Is learning styles-based instruction effective? A comprehensive analysis of recent research on learning styles

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Abstract
In an influential publication in 2009, a group of cognitive psychologists revealed that there was a lack of empirical evidence supporting the concept of learning styles-based instruction and provided guidelines for the type of research design necessary to verify the learning styles hypothesis. This article examined the literature since 2009 to ascertain whether the void has been filled by rigorous studies designed to test the matching hypothesis and identify interaction effects. Correlational and experimental research recently published on learning styles is reviewed, along with an examination of how the subject is portrayed in teacher education texts. Results revealed that the more methodologically sound studies have tended to refute the hypothesis and that a substantial divide continues to exist, with learning styles instruction enjoying broad acceptance in practice, but the majority of research evidence suggesting that it has no benefit to student learning, deepening questions about its validity.

Keywords
Achievement, cognition, interaction effect, learning styles, matching hypothesis, research-based instruction

Background
Over the last two decades, learning styles instruction has become ubiquitous in public education. It has gained influence and has enjoyed wide acceptance among educators at all levels, parents, and the general public (Pashler et al., 2009). It is prevalent in teacher
education programs, adult education programs (Bishka, 2010), promoted in K-12 schools in many countries (Scott, 2010), and frequently a main attraction at academic conferences. School districts and universities spend millions of dollars each year on assessments, training programs, textbooks, materials, and speakers who advocate for learning styles instruction.

The phrase learning styles refers to the concept that different people prefer to process information in different ways and therefore learn more effectively when they receive instruction in a way that conforms to their preferences (Pashler et al., 2009). The inventories created to measure learning style preferences generally classify learners into different style categories. Since at least the 1960s researchers have hypothesized about aptitude–treatment interactions (ATIs), the idea that a student’s aptitude, in some cases characterized by a student’s preference such as learning style, can interact with a corresponding treatment (instructional approach) to produce an enhanced effect, most commonly purported to be increased learning (Scott, 2010). By the 1970s, the bulk of the empirical research had refuted the most common hypotheses associated with ATIs, yet the idea reemerged a decade later to find unprecedented acceptance and widespread use in the form of learning styles-based instruction. These practices are so widely accepted that they go largely unquestioned (Bishka, 2010). The vast amount of educational time, resources, and funds spent on learning styles would suggest that it is warranted to closely examine the claims behind the practice and the research that supports it.

Pashler et al. (2009) trace the history of learning styles to the Myers–Briggs assessment that became popular in the 1940s and continues to find extensive use today. The Myers–Briggs is commonly used by businesses to make occupational decisions about the suitability of potential employees. The idea that people cluster into categories as conceived by the Myers–Briggs is not strongly supported by research, yet that has not limited its popularity. In essence, there seems to be an appeal for industries and the general public to find out what ‘type of person’ someone is by slotting them into predetermined categories, and this concept has found its way into a wide variety of educational settings.

Other researchers trace the learning styles phenomenon to the much more recent development of Gardner’s concept of multiple intelligences. Gardner initially proposed that there are eight forms of intelligence that all people possess: visual-spatial, verbal-linguistic, logical-mathematical, bodily-kinesthetic, interpersonal, intrapersonal, musical, and naturalistic. Allcock and Hulme (2010) argue that Gardner’s multiple intelligence theory (Gardner, 1991, 1993) has influenced the learning styles approach by advocating matching instruction to students’ preferred learning style. They point out that many teachers are expected to consider all intelligences when lesson planning in order to appeal to students’ learning styles. Fridley and Fridley (2010) also link the expansion of learning styles to Gardner’s hypothesis and emphasize inherent weaknesses in Gardner’s model. While Gardner’s propositions have encountered substantial criticism in the field of psychology due to a lack of empirical support, this analysis will focus only on learning styles, as it has become an extensive field in its own right.

Kolb’s (1984, 1985) inventories are the most commonly used learning styles models in recently published research. The Kolb inventory classifies learners along two dimensions: a preferred mode of perception (concrete or abstract) and a preferred mode of
processing (active experimentation or reflective observation) (Gogus and Gunes, 2011; Pashler et al., 2009; Zacharis, 2011). Based on these categories, it classifies learners into one of the four categories: divergers who favor feeling and watching (concrete, reflective), assimilators who favor thinking and watching (abstract, reflective), convergers who favor thinking and doing (abstract, active), and accommodators who favor feeling and doing (concrete, active). As with other learning styles frameworks, there have been concerns about the validity of the constructs measured in the Kolb inventories as well (Kappe et al., 2009; Martin, 2010).

But while Kolb’s inventories are commonly used in research, the visual/auditory/kinesthetic (VAK) or visual/auditory/read–write/kinesthetic (VARK) is the most common learning styles taxonomy in practice (Bishka, 2010; Fridley and Fridley, 2010; Riener and Willingham, 2010) and has become commonplace at all levels of education and through a wide range of commercial products. VAK/VARK instruments can be found in a wide variety of different forms and can be traced to numerous theorists, but are most commonly associated with Fleming (2001). Scott (2010) suggests that the VAK/VARK model may have taken hold to the extent that it did in educational settings because the categories relate to specific senses and are concrete in comparison to other learning styles models which can appear abstract to the point of ambiguity. But this grounding in our natural senses should also make this model more straightforward to study. For instance, since the premise of the learning styles hypothesis is that matching learning style to instructional mode produces increased learning, for the VAK/VARK models, this would mean matching instruction to students’ sensory functions – a visual learner would be provided visually oriented instruction, an auditory learner would be provided with verbal instruction, and so on. This would seem to be more readily measurable than the more fluid constructs of the Kolb inventory.

Some researchers, however, have questioned the validity and reliability of various learning styles inventories. Fridley and Fridley (2010) argue that VAK instruments have little or no predictive value. They note that according to the learning styles hypothesis, if instruction is matched to students’ learning preferences, then we should see an increase in learning, yet research does not yet support this claim. Scott (2010) points out that factor analyses have shown Kolb’s learning styles inventories to be unreliable, bringing into question the validity of the constructs they purport to measure. Another popular model, Honey and Mumford’s (1986) Learning Style Questionnaire (LSQ) was developed precisely because of concerns about the validity of the Kolb assessments (Kappe et al., 2009). The LSQ identified four types of learners: activists, theorists, pragmatists, and reflectors. But factor analyses have shown the LSQ to have reliability issues as well (Scott, 2010).

However, despite concerns about the validity and the reliability of the measures, the commercial component of the field is so vast that there is little incentive for critical reflection based on objective empirical findings (Bishka, 2010). These commercial entities have been a powerful force behind the propagation of learning styles instruction, a curious dynamic at odds with the reality that educational psychologists, those who are best equipped to study the concept, generally regard it with great skepticism (Scott, 2010). But lay people in the business world, administrators in education, and teachers in the classroom tend to be unfamiliar with psychometric evidence and remain unconvinced.
with it when it is presented to them, instead allowing the marketing of the product to influence their decision-making. Fridley and Fridley (2010) speculate that the expansion of learning styles is mainly due to flourishing professional development programs where educational and commercial goals overlap despite the fact that support for learning styles is sparse in peer-reviewed literature. A number of other researchers have noted the seemingly incongruous dynamic of a highly profitable and thriving learning styles industry on one hand and a lack of empirical support for the method on the other (Kappe al., 2009; Pashler et al., 2009; Rohrer and Pashler, 2012).

