Fig. (0.28). On the other hand, lower achieving students showed larger effects for light ($r=0.45$) and not visual ($r=0.42$) and medium effects for tactual ($r=0.23$).

Lovelace (2005) included 76 studies and found a correlation between learning styles of 0.32 for achievement and 0.37 for attitudinal outcomes. She asserted that "the Dunn and Dunn Learning-Style model has a robust moderate to large effect that was practically and educationally significant" (p. 181) with the potential to improve student achievement and attitudes to learning. It is difficult to see how such a correlational study can possibly lead to this conclusion.

Salvione (2007) used 27 studies correlating the Dunn and Dunn model with reading ($r=0.09$) and math (0.15), which led to the over-inflated conclusion that achievement was significantly correlated with the learning styles of elementary school children. She noted that remedial students prefer bright light ($r=0.46$) and adult motivation ($r=0.39$), and students with high mathematics and reading scores (unlike their low-performing peers) showed preferences for learning alone, working in the afternoon, and being persistent, responsible, motivated and visual. She wondered why the Dunn and Dunn model "has not been implemented in every public school" (p. 110).

Ay (2017) reported a correlation of $r=0.23$ between learning styles and students' achievement. The correlation differed depending on the learning styles measures used: for example, Nigro LSI ($r=0.60$), LSA ($r=0.47$), Kolb's LSI ($r=0.33$) and Burke and Dunn LSI ($r=0.33$). Curiously, the LSI used in Nigro's (1998) thesis, focused on students' attitudes towards different instructional strategies (such as lectures, programmed instruction, drill and recitation, discussions, peer teaching, teaching games, independent study, projects, and simulation). These lend themselves to the argument that it is not learning styles or preferences per se, but rather the learning strategies used.

Mohammadi et al. (2013) used 10 articles involving nursing students and reported correlations between achievement and converger style 0.25, assimilator 0.17, diverger 0.14, and accommodator 0.12. They concluded: "the foremost learning styles of nursing students respectively are converger, assimilator, diverger, and accommodator" (p. 752) and "teachers should pay more attention to these styles in their teaching and employ teaching methods appropriate with them" (p. 752) The correlations are all low, and there is no design that allows for this conclusion about matching.

Kanadlı (2016) investigated and summarized experimental studies from Turkish theses that correlated learning style and academic achievement. The overall correlation was $r=0.46$. There were no significant differences according to learning style models (4MAT System 0.50, Perceptual Learning Style Model 0.40, Dunn & Dunn Learning Style Model 0.55, and the Kolb Learning Styles Model 0.47). Additionally, the correlations between learning style scores similarly related to attitude towards learning ($r=0.49$) and retention of learning ($r=0.54$).

Takase and Yoshida (2021) investigated the relationships between academic achievement and the learning approaches used by undergraduate nursing students. Of interest was the distinction between surface and deep approaches. In the context of their work, surface approaches involve extrinsic motivation to successfully pass exams with the minimum effort driving students to draw upon a low level of cognitive activities (i.e., rote learning/memorization), which can be effective when memorization and recall of facts is required but less so when understanding is required. On the other hand, deep approaches to learning involve students' drawing upon students' intrinsic motivation to spend time studying, drawing upon a diverse range of strategies to achieve a meaningful understanding of a subject. Summarizing findings from nine studies with 10 cohorts ($N=1830$), they found a statistically significant positive correlation ($r=0.26$) between academic achievement and deep approaches to learning and academic achievement. Furthermore, summarizing findings form 11 studies with 12 cohorts ($N=2138$), they found a statistically significant negative

correlation ($r=-0.25$) between academic achievement and surface approaches to learning. They concluded with the strong assertion that "higher education institutions should encourage the use of the deep approach and discourage the surface approach to learning by utilizing appropriate educational instructions and assessment methods" (p. 844).