**Pashler et al. (2009), the matching hypothesis, and an interaction effect**

Recently, a group of distinguished cognitive psychologists were commissioned to assess the type of evidence that would be required to confirm the learning styles hypothesis and to search for empirical research that met those criteria (Pashler et al., 2009). These researchers concluded that in order for the learning styles hypothesis to be confirmed, numerous well-designed studies would have to test the matching hypothesis and show significant interaction effects. The matching, or meshing, hypothesis implies that students’ learning is enhanced when a mode of instruction is used that matches their learning preference. It is not enough for research to simply show that students may have preferences for certain modes of learning because studies on metacognition have consistently shown that students’ preferences and evaluation of their own learning tend to be highly inaccurate when compared to actual learning. Consistent, replicable evidence of achievement is necessary to justify the cost and effort required to implement learning styles-based instruction.

The criteria Pashler et al. (2009) identified for a study to provide adequate evidence for the learning styles hypothesis are as follows: multiple groups or conditions, random assignment of participants, all subjects must be given the same achievement test, and findings must show a crossover interaction effect where students show higher achievement when they are in a condition in which their learning style matches the instructional mode (i.e. visual learners excel more with visual instruction and auditory learners excel more under auditory conditions such as lecture or discussion) and lower achievement when there is a mismatch. Pashler et al. differentiate between learning preference and ability although they acknowledge that in practice educators make little or no distinction between the two. If learning style is conceived as a proxy for ability, as some researchers have noted is often the case (Scott, 2010), then the hypothesized effect would be classified as an ATI. Aptitude would be represented by the learning style, treatment would be represented by a mode of instruction that matched at least some students’ preferred learning styles, and a significant interaction effect would reveal greater learning in the matched groups.

Having identified the type of research design that would be necessary to validate the learning styles hypothesis, Pashler et al. (2009) set out to find published peer-reviewed studies that met those criteria. Remarkably, even though there is a vast amount of literature on learning styles in the form of books, training materials, practitioner guides, theoretical articles, and so on, only one study could be found that met the criteria and reported
positive results. And that study’s findings were questionable because of a number of methodological issues. In addition, the instructional modes it tested did not correspond to any of the widely promoted learning styles inventories. Pashler’s team could not find one study of sufficient quality that supported any of the learning styles models commonly promoted and marketed to teachers. They did, however, find a number of studies with strong designs that showed negative findings contradicting the learning styles hypothesis. In short, there was almost no research whatsoever that supported the learning styles hypothesis, but there was some high quality research that seemed to refute it. So as of 2009, there was little evidence that learning style-based instruction improves student learning. Pashler et al. came to the conclusion that the application of learning styles instruction is unwarranted given the lack of support for the method.

Since then other researchers have highlighted the need for learning styles proponents to produce rigorous studies showing a significant interaction effect to confirm the matching hypothesis and have emphasized that prior research has failed to do that (Allcock and Hulme, 2010; Bishka, 2010; Martin, 2010). Norman (2009) acknowledges that most research surveys students’ learning styles and then simply makes the assumption that it would be good to tailor instruction to those styles without actually ever testing that assumption. However, he notes, studies that have tested that assumption empirically have almost universally found no effect. He concludes that while learning styles instruction has very broad appeal, it has very little to do with learning. Mayer (2011) similarly argues that learning styles research has persistently lacked rigor and that there has been no evidence that clearly supports the application or practice of learning styles-based instruction. While much has been written about learning styles, very little of it contributes to evidence-based support for the concept.

Two other cognitive psychologists, Riener and Willingham (2010), classify learning styles as a myth. They contend that there is no credible evidence that learning styles exist and that real harm may be done by the education establishment’s continued insistence on implementing instructional methods that we know do not work. While learners have preferences, Riener and Willingham note that when put to the test empirically under controlled conditions, these preferences have no effect in terms of the amount of material learned or the pace of learning. They simply make no difference. And from an instructional point of view, there may be another problem with learning styles. It is not only difficult, but largely ineffective to try to find ways of delivering instruction that are based purely on preference yet independent of content. For instance, it would seem inefficient and unproductive to attempt to teach math through auditory means and music through visual means when other formats match the content better.

Others have expressed concerns that, in addition to a lack of credible empirical evidence, learning styles research has not been grounded in credible psychological concepts (Allcock and Hulme, 2010; Pham, 2012). Instead, studies on the subject have generally been published in periodicals other than psychology journals and have used research designs that do not conform to basic and widely accepted psychological principles. This is a major weakness of the field considering that the learning styles concept is based on assumptions about cognition and is, at its heart, a psychological hypothesis. Kappe et al. (2009) and Rohrer and Pashler (2012) have also questioned the methodology of the bulk learning styles research and contend that little of that research is linked to cognition or
achievement. Fridley and Fridley (2010) illustrate a curious case in which an inordinate number of dissertations focused on learning styles have emerged from the college of education at St. John’s University, yet relatively few were published, presumably because they were unable to pass peer review. So despite the continued prevalence and expansion of the learning styles concept in practice, a number of scholars, researchers, and psychologists have expressed substantial doubts about its validity.

Purpose

The purpose of the investigation detailed in this article was to examine the empirical research on learning styles since 2009 when Pashler et al. published their influential findings. After 2009, when it was revealed that despite its vast popularity there was virtually no empirical research to support the learning styles approach, the expectation was that researchers would rush in to fill that void in the research literature. Because Pashler et al. so clearly laid out a template for how a study should be designed and revealed the criteria necessary to confirm the learning styles hypothesis, researchers would have a blueprint, definitive guidelines for how to design their studies. The current investigation searched for this type of evidence in an attempt to evaluate whether a gap remains between research findings and the methods advocated in pre-service teacher education programs and those practiced in the classroom. Has new evidence, based on rigorous methodology, surfaced to support widespread learning style practices, or does the latest research continue to suggest that learning styles instruction is a misguided and wasteful endeavor? It also went further and examined how learning styles are represented in teacher education textbooks, as this could potentially be one of the causes of the gap between research on the subject and its acceptance in practice.

Texts

The learning styles hypothesis is arguably more important to teacher education than any other field because what tens of thousands of pre-service teachers learn in certification programs and subsequently take with them into the classroom can potentially impact the instruction of millions of k-12 students over the decades they teach. But, like students in other undergraduate fields, undergraduate students in the field of education do the bulk of their assigned readings from textbooks and do not tend to read a great deal of peer-reviewed primary source research studies, which are usually not picked up en masse until the graduate level. For this reason, it is worth briefly examining how learning styles are portrayed in a number of textbooks common to teacher education programs. Both general education texts containing advice for pre-service undergraduate teacher candidates and undergraduate educational psychology texts were included, and their portrayals of the subject of learning styles are contrasted below.

General teacher education texts

All of the general teacher education texts reviewed for this article included sections on learning styles, most commonly in conjunction with a discussion of multiple intelligences,
and presented the topic as a way to differentiate instruction for learners. Some presented information on multiple intelligences and learning styles as if the two were synonymous, flowing seamlessly from one to the other (Hipsky, 2011; Silver et al., 2000). The model that was most frequently described was the sensory-based visual, auditory, kinesthetic, tactile (VAKT) framework (Carjuzaa and Kellough, 2013; Powell, 2012; Smith and Throne, 2009). One text used the 4MAT system in discussing learning styles, a model that encompasses experiences, viewing, doing, and exploring what-if questions (Wormeli, 2007). Another advocated for the Myers–Briggs model for math instruction, which includes mastery, understanding, self-expressive, and interpersonal domains (Smith and Throne, 2009).