A more recent study by Erdem and Kaf (2023) investigated experimental studies to understand the impact of learning style-based instruction on academic achievement. The overall effect size from 18 Turkish theses was $r=0.36$. There were some very large effects (e.g., $r=0.88$), but most seemed more comparisons about two different teaching methods and did not involve matching studies. For example, consider the three largest effects (thanks to the authors for providing the theses). Çakıroğlu (2014) used two classes of 34 students for 9 weeks of biology lessons: one control class where traditional teaching methods were used and one class where brain-based learning was implemented. The students completed the Kolb LSI and nine students were diverging (imaginative), 14 were assimilating (analytical) 20 were "common sense" (problem solvers), and 25 were accommodating (intuitive). There were no pre-group differences, but the experimental group increased $d=4.63$, and the control group 1.27; such that the difference was $d>3$. This shows that it is not a matching hypothesis study but a difference between two different teaching programs. There were no analyses relating to learning styles, so the differences were a function of differing teaching implementation and intensities. Önder (2006) compared the progress of 61 10th grade students in a 4-week physics session and found "motional" students (who conducted experiments) outperformed all others: visual students (who completed writing tasks), and auditory students (who explained their readings to the class). Çömek (2009) used science-teacher students to undertake homework using computer-based ($N=30$) vs non-computer resources ($N=30$). The Grasha-Riechmann Student Learning Style scale (1975) was used to classify students into four groups: independent (23%), dependent (7%), passive (7%), and competitive (13%) with the other 50% not classified into a specific group. The achievement scores of those classed as Independent went up from pre to post, whereas the others remained the same or went down. There is no matching, and it seems that computer-based teaching excelled in non-computer based teaching.

Concluding Comments from These Meta-analyses

A review of these two groups of meta-analyses highlights three important points plus an important sweeping observation. Firstly, the limited number of matching meta-analyses, which attempt to show the benefits of matching teaching strategies with learning preferences, suggest a small, negligible effect size of $d=0.04$; this clearly demonstrates the hypothesis's poverty. The key takeaway point is that matching teaching with students' learning preferences has very little impact, and many more effective interventions exist.

Secondly, the correlation-based meta-analyses have an overage correlation of $r=0.24$ ($d=0.50$) and say nothing about matching styles to optimize achievement outcomes. Causality and directionality are lost in these correlations. But all is not

as predicted. As the above review shows learning styles have very low relations to acceptance of information, critical questioning of information, a focus on the utility or applicability of information, and the acceptance or integration of information (Tamir, 1985). There are low correlations with achievement for divergers, assimilators, convergers, and accommodators (Iliff, 1994). Achievement correlations are largest for kinesthetic learners, when there is no sound or bright light, when working in the afternoon, and when sitting up straight (Mangino, 2004; Salvione, 2007).

Thirdly, when looking at the learning styles summarized in both the matching and correlation studies, it is hard not to be dismayed by the broad range of what is indeed considered a "learning style." Ranging from preferences related to the environment, presence of sound, temperature, time of day, motivation, persistence, food and drink intake, personal, perceptual preferences such as visual, auditory, kinesthetic, ways of thinking, approaches to learning, types of tasks and so on. It is hard to distinguish between what is truly a learning preference or style and what is not. Is it really a learning style to like to work in pairs, in the afternoon, when it is warm, and while snacking?

Perhaps there is a kernel of sensibility in the notion of styles when they overlap with students' strategies and approaches to learning. For example, think of Takase and Yoshida (2021) findings about the importance of deep approaches to learning, and Tamir's (1985) cognitive preferences of Recall (acceptance of information), Questioning (critical questioning of information), Application (a focus on the utility or applicability of information), and Principles (acceptance or integration of information) on the basis that it represents fundamental scientific principles. It is not a stretch to see these four "cognitive preferences" being a function of strategies used by a student.