Because all of the texts were targeted at training future practitioners, they were heavily focused on practical application in the classroom. Smith and Throne (2009) provide the reader with a reference to an assessment designed to measure multiple intelligences, which is simultaneously listed as a learning styles assessment. The implication is that teachers should test students for learning style preferences so that they can modify instruction to conform to those preferences. Likewise, Powell (2012) suggests that teachers incorporate multiple intelligences and learning styles information into their instructional plans. Carjuzaa and Kellough (2013) also recommend that teachers should take learning styles into account and plan instruction based on them. Hipsky (2011) provides suggestions for different ways for teachers to modify their instruction to conform to students’ learning styles. Learning styles seem to be a foundational aspect of this text, as it is mentioned early and much of the advice that follows throughout the book branches from the idea that instruction should be differentiated according to students’ learning styles. Silver et al. (2000) argue that when designing performance assessments for the classroom, the four learning styles should be integrated with the seven multiple intelligences. So, for instance, for verbal-linguistic intelligence, teachers would offer a separate assignment relating to each of the four VAKT learning styles. Presumably, the same would be done for logical-mathematical, spatial, kinesthetic, musical, interpersonal, intrapersonal, and naturalist forms of learning.

In order to justify their advocacy for incorporating learning styles-based instruction into teaching practice, a number of the authors make a variety of strong claims in their texts. Carjuzaa and Kellough (2013) make the case that learning modalities influence students’ academic learning and that teaching to these modalities has been shown to increase academic achievement, a very tenuous assertion based on the empirical research we now have. In reference to learning styles instruction, Wormeli (2007) states that the ‘single greatest tool you have as a teacher is your knowledge about how the mind works’ (p. 75). Smith and Throne (2009) describe multiple intelligences and learning styles as ‘brain-based predispositions’ (p. 90). In describing learning styles as ‘how the mind works’, it suggests that the hypothesis has been confirmed as part of the human cognitive process. In using the term ‘brain-based predispositions’, it suggests that the learning styles hypothesis is based on a biological reality, that some identified neurological structure guides learning in a way these authors describe. Again, these assumptions are not supported by current research in the field.

Considering that these texts make a number of substantial claims and advise teachers to deliver instruction that conforms to the learning styles hypothesis, the evidence they
present for the concept becomes highly relevant. Yet, almost none of these texts referred to peer-reviewed research on the subject. Powell (2012) did not mention anything about the empirical support or lack thereof for the models advocated. Wormeli (2007) did not discuss the status of empirical research behind the theories or provide critical analysis. Likewise, Smith and Throne (2009) made no mention of empirical research or doubts about the efficacy of the methods. Carjuzaa and Kellough (2013) discussed a handful of theorists on the topic but did not mention doubts about the validity of the method or any information about empirical research on the matter. Instead, they presented the information as if it was widely accepted and verified. Silver et al. (2000) cited theoretical sources, most often books. Very few empirical studies were mentioned, and those that were discussed were comprised of survey research that gauged student preferences, not learning. The text was entirely devoid of any mention of empirical studies that showed that the learning styles approach could have a positive impact on student learning. The authors discussed the topic as if the hypothesis had been confirmed. Hipsky (2011) also discussed learning styles as if the matter is settled and accepted by consensus with no mention of doubts among researchers or controversy in the literature. It is worth noting that none of the authors of these texts appear to have a background in cognitive psychology, educational psychology, or neuroscience, the fields most well-equipped to delve into the legitimacy of the learning styles hypothesis.

The evolution of textbooks’ treatment of learning styles can be illustrated through two interesting cases: one in which a current version actually expanded its discussion of the topic and one in which the treatment of the topic changed dramatically in a more recent work. In a 2010 version of an undergraduate, pre-service teacher education textbook, the authors explain learning styles in terms of individual differences (Parkay and Stanford, 2010). They acknowledge that critics have pointed out that there is little evidence to support the idea of learning styles or the validity of learning styles assessments. Yet the authors still argue that teachers should identify students’ learning styles and tailor instruction to conform to those styles. The following edition of the same text has virtually the same wording but expands on the section dealing with multiple intelligences (Parkay, 2013). In contrast, in a 2001 textbook, a prominent education author, Tomlinson, mentions both multiple intelligences and learning styles in the ‘How To’s of Planning Lessons’ section. Both are discussed matter-of-factly, with the text suggesting that they are accurate models of cognition that should be applied to student learning. It then goes on to describe ways that teachers can tailor instruction to address students’ learning styles. No mention is made of doubts concerning the method or of research that may reject the concept. In a subsequent text written by the same author after the publication of Pashler et al. (2009), the new text did not appear to mention multiple intelligences or learning styles at all (Tomlinson and Imbeau, 2010). Instead, it tended to focus on issues such as planning, organization, structure, environment, and so on rather than cognitive or ‘brain-based’ methods of instruction. This may reflect a realization that current research does not support claims that had been made previously.

On the whole, the general education texts were likely to include discussions on the subject of learning styles and also to advocate for applying the method in the classroom. Yet they did not support their claims by referencing research, nor were they likely to make any mention of the studies that have called the concept into question. They
essentially asserted that learning styles instruction was a valid concept and encouraged pre-service teachers to incorporate it into instruction without providing evidence to substantiate those assertions.

**Educational psychology texts**

In contrast to the way learning styles are depicted in general education textbooks, undergraduate educational psychology texts in general appear to be more measured in their discussion of the topic, with most recent texts making some mention of the research on the subject. For example, Ormond (2012) covers learning styles such as analytic versus holistic and visual versus verbal, yet notes that matching instruction to students’ preferred learning styles does not necessarily have any impact on academic achievement. The text acknowledges that the evidence is sparse and does not advocate for the popular models of learning style instruction such as VAK though neither does it refute their claims. Henson and Eller (2012) give only a cursory mention of learning styles. They do, however, point out that research on the subject has been inconclusive and that teachers should be cautious in implementing such an approach.

Slavin (2012) briefly explains learning styles theories but does note that research has not provided support for an ATI effect. However, later the text makes the case that learning styles affect student achievement, which seems incongruous with the preceding information. Santrock (2011) also only briefly mentions learning styles. This text focuses on two models: impulsive versus reflective and deep versus surface, with no mention of the far more common types such as VAK or Kolb’s. It discusses two common criticisms of learning styles: the low reliability of the styles and poor validity. It discusses multiple intelligences in greater detail, lending more credibility to that hypothesis. However, the author acknowledges that critics have pointed out that the empirical research supporting multiple intelligences is not strong and that research appears to be stronger for the alternate concept of general intelligence.

Bohlin et al. (2012) do not mention learning styles at all. They give detailed explanations of Gardner’s multiple intelligences and Sternberg’s theory of successful intelligence. The authors admit that while Sternberg’s theory is supported by a body of research evidence, there are no published research studies that provide evidence for the validity of Gardner’s hypothesis. Since current thinking on learning styles often stems from Gardner’s hypothesis, it would follow that learning styles instruction may also lack validity. The authors caution educators about implementing any theory that is not supported by research evidence, a responsible position to take and one that did not appear among any of the general education texts reviewed.

While most of the educational psychology texts included only a cursory discussion of learning styles, Woolfolk (2013) provides a relatively in-depth analysis about the concerns associated with learning styles. Woolfolk notes that research has not been able to verify the matching hypothesis and that because a learning styles approach has not been shown to increase achievement its use in education is questionable. The text also discusses how the commercial aspects of the movement have made claims that go far beyond what evidence can support. In a rather blunt assertion, Woolfolk argues that the research behind learning styles is suspect, the measures unreliable, and the claims
inflated but does suggest that there is some value to learning styles, mostly in treating students as individuals and in helping them develop metacognition about their own learning.

Kauchak and Eggen (2011) cover learning styles, focusing on the Dunn model. They do make it clear that research on the issue has been controversial and that researchers have questioned both the validity and efficacy of the learning styles approach. They also admit that the vast majority of studies support the critics. However, they also claim, somewhat paradoxically, that it is important for teachers to adapt their instruction to the learning styles of students and to present information visually, verbally, and tactically. A more recent text by the same authors covers learning styles such as analytic versus holistic and visual versus verbal (Eggen and Kauchak, 2013). Again, it does mention the controversies stirred by a lack of positive findings in the research and the questions concerning the validity and efficacy of learning styles instruction. And again, it also suggests that attention to learning styles can be useful in relating to students and providing them with individualized instruction. In this case, the authors’ treatment of the subject did not appear to change in the more recent edition.

So, there appears to be a substantial difference between how learning styles are portrayed in general teacher education texts and how they are presented in educational psychology texts. The general teacher education texts almost universally portrayed learning styles in a positive light and advocated for learning styles-based instruction in the classroom. And, almost universally, they failed to cite any empirical research to support their claims, mention doubts about the validity of the learning styles hypothesis, or provide a critical analysis based on research findings. In contrast, the educational psychology texts tended to treat the subject with greater skepticism and presented the topic as a sort of curious phenomenon. Each one also discussed the lack of research findings to support learning styles instruction. While a number of them cautioned against the use of such unsupported practices, some also advocated for the inclusion of learning styles instruction nonetheless.

Search criteria

The search for empirical studies on the learning styles hypothesis encompassed a variety of academic, education, and psychology research databases. Out of approximately 1400 articles post-2009 with ‘learning styles’ in the abstract, 31 empirical studies were identified that examined the learning styles concept as it is currently conceptualized. Those studies are discussed below.

Findings

In sifting through the empirical articles, the first trend that stood out was that there seems to be a great deal of research activity on learning styles being conducted in the Middle East and Asia, with much of the published research on the topic coming from Turkey and Iran, specifically. Another interesting trend was that the topic appeared to be popular in medical education, engineering education, and educational technology journals. One unexpected finding was the preponderance of learning styles research that has been
published in predatory journals, sources that charge authors fees to publish their research and have questionable publication standards. One of these journals charged the authors as much as $1100 to publish their work. The decision was made not to cite articles from such journals to avoid lending credibility to them, and if it was determined that a study was published in a pay-to-publish journal it was not included in the 31 studies covered in this review. There were 16 studies omitted for this reason.

It should be noted that the majority of the studies on learning styles published in these predatory journals shared a few characteristics. Most of them tended to be correlational in nature and did not test the matching hypothesis. Instead, they surveyed students on their learning styles and correlated those results with data from some other survey or demographic variable. These studies generally did not include an instructional intervention of any sort. Finally, almost all of the studies published in these predatory journals reported positive findings confirming the notion that learning styles-based instruction is important to student learning despite the fact that the research was not designed to answer such a question.

**Correlational and descriptive research**

The vast majority of the research published recently on learning styles has been correlational in nature. Most of the studies used college students as the sample population, administered a learning styles inventory of some sort, and then ran a correlation analysis comparing the learning styles data to the results of another survey or demographic variables such as gender. Indeed, all of the following correlational research described below was done with college students. This is somewhat concerning because the broadest application of learning styles-based instruction is not at the college level but at the k-12 level, yet few recent studies have focused on k-12 students.

The learning styles inventory most commonly used was some variation of the Kolb inventory. Yenice (2012) administered Kolb’s learning style inventory (LSI) to college students and searched for correlations between those results and gender, age groups, and data based on a second survey, the California Scale of Critical Thinking Disposition. Tumkaya (2012) similarly examined the relationship between data gathered on university students from the Kolb inventory and the Epistemological Beliefs Questionnaire. Muscat and Mollicone (2012) sought to determine learning style preferences in college students using Kolb’s LSI. A revised version of Kolb’s inventory, the LSI-2, was used in an attempt to determine college students’ learning styles and to identify relationships between learning style and gender (Al BuAli et al., 2013). A third version, the LSI-3, was used in one of a number of studies published by researchers in Iran to search for correlations between learning style preference and gender, proficiency level, and achievement scores (Aliakbari and Qasemi, 2012).

Two correlational studies specifically examined the relationship between students’ learning styles based on the Kolb inventory and academic outcomes. Gogus and Gunes (2011) surveyed 418 Turkish undergraduate students using the Kolb LSI and compared the results to achievement data and study skills information collected using a separate survey. They found that none of the four different learning styles (accommodator, diverger, assimilator, or converger) made any contribution to students’ use of effective study
habits or achievement as measured by grade point average (GPA). Likewise, in a separate study, Nguyen and Zhang (2011) failed to find any significant relationships between college students’ responses to the Kolb inventory and course outcomes.

The learning styles assessment that is far more common in practice in public education, the VAK/VARK/VAKT model, was less likely to appear in published research although several studies did utilize this framework. For example, Breckler et al. (2011) asked second language college students in a biology course to predict their learning styles and then compared their responses to the results of a VARK assessment. Katsioloudis and Fantz (2012) also used the VARK questionnaire and sought to determine learning styles in college students and faculty members. They attempted to detect differences between learning styles of students and their professors. In another study published out of Iran, Gholami and Bagheri (2013) used the VAK questionnaire in an attempt to identify the learning styles of college students and investigated differences between learning styles and gender, and also examined relationships between learning styles and problem solving, as measured by a second questionnaire. In research that was strictly descriptive and did not involve the use of inferential statistics, Anu and Anuradha (2012) sought to determine the various learning styles of college students using the VAK questionnaire. They simply surveyed students to determine what their preferred learning styles were and reported the findings in terms of percentages.

The common thread that runs through all of this research is that none of the studies implemented an instructional intervention, nor did they test the validity of learning styles as a construct through factor analysis. They correlated the results of a LSI with some other variable, often a demographic variable. None of them were designed in such a way that they could test the matching hypothesis and, in turn, provide evidence that tailoring instruction to students’ purported learning style improves learning or retention of academic material. These types of studies contribute little to the field because up until now the validity of the central construct that they examine has been an open question.