Finally, a broad generalization. An important observation from this review is that many, if not most, of the studies in these meta-analyses exhibit many methodological weaknesses in research design; especially evaluating the aptitude-treatment interaction expected from the model. They are riddled with errors, and too often they are exemplars of poor-quality meta-analyses. The learning styles literature does not describe how styles develop, barely relate to meta-cognitive, motivation and personality mechanisms, and they seem unchanging, mutually exclusive, implying different kinds of students, and that the styles are hard-wired into the brain (An & Carr, 2017; Nancekivell et al., 2020). Indeed, it is hard not to be skeptical about many of these meta-analyses (and their underlying studies). We have coded and pored over the details in 2,500 meta-analyses and there is not another influence that is marked by such poor quality—too few studies that met minimum acceptability criteria of quality within the meta-analyses, incorrect calculations, too much overstatement, poor items and assessments, low validity, negligible impact on practice, and too much advocacy aimed at marketing and commercial ends.

Given the above, there is no support for the matching claim that students with different learning styles need different forms of teaching matched to their style. In reviewing the literature for this paper, we identified eight major confounding factors that have contributed to the persistent ambiguity surrounding learning styles. These factors highlight the need for careful consideration by researchers, whether they aim to support or critique the concept.

Confound 1. Must Not Confuse Matching with Correlates

As we have discussed, there are two distinct types of meta-analyses on learning styles; those that test the matching hypothesis and those that evaluate the correlates of learning styles. The two groups effectively measure different things: do students do better when taught to their preferred learning style (the *d*-studies) and is there a correlation between a learning style and academic outcomes (the *r*-studies)? In the first instance, with a negligible overall weighted effect size ($d = 0.04$), there is clear and strong evidence that there is little to no impact of matching teaching with the preferred learning style. In the second instance, while there is evidence of an overall modest relationship between self-reported learning and achievement ($r = 0.24$), it is important to remember that correlation does not imply causation, unless certain robust design conditions are met (Pearl, 2009).

Confound 2. Allusions to Aptitude-Treatment-Interaction (ATI) Research

There is a long history of seeking characteristics of students and relating these to teaching methods. One just needs to look at the attribute-treatment interaction research, which seeks to identify interactions between educational treatment/interventions and student aptitudes to nurture optimal learning environments within which the treatments/interventions align with student attitudes. The now 50-year-old conclusions by Cronbach and Snow (1977) remain supported: many ATI combinations are complex and difficult to demonstrate clearly, and "well-substantiated findings regarding ATI are scarce" (p. 6). They did note that those with superior intellectual development learn better than their peers mainly due to their self-confidence, logical schemata, analytic attitude, stored aids to meditation, effective learning tactics, etc. This leads to the conclusion that teaching these skills may need to be more explicit to those with less intellectual development.

Confound 3. Seductive Desire to Overclaim the Power of Teaching for Individual Differences

The appeal of learning styles may stem from educators' and parents' desire for children to be recognized as unique individuals. This leads to the expectation that teachers provide personalized instruction to address each child's specific needs. The fundamental assumption of the well-accepted model of individual differences is that all individuals differ in their behavior and personal qualities, which should be accommodated in the classroom. However, there are also commonalities; the differences and similarities can vary by subject, task, and motivation, and there seems to be no case for claiming individual differences in learning styles. Dehaene (2021, pp. 240–241) noted that "the idea that each of us has a distinct learning style is a myth. Brain imaging shows that we all rely on very similar brain circuits and learning

rules. The brain circuits for reading and mathematics are the same in each of us, give or take a few millimeters—even in blind children. We all face similar hurdles in learning, and the same teaching methods can surmount them."

Many have focused on "learner centeredness" or individualized instruction as the core of these claims. It seems a truism that each of us is different, but the false implication is that each learner needs a tailored, personalized, individualistic teaching model. We applaud the power of technologies to tailor, adapt, and work for individuals, and we cannot ignore that we are social beings, learn much together, and students have many attributes in common. Visible Learning Meta^X shows the low effects of individualized programs: Individual instruction $d=0.24$, one-on-one laptops $d=0.16$ compared to cooperative learning $d=0.55$, and collaborative learning $d=0.46$.