**Experimental research**

**Experimental research supporting the learning styles hypothesis**

There have been a handful of empirical studies published since 2009 using experimental-type methods that have found some measure of support for the learning styles hypothesis. These studies have varied in the quality of their research designs and the credibility of their findings. Each will be discussed in some detail below, as these are the only recent studies that could be identified that went beyond simple correlational research and found support for the widely held, yet still very tenuous, proposition that tailoring instruction to students’ learning styles improves learning.

In a study published in a medical education journal, Alghasham (2012) used Felder’s LSI to determine whether learning style had an effect on students’ learning behavior. The participants were 70 first-year undergraduate medical students in Saudi Arabia. Alghasham focused on the active and reflective styles and classified each student into one category or the other. Four competencies, or instructional modes, were incorporated into the teaching methods for the course over 5 weeks: independent study, group interaction, reasoning/
problem-solving skills, and active participation. Results revealed that there were differences in the learning behaviors in each of the categories. Active learners used multiple activities to further their learning, while reflective learners relied on multiple types of reading materials that they studied on their own. Active learners communicated more during group work, while reflective learners listened more intently to others. Active learners formulated a greater variety of novel solutions in problem-solving activities, while reflective learners tended to draw more on previously acquired information.

While clear differences in the behavior of the medical students during the learning activities seemed to emerge, the findings revealed no differences in overall learning (Alghasham, 2012). On assessments of course content, active learners scored better on two of the five assessments and reflective learners scored better on two. There was no difference on the fifth assessment. The matching hypothesis was not actually tested in this study because all students were exposed to the same instruction, and no true invention was implemented.

Learning styles research has been popular in the field of educational technology, most likely because technology may expand the possibilities for delivering content in a variety of modes. Popescu (2010) recently reported positive findings for the learning styles hypothesis as a result of applying a web-based learning system. Instead of using one of the many learning styles inventories in existence, Popescu created a learning styles assessment that combined the constructs from many different learning styles questionnaires: visual versus verbal, abstract versus concrete, field dependence versus field independence, deductive versus inductive reasoning, synthesis versus analysis, motivation, persistence, pacing, social aspects, and affectivity versus thinking. A number of these, such as motivation, persistence, and social aspects, do not closely align with the more prevalent learning styles models and instead are more commonly studied in their own right in broader areas of psychology. No data on the reliability of the new instrument or factor analysis were provided.

The 64 undergraduates were divided into two groups: one that learned via instruction intended to match the students’ learning styles and one that learned via instruction that was mismatched to the students’ learning styles (Popescu, 2010). The matched condition produced increased learning efficiency in terms of time and necessary resources but did not produce increased gains in achievement, that is, more learning. Details of the analysis or results of the academic assessments were not included in the article, and instead the results section focused almost entirely on a questionnaire students completed at the end of the study that gauged students preferences and perceptions of the instruction. While potentially interesting theoretically, this type of survey instrument that measures affective traits cannot provide evidence for the matching hypothesis, and the specifics of the academic findings that could speak to the quality of learning were not reported in this study. Therefore, this particular study could not contribute to verifying the validity of the learning styles hypothesis.

In another study published in the field of educational technology, Hung (2012) sought to test the matching hypothesis with 98 Taiwanese program design students using web-based education systems over an 18-week semester. The study used the Felder and Silverman (1988) model that includes five dimensions: processing (active/reflective), perception (sensing/intuitive), input (visual/verbal), understanding (sequential/global),
and organization (inductive/deductive). Hung (2012) focused on only two styles, input-oriented and perception-oriented, because a previous survey had suggested that students with these styles performed more poorly in program design courses. For students who were identified as input-oriented (visual/verbal), a diagram-based instructional method was adopted. This seemed an appropriate match theoretically given the description of the dimension. For students who were identified as perception-oriented (sensing/intuitive), an analogy-based instructional method was adopted. Descriptors for the perception-oriented category were numerous and broad so that many, if not most people, would identify with some of the characteristics. For this reason, it was difficult to see a clear, justifiable link between the perception-oriented dimension and the analogy instructional method that was chosen as a match for that learning style. A third group, the control, was described as having ‘unidentified’ learning styles. It was not clear whether this group contained an equal mixture of students with the five dimensions or if it was skewed and included a higher ratio of one or some of the types. Very little was reported about the sample or teaching methods beyond what is stated here.

Students in the three groups were given a pre-test, three midterm tests, and a post-test (Hung, 2012). A two-way analysis of covariance (ANCOVA) was used to examine ATI effects between learning style and instructional method. Interestingly, significant interaction effects were found on the post-test scores for both experimental groups. Students with the perception-oriented style who were exposed to analogy-based instruction performed better than those who did not receive that type of instruction, while students with the input-oriented style who were exposed to diagrammatic-based instruction performed better than those who were not. While the results do seem to support the Felder and Silverman model to some extent, it must be noted that it only tested two of its five dimensions. Dual-coding theory may explain the input-oriented students’ success with the diagram instruction as well or better than learning style. The strongest performance was shown by the perception-oriented group when they were matched with analogy-based instruction, but as mentioned, because of the broad nature of the perception-oriented criteria the link to analogy-based instruction seemed somewhat precarious.

The study also did not report important information about the procedures (Hung, 2012). In addition to other important details, it was not clear whether the experimental groups were homogenous and only contained students of a single learning style or if they were heterogeneous and contained students with a variety of styles. The authors did state that ‘each student underwent instruction through a teaching method matched to their learning style’ (p. 417), suggesting a homogenous structure, but tables included in the study seemed to indicate that students in each of the three conditions also received instruction that was not matched to their learning style. This, and the fact that the students in the control group were described as having unidentified learning styles, left some obscurity in regard to the validity of the results although the findings did appear to be more interesting than much of the other available research on the topic.

Another study from the field of educational technology also tested the matching hypothesis, but with 39 Taiwanese fifth-grade students (Hsieh et al., 2011). The researchers used Felder and Soloman’s (1997) Index of Learning Styles which categorizes students into two learning styles: active or reflective. Two classes were involved, both taught by the same two teachers. Pre- and post-tests were administered, with each test
comprised of a single open-ended essay-type question. A rating scale was used to assess
the students’ work, and the authors reported strong inter-rater reliability of .97 for the
pre-test and .99 for the post-test. The intervention consisted of a single lesson, most of
which was delivered via personal digital assistants (PDA). Then the active class brain-
stormed as a group for 15 minutes, and the reflective class received instruction and
prompts for 10 minutes on their PDAs before being asked to summarize for 5 minutes.

Hsieh et al. (2011) controlled for prior knowledge using ANCOVA. A significant
interaction effect did emerge, with reflective learners’ gains being significantly higher
when they were taught via reflective means, such as instruction and recall, and the active
learners’ gains being significantly higher when they were taught via active means such
as brainstorming. Matched groups learned significantly more than mismatched groups.
The researchers concluded that teachers should take learning style into account and
match instruction accordingly. This study did seem to test the matching hypothesis and
appeared to produce positive results supporting the validity of the active/reflective learn-
ing styles and their impact on learning. There were some concerns about the methodol-
ogy, however. The study took place during a single 1-hour lesson, and the instruction for
both groups was identical except for the last 15 minutes of the lesson. The sample size
was also small. It is difficult to make the claim that an intervention that lasted 15 minutes
for a total of 39 students constitutes robust evidence or is indicative of enduring learning.
This study and the results would have to be replicated, preferably with a larger sample
size, multiple lessons, and a longer intervention of at least 2 weeks in order to build a
stronger case for the validity of the findings. In addition, for the purpose of practical
application, the effect sizes would need to be large in order to justify the time and expense
of administering learning styles inventories and tailoring instruction and materials to a
variety of learning styles (Pashler et al., 2009).

Perhaps the strongest and most interesting research on learning styles was published
recently by Mahdjoubi and Akplotsyi (2012). This was one of the few studies that used
the VAK model, the most widely used assessment in schools. The researchers used a
39-item assessment that was made up of 13 items for each of the three learning modalities.
The participants were 151 elementary school students from four schools in the
United Kingdom. The purpose of the study was to test students’ sensitivity to sensory
cues, not academic learning. All students were assessed on their learning style and then
all of them were given the same three tasks to complete, which were designed to
address the three different learning styles. For the visual condition, students completed
a photo-safari. For the auditory condition, students took part in small discussion groups
of 10–15 students lasting about 45 minutes. For the kinesthetic condition, students
wore global positioning system (GPS) loggers for 2 days and were allowed to freely
explore the outdoor environment around the school. All the students were exposed to
all three conditions.

Mahdjoubi and Akplotsyi (2012) found a significant interaction effect that appeared
for all three conditions. Visual learners chose to take more photographs and tended to
gravitate toward more picturesque locations. Auditory learners spoke the most fre-
quently in discussion groups. Kinesthetic learners were the most active during the free
outdoor exploration time. The research used an adequate sample size, was conducted
over the course of multiple school days, and appeared to show clear results suggesting
that VAK learning styles may have some influence on learning behaviors. This study does not provide support for the matching hypothesis because academic learning was not measured, but it does offer some interesting findings that suggest that there may be some validity to the hypothesis that the VAK learning styles are related to learning choices and may have some real-world implications. The implications do not lend themselves to the traditional learning styles approach in which a classroom teacher would attempt to present the same subject matter in a variety of modes based on students’ learning styles in an attempt to have them all learn the same material at an optimum level. Rather these results might have some value in assisting students with choosing academic courses or occupational tracks they would find interest in and for which they might have increased chances of success.

**Experimental research refuting the learning styles hypothesis**

There are also a handful of recent empirical studies that were designed to reveal an interaction effect, if one exists, between students’ learning styles and their instruction, yet were unable to provide evidence for that effect, thereby reinforcing the questions about the validity of the learning styles hypothesis. The quality of these studies varied, much as those supporting the hypothesis did. However, in general the following studies used somewhat stronger research designs than those above and their findings appeared to be more valid, although admittedly, in any study it is typically more likely for the researcher to be forced to accept the null hypothesis than to be able to control enough variables to show causation. And, like those above, the studies that refuted the hypothesis tended to emanate from the field of educational technology and used some type of inventory other than the ubiquitous VAK/VARK models. Interestingly, a number of the researchers whose findings refuted the learning styles hypothesis began their experiments as supporters of the method and continued to argue for a learning styles instructional approach even though their data appeared to contradict that conclusion.

Choi et al. (2009) tested the learning styles hypothesis in an e-learning environment with 70 third-year anesthesiology students from a dental school in South Korea. The purpose of the study was to examine how students’ learning styles influence learning while students solve complex problems. The study used Felder and Soloman’s (1991/1994) Index of Learning Styles Questionnaire, which includes four dimensions: sensing or intuitive, visual or verbal, active or reflective, and sequential or global. All four learning styles were represented evenly. Students completed five complex case problems while working through five learning modules during the 16-week course. The researchers tested for interaction effects between the students’ learning styles and their achievement as measured by their written responses to the case problems. Choi et al. found no significant interaction effects, suggesting that learning styles did not have an influence on students’ problem-solving ability. The researchers concluded that learning styles’ impact on learning outcomes is negligible and that it is more effective to have students adapt to different learning environments than to design instruction to conform to students’ learning styles.

One of the few studies that overtly linked the learning styles hypothesis to Gardner’s multiple intelligence hypothesis was conducted by Allcock and Hulme (2010). The study
used Honey and Mumford’s Learning Styles Questionnaire and one created by the researchers based on Gardner’s work. The purpose was to test the performance of 33 college-level psychology students based on lessons differentiated either by learning style or by ability while controlling for initial achievement levels. The teacher, topics, amount of time for instruction, and tests were all the same for each condition, and all learning styles/intelligences were equally represented. For nine sessions, students were taught via lessons differentiated by either learning style or ability. Students were given tasks matched to their learning style or grouped by learning style, so the researchers did test the matching hypothesis. Only the learning tasks and method of delivery varied between groups.

When the results were analyzed, there were no significant differences based on learning style (Allcock and Hulme, 2010). The test scores were consistently higher for the students who received differentiation by ability than they were for those differentiated by learning style, and those in the ability group improved more from pre-to post-test although not significantly. So both groups improved, but the learning styles instruction did not produce more learning, and actually produced slightly less than the ability group. Therefore, the researchers had to conclude that the improvement was due not to the learning styles approach but simply to being involved in academic work. In fact, students reported the most satisfaction with the one task that was assigned that contrasted with their preferred learning style. The researchers concluded that learning styles-based instruction was not effective and that instructors should carefully consider whether adopting such a method is prudent.

Another recent study examined how learning styles impact course selection and achievement by comparing college students’ outcomes in web-based and face-to-face computer science courses (Zacharis, 2011). The participants were 161 freshmen, 77 of which took the class online while 84 took the class in a traditional format over a 12-week period. Students took part in two 90-minute lectures plus one 2-hour laboratory per week. Students in both conditions had access to all the same materials and took the same assessments. Since all materials were available to all students, Zacharis reasoned that students would gravitate toward the material that fit their particular learning style. The Kolb LSI was administered, and achievement was measured by grades determined by a midterm exam, eight homework assignments, two group projects, and a final exam. Results indicated that students’ learning style did not influence their course selection, so their rationale for taking the course in a specific format had to do with reasons other than learning style. More importantly for this discussion, there were no significant differences in the achievement between the two groups and there was no statistically significant interaction between students’ learning style and method of instruction based on course grades. Zacharis argued that diversifying instruction is useful but acknowledged there is not sufficient evidence to conclude that matching instruction to learning style has an effect on learning or students’ ability to successfully complete a course in either of the two instructional environments.

Kozub (2010) tested the matching hypothesis with 159 undergraduate business school students using two different web-based instruction modules and Kolb’s LSI-2a. One instruction module was in a text-only format and the other provided the same text but also was enhanced with multimedia and interactive components such as games,
pictures, pop-up elaborations, and links to additional information. In-class lectures were also used. Assessments were administered online for the two module conditions and in class for the lecture material. It was posited that if the matching hypothesis was correct, students with different learning styles should perform differently based on the type of instruction they received. Kozub suggested that divergers and accommodators in particular should perform better on the enhanced module. However, there were no significant differences in students’ performance based on the type of program, and the mean test scores for students of different learning styles showed no significant differences. In addition, there were no significant interaction effects between learning style and the type of online instruction the students received. There were also no significant differences on the in-class exam scores due to students’ learning styles, which suggest that students from all four learning styles categories performed equally well when exposed to the lecture-only instruction.