Confound 4. Seductive Desire to Find Beliefs that All Students Can Learn and be High Achievers

Classrooms can be unpleasant, nasty, and brutal for many who are not winners in the current grammar of schooling. Wherever there is an emphasis on high achievement, high standards, and rigorous curricula, there needs to be the realization that not all students will be "above average" (other than in Lake Wobegon). All students, however, can progress over a year in their learning, leading to higher achievement than at the start of the year. Teachers, who are fundamentally disposed to finding the best in every student, can adopt models of teaching and learning that make these learning advances. There are many alternatives to learning styles. For example, we can teach students to have the confidence to take on challenges ($d=0.67$), develop self-control ($d=0.66$), be open to experiences ($d=0.51$), feel they belong in a learning environment ($d=0.45$), and enhance curiosity ($d=0.74$). Teaching also needs to optimize individual and collaborative methods, be aligned to the nature of the task (facts, ideas, and concepts compared to problem-solving, reasoning, and connecting ideas), and be attentive to the impact of the teaching on the learning (Hattie et al., 2024). All students can be great learners and improve their current attainment.

Confound 5. An Overreliance on Self-Reports

One of the dilemmas is that learning occurs "in the brain" or "within the person"—it is not visible, it is often not transparently known to the learner, and it is often situationally specific. We may hear but cannot see learning. Asking people about how they learn, think, and solve problems to build learning models has long been a holy grail for researchers. Teachers also have very strong theories of teaching but are far more opaque about their theories of learning. All the learning styles literature is based on self-reports or teachers observing student learning and inducing how students think and learn. There are too few think-aloud or experimental approaches, and this is the case not only for the learning styles but also for many of the learning

strategies in research. As noted in the snippet at the start of this article, it is easy to move from discussions about how we learn to preferred ways of learning!

Pashler et al. (2008) have noted, "There is growing evidence that people hold beliefs about how they learn that are faulty in various ways, which frequently lead people to manage their own learning and teach others in nonoptimal ways" (p. 117). Further to this, Riener and Willingham (2010) have suggested that confirmation bias is a contributing factor in the acceptance of the learning styles hypothesis, and additionally, that the learning style hypothesis has gained the status of "common knowledge" (p. 35), which may lead instructors to view it positively, despite stronger evidence to the contrary.

Confound 6. Confusing Learning Styles with Learning Strategies

When students tackle a problem, they use strategies, engage in error detection, and want feedback about their success (or not). One way to view learning styles is that some of the studies included are more correctly considered as focusing on learning strategies (e.g., Phillips et al., 2016). For example, Cano-Garcia and Justicia-Justicia (1994) administered various strategies and style questionnaires to 991 university students. These included the Learning Styles Inventory (Kolb, 1971), the Learning and Study Strategies Inventory (Weinstein, 1987), the Inventory of Learning Processes (Schmeck et al., 1977), and the Approaches to Studying Inventory (Entwistle & Ramsden, 1983). The four Kolb scales did not load on any learning strategy factors, leading them to abandon them. The request is to move the debate to discussions about optimal learning strategies, how they can be taught in context, and the differential impact of learning strategies (Hattie et al., 2024).