So in this study (Kozub, 2010), learning style appeared to have no impact on how well the students learned the material, regardless of the mode of instruction. Thus, learning style did not have any predictive value in determining how well students learned in any of the three instructional conditions. Furthermore, students’ American College Testing (ACT) composite scores, which were collected in the research as a measure of initial cognitive ability, did predict students’ scores in all three conditions, yet there was no relationship between ACT scores and learning styles. This suggests that learning styles, while possibly an indicator of preference, are not related to measurable cognitive ability. This research provided a relatively well-designed format for testing the matching hypothesis, and the results of a variety of analyses consistently refuted the matching hypothesis and indicated that students with different learning styles learned at similar rates regardless of the mode of instruction.

A three-year longitudinal study focusing on 99 undergraduate students was conducted to test the predictive validity of a LSI using multiple learning criteria (Kappe et al., 2009). The authors noted that Kolb (1984) had proposed that matching the learning environment to students’ learning style would enhance learning, but because Kolb’s LSI had low face validity and other problems, Kappe et al. used Honey and Mumford’s LSQ. The LSQ identified four types of learners: activists, theorists, pragmatists, and reflectors. Students completed the LSQ twice, at the beginning of their first year and end of their third year. Five criterion measures were used: lectures, skills training, group projects, on-the-job training, and written theses. Each of these measures coincided with at least one of the learning styles so Kappe et al. (2009) were able to test the matching hypothesis. Achievement was assessed in each of the five categories via different means: multiple choice and essay exams for lectures, mentors and independent judges for training and projects, and so on.

Kappe et al. (2009) found that the LSQ’s test–retest reliabilities were strong, particularly for a 2-year time period. However, contrary to their expectations, none of the correlations between learning styles and criterion measures were significant. Even though students reliably self-identified their preferred learning style over time, learning style had no validity in predicting achievement outcomes for instruction and assignments matched to that learning style. In other words, no interaction effect between learning style and instruction emerged. The groups that should have performed better on certain
types of tasks based on their learning style did not perform any better on those tasks than those students whose learning style preference contrasted with the type of task. Kappe et al. (2009) admitted that the “most important finding of this study is, in essence, a non finding” (p. 466). Although the researchers designed the tasks to match students’ learning styles, their learning style offered no predictive validity and none of the groups scored significantly better on tasks matched to their learning style. They concluded that measures that assess generalized individual differences are not adequate for explaining performance on tasks that are specific to content or context.

Because the Kolb inventories and, to a lesser degree, Honey and Mumford’s are used so commonly, it is worthwhile to examine the validity of the measures. Martin (2010) did so in a study in the United Kingdom, where learning styles instruction is popular. It was one of the few studies available dealing with students and teachers at the k-12 level. The study examined the results of Kolb’s LSI-2 and Honey and Mumford’s LSQ, which mirror each other closely. It involved four UK secondary schools identified as highly successful schools by governing boards, all heavily invested in learning styles instruction at the institutional level and the classroom level. The schools had much investment in learning styles in terms of time, training, money, and resources for both administrators and teachers. Both LSIs were administered to 16 classes, or 394 total students. No intervention was implemented; instead, factor analyses were conducted to determine the strength of the instruments’ validity and reliability, and qualitative interviews were done with faculty and staff.

Factor analysis showed that the assessments had very poor validity and reliability, so poor in fact that the internal constructs that should have theoretically been related were only found to be related by chance (Martin, 2010). This means that teachers who tried to make judgments about a student’s learning style would likely come to different conclusions about that student depending on which assessment was used. Factor analysis showed that teachers would have had the same quality of information in terms of identifying students’ learning styles if they randomly assigned learning styles to students as they would have with the LSI-2 and only slightly better than that for the LSQ. Essentially, if teachers had asked students to pick learning styles labels out of a hat and then based instruction for each student on that randomly chosen label, they would have had about the same level of accuracy as was provided by the two inventories. Clearly, these concerns about both validity and reliability raise serious questions about whether the Kolb LSI-2 or Honey and Mumford LSQ measure legitimate constructs.

The study suggests that teachers could not use these learning styles inventories to improve student learning because the inventories could not actually determine students’ learning styles even if those constructs do exist (Martin, 2010). This would make basing instruction on learning styles fruitless because there is nothing to match the instruction to or no way to tell what should be matched. When this information and critical results from other studies were revealed to the faculty, they were unperturbed by it and said they continued to have confidence in the learning styles approach. Most of the faculty were exposed to the learning styles hypothesis during initial teacher training, but were never exposed to the research that questioned its efficacy or educational value. After they began teaching, they did not explore research on the subject or look into research.
in general. Instead, they were guided by anecdotal experiences about what types of instruction were effective. While the teachers insisted they used a learning styles approach in the classroom based on matching instruction to students’ preferences gleaned from these inventories, when queried about their practices, it was discovered that they used relatively standard teaching methods. Martin suggests that as university instruction for pre-service teachers has moved away from theory and research in recent years to a model based more on placements in schools, subsequent practice has actually declined due to a lack of understanding of theory and research.

One study was identified that used the VARK assessment. Sankey et al. (2011) recruited 60 undergraduate and post-graduate students from Australia to take part in the study. The students’ ages ranged from 17 to 60 years, but they were all high achievers. A multimedia approach was used to deliver six different experimental conditions, each of which received a slightly different instructional intervention. In all, 10 students were included in each condition. Each learning condition was comprised of two students from each of the five learning styles. So, for instance, the 10 students in condition one consisted of two visual, two aural, two read/write, two kinesthetic, and two multimodal learners. The same was true for the other five learning conditions. A pre-test and a post-test were administered to control for prior knowledge. The type of statistical analysis used by the researchers was not revealed, but they reported that the experimental data did not show any significant differences in learning across the six groups based on learning style, that is, there was no interaction effect. The authors acknowledged that their inability to find support for the matching hypothesis was consistent with previous research findings. The researchers also sought to determine whether there was an optimal blend of instructional practices based on learning style preference, but since there were no significant differences in learning performance across the conditions in relation to learning style, this could not be determined. The bulk of the results section in this study was devoted to qualitative data based on students’ perceptions of the instructions, possibly because the experimental data did not yield significant findings.

Despite the lack of evidence to substantiate the matching hypothesis, the authors were supportive of the method nonetheless (Sankey et al., 2011). They suggested that the feedback from students was an indication that learning styles-based instruction would have a positive impact on motivation and therefore would be beneficial to include in instruction. The authors seemed to miss several salient points in this assertion. First, research on metacognition tells us that students are not always the best judges of their academic needs or progress, and that preferences and learning are two different things, constructs that often have little correlation with each other. It is also well established that using a variety of instructional approaches can enhance engagement and motivation. This dynamic has nothing to do with learning styles, as variety simply works to decrease boredom and stimulate interest when students experience different methods in the classroom. The qualitative data were also not uniform and do not show clear delineations according to learning style. And finally, the researchers own experimental data failed to show a positive impact on learning based on the approach. For these reasons, their insistence on recommending the continued use of learning styles instruction did not seem to be consistent with the evidence they collected.
Discussion

Despite a great deal of literature having been published on the concept of learning styles since 2009, the empirical evidence for the validity of the learning styles hypothesis seems to have gotten weaker in recent years. While a number of studies suggest that learning styles may have some impact on behavior, only two (Hsieh et al., 2011; Hung, 2012) reported an interaction effect supporting the matching hypothesis, indicating that learning styles had a positive impact on learning. Neither of these incorporated the ubiquitous VAK/VARK model, and there were substantial limitations in both of the studies. Six studies tested the matching hypothesis in search of an interaction effect yet were unable to find one. These studies tended to be stronger in their designs than those that produced positive results. There may, however, have been other rigorous studies conducted during that time that were never published because they did not produce statistically significant findings, and this could be a weakness of a peer-review system that tends to strongly favor studies that report positive, significant findings. Non-findings tend not to be considered ‘news’. Regardless, had methodologically sound studies been conducted that did show a significant interaction effect, they should have appeared in the research databases, yet none did.

A notable finding in the present investigation was the lack of published research in reputable psychology journals or high-level education journals, where experimental research on learning styles was practically nonexistent. Instead, the studies that reported positive results in regard to learning styles tended to be over-represented in relatively obscure journals and in predatory journals in particular. There was also a great deal of correlational research that could not contribute to verifying learning styles’ effect on student learning or achievement. Another significant finding was an almost complete lack of VAK/VARK studies in the research database. This is very concerning considering that the VAK/VARK framework is the most common model, widely applied in k-12 education and heavily advocated in teacher education programs. Yet, there is a total absence of evidence that the implementation of this framework has any benefit whatsoever to students’ academic learning.

Going beyond instructional interventions, Bishka (2010) makes the case that neuro-imaging shows that the various sensing modalities (visual–auditory–kinesthetic) are actually interlinked in the brain so that they are triggered in unison, suggesting no single mode can operate in isolation. If so, this would further erode the foundations of the learning styles hypothesis and strike a blow to other so-called brain-based hypotheses such as multiple intelligences. Barring a disability, we are all visual learners, just as we are all auditory learners, and we are all kinesthetic learners. And we normally use a combination of senses when learning. Yet, educators have often confused learning styles with cognitive abilities. Learning styles, if they are a valid construct, represent a preference while cognitive abilities represent a capacity or proficiency. Abilities can be measured objectively and with relative accuracy, but self-reported preferences, as we have seen here, are highly subjective and have not been measured reliably or with sufficient validity.

So the question remains as to why learning styles proponents continue to advocate for the method. As Pashler et al. (2009) note, “There is growing evidence that people hold beliefs
about how they learn that are faulty in various ways, which frequently lead people to man
 age their own learning and teach others in non-optimal ways” (p. 117). Even though decades
of research have failed to confirm the learning styles hypothesis, it has not stopped its pro-
liferation among practitioners from preschool to the university level who attempt to apply
the theory in classrooms and administer unreliable tests (Martin, 2010; Scott, 2010). This
constitutes a tremendous waste of valuable and finite learning time, distracting teachers and
students from instructional methods that have been shown to be successful in increasing
learning. One possible answer for the continued propagation of the learning styles approach
is that proponents might simply be unaware of the research evidence. If so, it may under-
mine the credibility of the scholars, educators, researchers, or professors who strongly adva-
ocate for a method without having knowledge of the research base underlying it. Scott argues
that university instructors in teacher education programs should be well aware of the research
that questions, if not directly refutes, the learning styles hypothesis, yet all too often they are
not, as evidenced by its continued expansion in educational circles.

Riener and Willingham (2010) posit that the wide popularity and acceptance of the
learning styles hypothesis is due to confirmation bias, the tendency for people to only
consider support for the perspective they favor, and at this time the hypothesis has
become ‘common knowledge’ in education so instructors may have cause to view it posi-
tively even in the face of stronger contradictory evidence. If this is the case, then advoca-
cates of the model might base their views on the rather superficial theoretical literature
and disregard the more substantial scientific findings of empirical studies. Another pos-
sibility for its continued popularity is that acceptance of the learning styles hypothesis
transfers responsibility for learning from the student to the teacher because if adequate
learning does not transpire a claim can be made that the teacher’s instruction did not
properly conform to the student’s learning style (Pashler et al., 2009). This explanation
corresponds with conventional wisdom in the current era of teacher accountability and
differentiation for students.

So, part of the attraction of learning styles may have to do with parents’ desire to have
their child treated as a unique individual and, as a consequence, require teachers to
deliver individually tailored instruction to meet the child’s needs, which seems intui-
tively appealing (Fridley and Fridley, 2010). However, the irony is that by classifying all
students into several basic categories it may serve to do exactly the opposite by labeling
students as a certain ‘type’ (Pashler et al., 2009) despite the fact that learning styles
instruction is often adopted in the name of tolerance and diversity for different types of
learners. Indeed, at its core, learning styles is about classifying individuals into a handful
of limited categories and treating them differently based on those simple labels (Fridley
and Fridley, 2010). Scott (2010) argues that the concept of learning styles also promotes
an entity view of intelligence, as opposed to an incremental or process view of intelli-
gence. This results in an individual being seen as a certain type of learner by nature
instead of as a complex, changing human being, and essentially creates another way to
label or stereotype students, ultimately limiting them.

Some psychologists contend that real harm may be done by continued insistence on
implementing instructional methods that we know do not work (Fridley and Fridley,
2010; Riener and Willingham, 2010). For instance, it is common for students who have
difficulty in the classroom to be categorized as tactile or kinesthetic learners, which
based on the research evidence is clearly a dubious assumption in terms of both the classification and its instructional ramifications (Scott, 2010). Then interventions are implemented as a result of that questionable categorization instead of teachers conducting a more thorough diagnosis and remediation program founded on more well-substantiated methods that would actually have some chance of helping those struggling students. In essence, despite the good intentions of their teachers, those students are left to flounder due to a hypothesis that may amount to little more than pseudoscience.

**Conclusion**

Education policy has often been driven by fads and the ‘newest’ methods of categorizing students, even in the absence of empirical evidence supporting the efficacy of those methods (Fridley and Fridley, 2010). It should be part of an educator’s professional responsibility to seek to implement instruction that is scientifically supported, or at least to have an understanding of what is and what is not. Just because someone self-reports that they prefer to learn a certain way does not mean that they will learn all concepts best if they are presented in that fashion, regardless of the specific content. Instead, the nature of the subject matter should determine how it is best taught and how it is best learned. Good teachers develop a variety of ways to present their content over the years and treat each student as a unique individual without pigeonholing them into unfounded categories.

One question a reader might have is whether the learning styles hypothesis has by now been debunked. The answer at this point is ‘not completely’. Additional research is always warranted, but correlational and theoretical research on the issue currently has little if any value. Only experimental research that tests the matching hypothesis for interaction effects can meaningfully contribute to the knowledge base at this point. But the learning styles hypothesis has been refuted by empirical research to the extent that it may be considered irresponsible for teacher education programs and public educators to apply the method in practice. When educators insist on advocating for discredited hypotheses that have not been shown to work, it takes the focus off of interventions and instructional strategies that have a stronger scientific basis and are more likely to help learners in their development. There are instructional strategies such as those involving dual-encoding, interleaving, and temporal spacing, for example, that have the potential to positively impact student learning in real terms, yet too often educators waste valuable instructional time on misguided and unsupported models. It appears to be time to put the learning styles approach to rest in practice unless researchers can produce convincing evidence that the hypothesis is a valid one, and that has not begun to happen.

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