The notion of learning styles parallels some learning models, such as the dual coding model (Cuevas, 2015; Dinsmore et al., 2022). Dual coding theory proposes that information is processed by the mind contemporaneously through verbal and non-verbal channels (Paivio, 1971). Accordingly, if a student is provided complementary non-verbal (i.e., visual) and verbal (i.e., written or spoken) information it improves learning outcomes (see Mayer & Anderson, 1991). For instance, when teaching fractions, the dual coding hypothesis suggests that students benefit from simultaneously seeing and hearing or reading information about fractions when the information is complementary (also see Clark & Paivio, 1991; Sadoski & Krasny, 2018). While there are parallels between dual coding and learning styles, they are not the same and there is, indeed, a very real potential for false conflation. Unlike the concept of learning styles, which assumes the effectiveness of tailoring instruction to a learner's preferred modality (the matching hypothesis), dual coding posits that all learners, regardless of their preferences, achieve optimal learning when complementary non-verbal and verbal information is presented together in a focused, distraction-free environment. It is both verbal and non-verbal, not either.

Multimedia learning theory is another complementary but well-supported parallel (Mayer, 2024). This theory, which builds on dual coding and Sweller's Cognitive Load theory, posits that learning will be enhanced by decreasing extraneous processing and managing essential processing strategies (Mayer,

2017). However, unlike learning styles, multimedia learning theory suggests that presented information must complement and not detract from one another. For example, in a series of studies, Mayer and colleagues (2019) found that narrated PowerPoints in which auditory and visual information were synced were more meaningful for immediate and future learning outcomes than when just auditory or visual information was given. Further, importantly, the worst outcomes occurred when the auditory and visual information were out of sync.

It is also important to note the importance of prior knowledge in discussions about learning strategies. Prior knowledge (or lack of knowledge, misconceptions) plays a crucial role in effective learning strategies, serving as the foundation upon which new information is built. When students connect new concepts to what they already know, they deepen understanding, enhance retention, and improve their ability to apply knowledge in different contexts. Activating prior knowledge helps learners recognize patterns, make meaningful connections, and bridge gaps in understanding, making learning more efficient and engaging. Without this foundation, new information can seem abstract or disconnected, increasing cognitive load and making it harder to process. Effective teaching strategies, therefore, intentionally assess and activate students' prior knowledge through discussion, questioning, and scaffolding techniques to maximize learning outcomes.

Confound 7. Ignoring the Dangers of Labeling

We love to "label" as this helps organize complexity, invites similarities among individuals, helps make more predictions, is a shorthand way to communicate complex attributes of individuals, and provides a sense of order so that we can refine our teaching to these "labeled" students. Such diagnosis is the essence, for example, in medicine before implementation of remediation, but in schools too often the labeling is the endpoint. Students need to be offered differentiated activities to maximize their engagement and learning. The label becomes a reason "why the student(s) cannot," and this is indefensible (see Rubie-Davies & Hattie, 2024).

The use of learning styles has led to such adverse effects of labeling. Sun et al. (2023) conducted three studies that showed that "parents, teachers, and children judged children described as visual learners as more intelligent than children described as hands-on learners" (p. 46). Additionally, visual learners were expected to excel in core subjects like mathematics, language arts, and social sciences, whereas hands-on learners were predicted to perform better in more practical subjects such as physical education and music. Science was an exception, with both groups anticipated to achieve similar results. Rubie-Davis (personal communication), as part of her interviews about teacher expectations, noted that teachers primarily referred to kinaesthetic learning styles when referring to low achievers, whereas high achievers were deemed visual or verbal.

Why Does the Belief in the Discredited Concept of Learning Styles Persist?

The re-emergence of learning styles (perhaps they have never gone away) is concerning despite the overwhelming evidence of their mythical status, the lack of evidence for the matching hypothesis, and the copious articles showing the poverty of the idea. We have shown that the move to correlate learning styles with achievement is somewhat sensible (particularly given the use of verbal styles), and the cross-over with learning strategies has meant that the more recent meta-analyses have effect-sizes that look worthwhile. But the jump within meta-analyses in their conclusions to support the matching hypothesis or even the use of learning styles is not warranted. So why do learning styles remain seductive, particularly in these "evidence based" times?

Evidence is a slippery term, as it can refer to published articles in learned Journals, evidence from experience in the classroom by teachers, evidence by students as to their engagement, motivation, and progress, evidence from assessment data (interpreted correctly or not), evidence from student work samples, evidence from classroom observation, evidence from technology and digital tools, and so on. Such evidence may or may not be interpreted correctly, or at all. In this case, the evidence from the research articles is overwhelming, but the evidence from educators' sources of evidence is contrary. As Brown (2023) noted, William James (1896), in *The will to believe*, argued that when evidence cannot definitively resolve a question and the decision is momentous and forced, it is rational and justified to let personal faith or passion guide belief. Defense can also be garnered from some of the state-sponsored evidence bases that defend learning styles (e.g., ERIC, Victorian Department of Education; see also Newton et al., 2021; and see the damning statements in What Works Clearinghouse, Education Endowment Toolkit, Visible Learning, and National Center for education Statistics). A fundamental concern is the lack of translation of the systematic research evidence against learning styles into teachers' beliefs, classroom practices, and education policies.

The main reasons for learning styles remaining popular are: Individualization, uniqueness, personalization, preference, bias, adaptiveness, complexity, simplicity, differentiation, promotion, brain-seduction, and commercialism.

- Our continual quest for individualization, acknowledgment that every learner is unique, and desire to personalize teaching to each student invokes a sense of tailoring instruction to the student's way of learning.
- We struggle to engage in a language of learning, and as we noted at the start of this article, when asked about "how we learn" we often fall back to our preferred (first) method of how we learn. We recall situations when certain ways of learning seemed to work, thus reinforcing a belief in tailored teaching to our preferred style.
- We have biases and selectively recall instances supporting learning styles while ignoring disconfirming evidence. We often forget that great learners are

adaptive, and switch and modify how they learn in light of experience, error management, and feedback. When we recall our own learning, we forget the struggle of learning, the often many false starts and leads, the involvement of others (teachers, books, peers), and the effect of feedback, and this forgetting leads us to confirm our belief we learn in a particular way.

- Learning is complex, yet learning styles offer a simplified framework that feels actionable and manageable. We naturally gravitate toward straightforward solutions, even when the reality is far more nuanced. The idea of learning styles creates the illusion of easier lesson planning and provides a perceived method for differentiation. Learning styles are everywhere, and as noted in the literature review, still widely believed. They are still promoted in teacher education programs, popular psychology, and many evidence bases (e.g., the meta-analyses reviewed in this article) can be (mis-)used to support these styles.
- Learning styles are often introduced with allusions to brain science. Such neurophilia (Pasquinelli, 2012), neuroevangelists, or cerebral crusaders make seductive over-claims but have "scientific appeal" (Zrudlo, 2023).
- A commercial juggernaut promotes tests, reports, books, blogs, training, and software relating to learning styles and the matching hypothesis.

Despite the strength of the evidence-based movement, there is clearly more work to do as learning styles keep reemerging, misinformation spreading, and false-truths abundant.

Replacing Learning Styles with Cognitive Styles?

Zhang (2017) and Sternberg and Grigorenko (1995) critiqued the VARK model as "activity-centered," categorizing learners by sensory preferences rather than cognitive processes or cognitive flexibility. Zhang advocates for intellectual styles that emphasize adaptability and problem-solving over rigid classifications. She identified three intellectual styles: Type I: Highly creative, flexible thinkers who prefer open-ended tasks and perform well in autonomous environments; Type II: Structured, detail-oriented learners who excel in rule-based, organized settings; Type III: Adaptive individuals who switch between Type I and II traits based on context. The claim is that Type I learners are generally more intellectually advanced, preferred by teachers, and outperform Type II peers in conceptual learning. However, Type II learners may perform better on structured assessments. Type III learners' success depends on their ability to select the right strategies for each task.

Pashler et al. (2008) argued that intellectual styles can be misleading without robust evidence for effectiveness, possibly diverting attention and resources from more universally effective instructional strategies. Similarly, Coffield et al. (2004) found weak empirical support, questionable validity, and the overlapping with many other cognitive or personality traits makes it challenging to discern cognitive styles unique influence on learning. Kozhevnikov et al. (2014) argued that intellectual styles are defined too broadly, capturing an unclear mix of attributes, often compounding cognitive styles, and intellectual or personality traits. Mayer (2024) argued that

intellectual styles do not contribute significantly to instructional design and offer few actionable insights for improving instruction. Instead, there needs to be more focus on identifying effective strategies rather than catering to individual style preferences.

Zhang and Sternberg (2012) have clarified that intellectual styles could be misunderstood or misused if oversimplified, and they are not intended to pigeonhole learners (as intellectual styles are more context-dependent than fixed). They also recognized some confusions and provided much evidence for the superiority of Type I intellectual styles over Type II and II styles. It may have been more convincing if she had used different terms than "styles," which naturally immerses her work in the critique of styles, and instead used Type I, II, and III strategies and dispositions.

Replacing Learning Styles and Cognitive Styles with Learning Strategies

An important message from this article is that a more robust and deeper understanding of various learning strategies—when they work best, how to teach them, how to align different strategies with the depth and complexity of what is being taught—is a more powerful debate to (finally) kill the learning style myths. That is, a focus on how to teach students to self-regulate so they know alternative strategies when their first choices are not effective, how to engage in error management, how to align the optimal learning strategy with the context of the task, and how to articulate and have a language of learning.

Hattie and Donoghue (2016) identified over 400 learning strategies and conducted a meta-synthesis to identify the optimal strategies. This analysis led to a much-reduced set, but the effectiveness of the learning strategies varied depending on when they were used across the learning cycle. For example, organizing and summarizing were powerful when first being introduced to knowledge and facts (surface or "knowing that"); spaced practice, rehearsal, memorization, and deliberate practice were powerful when consolidating this surface learning; relating ideas and seeking clarity when first asked to engage in deeper ('knowing how") learning; self-verbalization and self-questioning when consolidating deeper learning; and identifying similarities and differences and pattern recognition when engaging in transfer of learning (see also Hattie et al., 2024) The development of self-regulation to choose the best strategy seems a critical skill, as is the evaluation of the success of the choice of strategies particularly when the first choice of strategy does not work.

Focusing on developing learning strategies has hints of the matching or meshing hypothesis but does not advocate that particular strategies are related to particular teaching methods or students' preferences. Rather, it has hints of individualization, uniqueness, and personalization, as the choice and use of strategies are decisions for each student. It has hints of preference and bias as some students continue to use the same mostly restricted use of strategies and thus need to be taught other strategies and when to use them. It has hints of adaptiveness, complexity, and simplicity, and has hints of differentiation and promotion as these strategies need to be taught, as does the optimal conditions as to when to use these strategies. There is hardly a hint of commercialism.

Conclusions

Learning style theories have appeal but, relying on them oversimplifies the intricacies of how students learn. Effective teaching requires strategies beyond matching instruction to supposed preferences, instead focusing on adaptable, evidence-based approaches that support learning. Learning is most effective when students develop cognitive and metacognitive strategies tailored to task demands rather than teaching them according to their learning preferences. Shifting away from learning styles toward focusing on developing students' adaptability and problem-solving skills aligns more closely with how learning occurs. Educators can foster a more robust and flexible learning environment by emphasizing critical thinking, self-regulation, and meaningful engagement with content.

There is still no evidence for matching, and as many previous reviewers have noted, we should not perpetuate myths, unsupported claims, and wishful beliefs. The recent surge of interest in promoting the correlates of learning styles is misleading, of little value, and should be resisted. Instead, we need to know more about how each student learns, the learning models of their teachers, the alignment of learning to the complexity and demands of the task, the optimal learning strategies in these situations, and how to teach students error management, effortful learning, and experience the AHA joy of learning.

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Declarations

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